Investigating Threshold Concepts in the Learning of Agriculture: Gearing Towards Quality and Relevant Curriculum Innovation

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A thesis submitted in total fulfilment of the requirements for the degree of

Doctor of Philosophy
in Education (Curriculum Innovation)

School of Education, Communication and Language Sciences

Faculty of Humanities & Social Sciences

Newcastle University

November 2014

Abstract

Agricultural education in Brunei Darussalam is torn between apparently conflicting patterns. There seems to be an economic agenda where policy makers attempt to make educational outcomes match national priorities. Worldwide, agriculture is being confronted by a globalised economy and market reforms. However, agriculture as a subject in schools is also confronting the issues of quality education. Quality education is the number one goal of Brunei's national education system; but how do we address quality in learning, in a prescribed curriculum?

In pursuit of that quality, this study explores what concepts in agriculture learning lead to higher levels of understanding, is there progression, and how do students arrive at their understanding?

This multicase study draws on data from secondary education students studying agriculture during 2009 – 2010. It uses the threshold concepts framework as an analytical tool for understanding students' learning and for exploring their personal experiences (and insights into their phenomenological reflections) based on interview data (n=7) and questionnaires (N=19), corroborated/triangulated by teachers' data (questionnaires n=14, interviews n=2) and other documents to inform future curriculum innovation. The methodological approach is phenomenological, interpretive, descriptive and qualitative, using four stages of Interpretative Phenomenological Analysis (IPA) supplemented with some quantitative analysis.

The threshold concept constituents that were discovered are very diverse, ranging from skills, science, business, research and management; but *planting* is the key. Eleven super-ordinate themes illuminated two stages of threshold understanding: *planting and plant science* at the crop production level; and *research, business and management* at the commercial level. The findings showed the importance of phenomenological experiences: *feelings* associated with sweat, yields and money generation, emanated from a sense of agency and affective labour, paving the way to power of purpose towards self and socio-economy. Understanding the importance and merits of their learning activities made students reflected their meaning and positive feelings about themselves and self-worth. This motivated them to achieve further learning goals.

Agricultural learning transformation seems to come through a combination of knowledge-based understanding in plants, and how they grow, alongside the *experience* of planting and growing crops successfully. Importantly, it is not just the knowledge about planting that the students get from the experience, but it is the *feelings* (emotion) that seemed to emerge from their words of sweating under the sun that helps to consolidate that knowledge into something which becomes part of their identity.

This study's findings about lower level agriculture learning seem to leverage on experiences to create bigger learning outcomes prior to mastery in the discipline. Transformative learning occurred when learners studied through situated contextual experiential activities, providing affective embodiment and thinking like agriculturists.

Thus agricultural understanding and transformation was triggered by *experiential threshold concepts* whose foundations arise from integration of personal, *emotional affective feelings* and everyday experiences with ideas from discipline. Emotional feelings (associated with phenomenal experiences) provide an added dimension to the 'basic threshold concept' work by Davies and Mangan (2008:39), 'where newly met concepts some of which transform understanding of everyday experience through integration of personal experience with ideas from discipline'. These results reveal a new perspective on threshold concepts work, particularly relevant to disciplines involving process skills and experiences, especially for agriculture.

The findings serve as key indicators to progression and quality learning outcomes. They also offer useful implications for a quality curriculum in agriculture which fosters personal identity transformation, so more students become future agriculturists and thereby will help the economy. Of foremost importance is to include, in the curriculum, the key threshold concepts capable of transforming understanding and how to teach these concepts through meaningful/engaging experiences (via practicality and doing project-evidence/outcome-based learning), and provision of connections and relationships. The key to quality in the agriculture curriculum is therefore, how to translate and teach these concepts into meaningful affective learning experiences.

Declarations

This is to declare that this thesis and the research work undertaken are to the best of my ability as the true copy and of my original work.

I also certify to the best of my knowledge that all the materials presented in this thesis are my own work and that no material offered has been previously submitted for any other award or qualification.

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Dedications

Foremost dedicated to :

My beloved and peaceful country Brunei Darussalam, and its people.

My loving family and parents, for being my greatest source of constant inspiration and motivation.

Acknowledgements

بِسْمِ اللَّهِ الرَّحْمَٰنِ الرَّحِيمِ *In the Name of God, Most Gracious, Most Merciful*

My utmost gratitude and appreciation goes to His Majesty's Government of Brunei Darussalam for this sponsorship to further my studies at the doctorate level. I am indebted to my employer the Universiti Brunei Darussalam (UBD), the Dean and the Faculty of Sultan Hassanal Bolkiah Institute of Education (SHBIE) for this golden opportunity. Not forgetting, the staff at the UBD Personnel Department and the strong support provided towards me. Enormous thanks are also due to the High Commission of Brunei Darussalam in London for any assistance rendered towards me and my family during our four year stay in the United Kingdom from September 2008 to 2012.

This case study could not have been materialised without the guidance and support of various people. In particular, I thank my two supervisors to whom I am hugely indebted – Professor David J. K. Leat (Professor of Curriculum Innovation, the Executive Director of the Research Centre for Learning and Teaching (CfLaT), Newcastle University) and Dr Pamela J. Woolner (Lecturer in Education), for their valuable advice, expert criticism, patience and encouragement provided throughout and towards the completion of this study. It would have been extremely difficult traversing this PhD journey without their continuous attentions and interest. My thanks are also due to my previous supervisor, Professor Ann R. J. Briggs, for her comments on my earlier work and in her understanding of my passion about agriculture education before her retirement and migration to New Zealand in summer 2009.

I would also like to express my sincere appreciation to the various schools and departments that offer agriculture subjects and the cooperation given by the respective principals and teachers for their permissions allowing me to conduct research in their institutions. My huge appreciation to the agriculture teachers who allowed me to get insights into their worlds, they truly deserve my admirations. My heartfelt gratitude goes to the students who took part in this research; it was striking how they took pleasure in describing the details of the activities that they enjoyed – which brings a smile to my face every time I reflect on their views. Thank you so much for sharing your joys, interesting thoughts and fascinating experiences! Unquestionably, meeting them and discovering their worlds during my fieldwork, was the most enjoyable and

rewarding experience for me. Without their participation,,this study would not have been illuminated. I sincerely thank them from the bottom of my heart and pray that may they find every success in their future endeavours, whether in agriculture or not.

The solitude and the chance to work uninterrupted were really critical for me; the perseverance, time management and teaching workloads, as well as family obligations, have all added challenges to this PhD study. I am, therefore, deeply thankful and blessed to have the support from caring people around me, especially my beloved husband, daughter, and dearest parents for all their endless love and prayers, continuous companionship and motivation, as well mutual understandings shown throughout these times. I am also indebted to my other family members especially my sisters for their moral support and prayers, encouragement and understanding, as well as from friends and colleagues during these difficult yet challenging and rewarding times in my PhD research study. And above all, it is with great humility and sincerity I thank Lord, the Most Supreme the Most High, for His every mercy and immeasurable blessings bestowed upon me, and for the endowment of knowledge, guidance, inner peace and strength, good health and the best of protection.

Finally, this whole PhD experience was unique, and has been eye-opening for me, both inspirational and exciting. It is almost like overcoming some sort of threshold, in itself, allowing me to celebrate another milestone in my lifelong learning. This study would not do itself justice sitting in an attic accumulating dust. It is a gratifying feeling to achieve greater understanding in my own disciplinary area, despite the gloom of trials and tribulations that tended to dominate the mood. I was greatly humbled by this experience, as I realised that the more I know the more that there is to know. It is a great pleasure to share this study with whoever may be interested: researchers, practitioners, planners, policy-makers alike and the general public. Foremost is the agriculture education community with whom I belong: agriculturists, farmers, stakeholders, educationalists, teachers, students, and parents, as well as any readers with interest. I do hope, however, someone could get benefit from my research no matter how trivial it may be, in one way or another, for I believe there will be no food without agriculture and no agriculture would survive a nation without agriculture education.

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Chapter 1

INTRODUCTION

This chapter aims to explain, against the backdrop of a local context, why this research study on agriculture education was undertaken in relation to the issue of quality and curriculum innovation through my own experiences and personal perspectives. It then discusses the important significance of the study before it finally describes the overall guiding conceptual framework of the research.

1.1 Towards Quality and Relevant Curriculum Innovation

Located on the Island of Borneo in the Southeast Asian region, Brunei Darussalam is a tiny country enjoying wealth from its petroleum revenue. Historically, before the oil boom and for many years until the late 1970's, agriculture was an important occupation for its people. Today, the nation is largely dependent on its petroleum resources. Agriculture is not much relied upon with a purported 80 per cent of its food requirements imported, and therefore there is a lack of self-sufficiency and a threat to national food security.

In view of unprecedented oil resource depletion and an emphasis on the need to create new sources of economic prosperity, the country is relentlessly encouraging its economy to diversify through other sectors, including the agriculture. On 4th March 2008, His Majesty the Sultan of Brunei Darussalam, in his opening address of the 4th State Legislative Council meeting, gave priority to agriculture in raising the country's standard of living and in diversifying the economy. However, over the years the record has shown that agricultural sectors are struggling due to low productivity, strong competitive market prices from neighbouring countries, and a lack of interest from the people. More recently in the wake of the food security issue, there has been more and more emphasis on agricultural sufficiency. Food security issues could be associated with, among others, curriculum content relevance and lack of manpower (Dhlamini, Simelane & Khumalo, 1993:220). They wrote, 'problems hampering the attainment of *food security* are associated with a lack of national manpower plan, financial resources, coordination and cooperation among institutions, and *curriculum content relevance*' (p. 220, emphasis added).

In addition, education must also be sustainable so that the skills and capacities of future generations can guarantee a country's economy as we move progressively into a more knowledge-based socio-economy (World Declaration on Higher Education for the Twenty-First Century: Vision and Action, 1998). To achieve such sustainability of knowledgeable citizens, quality education is becoming increasingly important. According to Brunei Darussalam's Ministry of Education, quality education 'seeks to develop and equip our children morally, intellectually, physically, socially and aesthetically with the right values and skills to become responsible dynamic citizens, who are able to contribute positively to the nation' (Ministry of Education Strategic Plan 2007–2011, 2008:5). Clearly, this broad statement implies that there are also many other values needed in nation-building aside from that of the desired quality of intellect. The insistence of this national focus shows how important quality education is for a small nation like Brunei Darussalam, and this is likely to be equally true for other nations elsewhere.

This study has been undertaken to focus on the curriculum innovation aspect of agricultural subjects in schools. Agriculture is not widely studied since it is offered as optional in secondary schools. Speaking from experience, despite the low student numbers taking it, the critical question is, however, how to teach agriculture so that we can unlock the soil to provide the food we need? On the other hand, we need to teach not just how to grow food for consumption (such as rice), but also how to make money out of it. Modern agriculture is not just all about food production for consumption, but also for business and marketing. In fact, it has turned into a commercial industry. So, how do we unlock the potential in our youth so that these youngsters are inclined to participate in agriculture? As an educator, my personal experience indicates that nothing is more important than what happens in classrooms between teachers and students and that curriculum is one of the important areas of quality. It is the heart of education for teachers to be informed on what to be taught to students, and what is needed to prepare students for the 21st century.

1.2 Rationale and the Research Questions

Agriculture education in Brunei Darussalam is torn between apparently conflicting patterns. There is an economic agenda where policy making attempts to make educational outcomes match national priorities. The national strategic plan (Agro-Vision 2023) aims to support sustainable agricultural activities besides capacity building and stimulate interest in the people. It also aims to propel the agriculture sector from being primary commodity-based to a modern agribusiness through the processing and trading of agricultural products. It hopes to reach an estimated value of B$2.7 billion by 2023. The country would need among other things a skilled workforce with relevant knowledge to help develop agriculture into a modern sector. The government policy has been made, and if this is what the government wants, how then do we get quality agricultural education? Where else can we get this skilled workforce from if not the education sector?

The Brunei Darussalam's National Vision 2035 (or Wawasan 2035) aspires for citizens to be well-educated, highly skilled and highly accomplished with a quality of life that is at least on par with other developed nations of the world. 'To make Vision 2035 a reality, a first class education system that provides opportunities for every citizen and resident is a key component of the strategy being pursued, especially to prepare the nation's youths for employment and achievement in a world that is increasingly competitive and knowledge-based' (Borneo Bulletin Yearbook, 2013:142).

Brunei Darussalam has always prioritised quality education in its vision and mission (Ministry Of Education, 2008). Therefore, it is appropriate that it be stressed in every disciplinary domain. Agriculture education is also confronting some issues and problems in its teaching and learning (Jabaidah, 2002). Moving towards 2035, Brunei has endeavoured to prepare its highly educated citizens in its goal (Ministry of Education Strategic Plan, 2012). In its mission, the ministry also hopes to 'offer educational programmes with a relevant and balanced curriculum to develop students to their fullest potential' (p. 7). These provided me the background to the need to improve agricultural education in Brunei Darussalam.

Quality curriculum is partly the requirement for agriculture learning in schools. There are opinions that curriculum should be relevantly aligned and socio-economically compliant to a country's need. But how do we address quality learning in a prescribed curriculum in the 21st century? The importance of consulting students in some way about their education (as according to the UN Charter on the Rights of Children and Jean Ruddock's research: Pupil voice is here to stay! QCA Futures, www.qca.org.uk/futures) has led me to explore their views about quality education. She writes, 'talking to pupils can help us bridge the gap and ... will open up opportunities what helps and what hinders their learning.'

I have previous experience in curriculum work and teaching as an educator in agriculture at Sayyidina Hasan Secondary School facility. From this, I have always felt that agriculture education is close to my heart. This provides the motivation for this thesis. To some extent, I have a personal experiential motive for being interested in the topic. So, the motivation for the thesis is not about solving the economic problems of the country, but improving education.

This study attempts to determine quality agriculture learning by investigating students' experience of learning in that subject. This helps to identify essential concepts for incorporation into the design of the curriculum and for them to stay relevant. To fulfil this purpose, the following are the research questions of this study:

1. What are threshold concepts in the learning of agriculture that could lead to higher levels of understanding in the subject, if any? (That is, by focussing on critical episodes/experiences, when it clicked for the students.)
2. Is there progression (students' transformation in terms of thinking development from simple to advance or complex knowledge and skills) in threshold concepts understanding?
3. How do students arrive at threshold concepts understanding, and what are the implications for teaching and curriculum design?

1.3 Statement of the Problem

There are tensions between the economy and education (the two E's I call it), plus other factors, which are affecting Brunei Darussalam's agriculture education. Issues facing the country's food security and self-sufficiency, economic diversification (away from oil and gas reliance), public perceptions of agriculture employment, and the unrealistic expectations of agricultural training programmes have some influential co-existence with the school agricultural context (Jabaidah, 2003). To reiterate, it is not the intention of this thesis to tackle all these problems at the national level since most of them are beyond the scope and time limitations of this study. Rather, from the educationalist's standpoint, this research is intended to deal with the learning of agriculture in schools – the smaller subsets of these problems which form parts of the bigger issue.

As an agricultural educator and reflecting on my past experiences, I am concerned that agricultural education should equip students to meet policy goals if they so choose. The ultimate aim of education should be for students to get a worthwhile agricultural education so the curriculum may eventually lead to employment and prepare them for being a citizen. This positional view postulates that getting real employment is utmost important as the final destination after schooling. Being employed or working provides an income source to meet daily basic needs, is a means of sustaining a living and securing the future. In 2001, it was reported that there is a lower percentage of agricultural employment in Brunei Darussalam, whilst employment in the manufacturing and services sectors have increased (see Fernandez & Powell, 2009:34). Similarly, other strong agriculture countries in the Southeast Asia region, such as Cambodia, Vietnam, and Thailand, have also showed a decline. The report claimed that the declining number of people employed in the agriculture sector may have serious implications for this region.

Usually, most curricula are seldom research-based because this approach to curriculum design is time-consuming. Instead, a fixed or prescribed curriculum is imposed on learners. 'Decades of calls for education reform have not succeeded in making schools where all young people want to and are able to learn. It is time to invite pupils to join the conversations about how we might accomplish that' (Cook-Sather A: Authorising Students' Perspective: towards trust, dialogue and change in education in Educational Researcher, 2002, cited in Myatt, 2009). In creating a curriculum fit for the 21st century, Professor David Hargreaves discussed the potential of the student voice in personalising learning. He defined the student voice as 'how students come to play a more active role in their education and schooling as a direct result of teachers become more attentive, in sustained or routine ways, to what students say about their experience of learning and of school life' (ibid.). Eliciting opinions to ensure students' voices are heard in determining what is relevant to curriculum planning is thus important to make it value-driven. Using the threshold concept framework as an analytical tool, I researched values and experiences as seen through the students' eyes to investigate these pressing issues. As Finch and Crunkilton (1989:17) wrote, 'the quality of curriculum materials is determined after data have been gathered from teachers and students who use them,' and student data is often neglected in curriculum decisions in traditional curriculum development.

In deciding what fits in a curriculum, the Victoria Education Department suggested, '... to consider *where are we now* and *where do we want to be*. And before choosing *which direction to go*, we have to consider *what are the issues*, *dilemmas and challenges we faced* and then only we know *where to go from here*. And in order to know where to go, we need to ask ourselves *how to go about it*. Indeed, these are the key factors to be considered before we can make a move' (Victoria Department of Education and Training, Australia, website, 2007). While doing so, it is important not to emulate others but to make changes from within or on local grounds by first looking at what surrounds us and what we encounter to guide us. This must be done from our own experiences and perspectives, incorporating individual and local social values, and the associated socio-economy to some degree.

Figure 1.1 represents the problem statement for this study. It describes the abiding tensions and the context of the intertwining issues of both the processes and outcomes of learning. If there is an initiative to provide greater relevancy and quality in learning and in the curriculum, there will be a greater chance of students becoming agriculturists in the future and play a role in helping Brunei achieve its agro-vision by 2023.

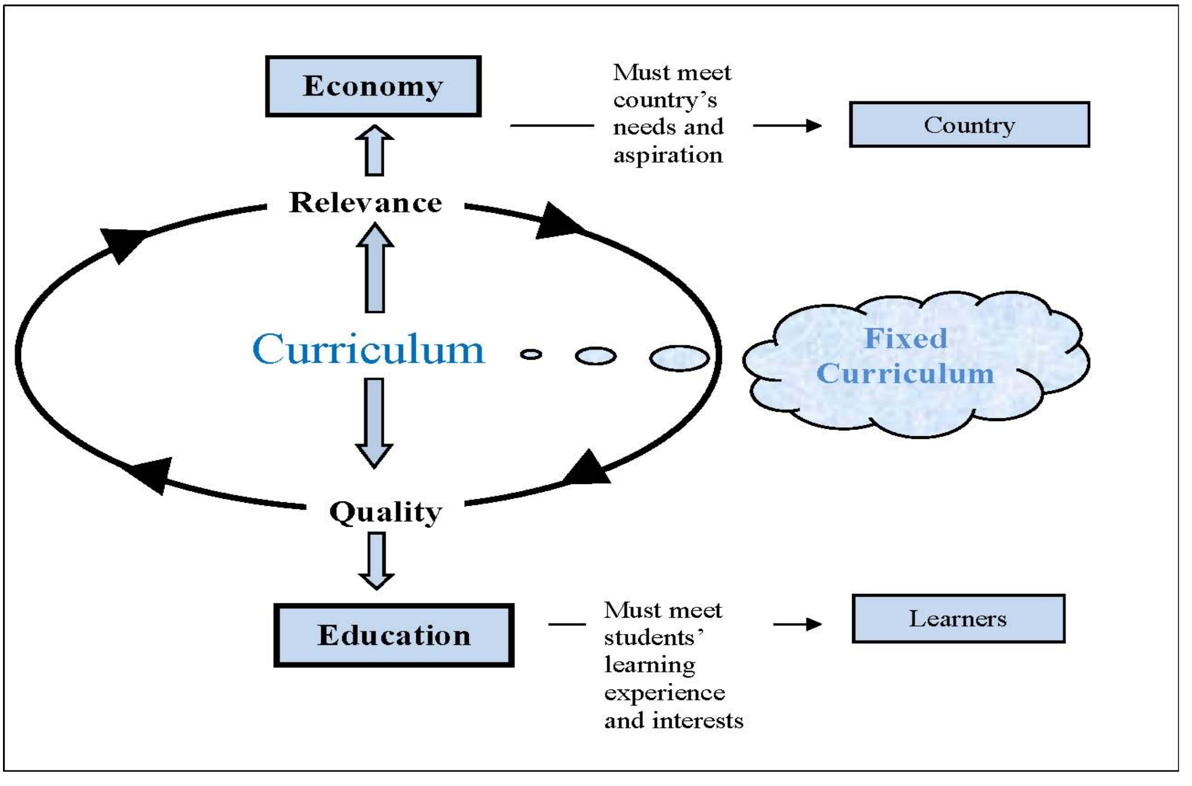

Figure 1.1 Flowchart representing the statement of the problem.

This section has discussed the issue of a fixed curriculum and how listening to the voices of the students may lead to more quality curriculum. Looking through the learners' lens to discover their viewpoints and understanding of the learning may point to a more appropriate curriculum. Examining quality through student perspectives may make a huge difference in agriculture learning and hopefully Brunei's future.

1.4 Quality and Relevance Definitions

This study is framed around the notion of quality and relevant understanding while embodying the threshold concept framework as an analytical tool for innovating in curriculum. Quality means high value and of highest possible standards, and is could also refer to the most ideal possible in strive for perfection. To prevent confusion, it is helpful to define the scope of quality and relevance in this study.

What do I mean by *quality education* for this study? Quality in education is a challenging concept to define and conceive. McCracken (1995:10) wrote, 'education is updated to reflect the world as it exists rather than the way it was.' Additionally, due to its dynamic nature, what people may accept as quality today may not be perceived as quality in the future. Quality is thus a wide concept and not so easily defined. In acknowledging its complexity, the UNESCO defined it as something that is usually related to improving a situation through what is lacking:

> Quality is a complex, dynamic, historically constructed and multifaceted concept, often defined by what is lacking rather than by its contents ... Thus it is quite difficult to grasp and operationalise ... But there is general consensus that, however defined in a society, institutions of higher education must strive to achieve and sustain the highest possible standards (UNESCO website, 2008).

However, quality has multifaceted meanings to various people. How they are perceived depends on relative purposes and the context. For example, Arthur Steller, President of Association for Supervision and Curriculum Development, Virginia, US, gave the basic definition of quality as 'excellence or just good education' and 'a goal we'd like to achieve for all students and in all areas of education ... [ ] and the vital underpinning of all we do in education: curriculum' (cited in Glatthorn, 1994:v). Entwistle (1995:2) reported that the Scottish Higher Education Funding Council (SHEFC) defined quality education based on a system model of *inputs* (such as staffing and the curriculum), *processes* (such as teaching and assessment), and *outputs* (such as learning outcomes, and student and employer satisfaction):

> Quality in education is dependent on many factors, which may be incorporated in an operational quality framework ... For example, curriculum aims and objectives should be explicit and known to staff and students; courses should be periodically reviewed to assess their suitability; the learning and teaching environment should be generally conducive to learning; accommodation should be appropriate for the curriculum on offer; lectures should be well planned and prepared, and effectively performed; and learning should be enriched by appropriate reference to cross-curricular links, current research, industrial applications and the development of generic skills such as communication and teamwork.

Quality in education thus encompasses a wide area. It can be summed up that quality may be defined as excellence in curriculum, the teaching-learning process and outcomes, aspects pertinent to the school support system and its contribution towards society. Bennett (2001, cited in MacAskill, Goho, Richard, Anderson & Stuhldreier, 2008:940) said, ‘quality is fundamentally what is improved about students’ capabilities or knowledge as a result of their education.’ Harvey and Green (1993, cited in Watty 2003:215) identified five definitions of quality, in which one of them was ‘transformation: qualitative change; education is about doing something to the student as opposed to something for the customer. Includes concepts of enhancing and empowering: democratisation of the process, not just outcomes.’ This definition relates to the characteristics of quality in curriculum and instruction, and is the transformational effect in learning. Quality in my study is in line with this – stressing individual transformation. That is, quality focuses on the transformational effect of the learners’ thinking and understanding for progression.

So what is *quality curriculum* in this study? Dimmock (2000) suggested quality curriculum should focus on providing successful learning experiences and outcomes for students. Dimmock argues that besides successful learning experiences (as Steller did above), quality in a curriculum arises from the outcomes of learning in the form of students getting the idea. He advocated ‘all students irrespective of gender, ethnicity, age and ability have the right to experience quality teaching and learning and a quality curriculum’ (p. 2). This further implies that quality curriculum should go hand in hand with quality instruction and learning and outcomes. Both aspects of quality are therefore complementary as both the *processes* of teaching-learning and *outcomes* of learning contribute to overall educational success.

To be successful, learners will have to find learning to be meaningful, useful and valuable. Hence, for the purpose of this study and as far as quality curriculum is concerned, my definition of quality can be defined as *meaningful or transformative learning* that provides learners with the best learning experiences and interests. Quality is a characteristic of the process of learning as well as its outcome. In my view, learning is meaningful if the teaching and learning of agriculture has relevant (and valuable) concepts that can provide students with the highest possible understanding of knowledge and its application. There will not be quality if learning has no provision of relevant experiences to meet students’ interests. Relevance here is also equated to students’ ability to use and apply the learning outcomes to any context that fits a purpose, regardless of immediate or future use. This could also mean that quality exists when students gain relevant knowledge that benefits their life and everyday experiences. Quality and relevance are, therefore, highly desirable components in a curriculum and inseparable attributes in this study, thus complementing each other since there would be not be quality without relevance and vice-versa.

Secondly, this leads to another question, what exactly is *relevance* in this study? As mentioned, it is very difficult to separate relevance from quality in the context of agriculture learning, and more so to define it. Having said that, relevance is also dynamic and variable upon context, just like quality. Both relevance and quality are difficult concepts to keep up with because 'change within agriculture is an ongoing process' (National Research Council, 1988:3).

At this stage, I can literally define relevance as *useful*, *directly related to one's needs*, or to be exact, one's *educational* needs. This definition is by no means simplistic and straight forward, and is open to debate. This is because in learning, both relevant curricula contents and learning experiences are to be valuable and compulsory for engagement. As Huang (2004:105) emphasised, 'relevant learning is where content-experience curriculum is transformed into learning experience', so that (in the words of Tyler, 1949) students can 'interact and react within the learning environment which interest or compel the learners'. Specifically, Tyler mentioned (cited in Huang, ibid.):

> ... the interaction between the learner and the external conditions in the environment to which he can react [which means] we are seeking to make the subject matter content *relevant* to and integrated with the conditions in the learning environment that interest or compel learners.

Note that above, *relevant curriculum* is associated with surrounding *experience and interest* which indicates that a relevant curriculum is where the content is equipped with utmost consideration to meeting students' best learning experiences and interests. And this is particularly important in agriculture learning where the subject is best learnt through some involvement of experience and practice.

Interestingly, both Dimmock (2000) and Huang (2004) above emphasised similar views on the learning experience. For the purpose of this study, therefore, it is thus more appropriate to define relevance at this particular point as the *usefulness* of the content of the curriculum to students' needs – meeting their interests and life experiences – regardless of present or future use. In other words, it is the *concepts* that students think will provide *most value* in giving the highest possible understanding of agriculture, and the knowledge and its application as manifested by their abilities *to use and apply* the learnt outcomes to any possible context that fits a purpose. Quality and relevance in this study are thus the products and characteristics of both the process of learning as well as the outcome.

In summary, quality curriculum in this study is defined as the curriculum content that will provide the most *understanding and meaningful* learning experiences (thereby transformative) by *meeting the learners' interests and life experiences in its outcome*. Whereas a relevant curriculum is one where the content is regarded as *useful and most valued* by students as seen by their *ability to apply the learnt knowledge* in any chosen setting or context.

1.5 Research Goals

The study is thus concerned with gaining deeper insight into students' *understanding* as a key area for investigating quality in agricultural learning. 'Understanding is an indicator of the quality of learning' (Newton, 2000:2). Here, I am trying to understand the issue of quality in learning and the identification of new and emerging issues for improvement and future innovation. Constantly innovating and improving practices will likely help attract more stakeholders and retain agricultural students' interests which are crucial for Brunei's long-term continuity and momentum for agriculture education.

The nature of this research is predominantly descriptive and qualitative, supplemented by quantitative data in some parts. The approach used is an interpretive phenomenological case study. Key concepts identified via Interpretive Phenomenological Analysis (IPA) is used as a *tool* to unravel what underpins quality in the subject and therefore serves as a key point *indicator* for innovating a quality-designed curriculum. In a nutshell, I am approaching quality through a threshold concepts framework investigation, with eventual findings extracted from IPA to shed light on the key implications for curriculum innovation. It is worth mentioning here that this study is mainly focused on curriculum, rather than institutional organisation effectiveness. It does not assess quality assurance interests for maintaining a programme involving anything from students' learning and teaching resources to school management and implementation. The earlier part of this section presented the rationale of the study and the underlying problems of particular concern that are specific to agriculture education and related wider issues. The next section will discuss the conceptual framework of the research in this study.

1.6 Conceptual Framework of the Research

This study's conceptual framework is built on issues which are inextricably linked to the complexities of the existing situation between the actors/cases and their contexts. I came up with what I called a 'two-wheeled theory' – my conceptual metaphor whereby there needs to be a pair of wheels, one on each side, working together in harmony to be able to move around in a stabilised direction to achieve the desired outcome. This metaphorical evolvement is used as an analogy to describe what I call agricultural success through education. That is, sustaining the younger generation's interest in playing a larger role in the country's agriculture sector.

The conceptual framework (as represented in Figure 1.2 below) shows two wheels which symbolise the country's economy and education – the two abiding tensions (or E's) within the contextual issues. It can be seen in the figure that the duo traps agriculture education between them and is encapsulated in the central shaft at the middle. As mentioned, the existence of agriculture in Brunei Darussalam and its learning is influenced by the country's economy as well as those factors intrinsic to education itself. Both the economy and the education sector have set different agendas – stressing relevant activities that boost the economy on the one hand and prioritising quality education on the other. Supporting one side over the other will cause an imbalance which could create an unfavourable situation. This implies that curriculum that overly emphasises the economic side may jeopardise the educational development of the learners. It is therefore conceptualised that in order for both wheels to rotate smoothly on their axles they must be stabilised at the central shaft by the curriculum model tagging quality and relevance, embedded within the purview of agriculture education that befits its purpose. Therefore, I believe we must pay serious attention to create this harmony by a balancing act of easing the tensions pulling between the two E's. We must ensure that the curriculum for agriculture is befitting – relevant to learners (in particular) as well the country, and for both to co-possess quality simultaneously. For such curriculum to characterise the delineation of the country's needs and aspirations, it must be capable of meeting students' best interests and learning experiences. To achieve this, certain threshold concepts are investigated in this study to determine the right fit of purpose within a curriculum whose content is appropriately formulated (with the inclusion of learners' input before considering that of the country) and would be most appreciated by learners. This stance is taken when searching for a best fit because education has always been about prioritising students' learning development first, whereas a country's economic focus and priorities are

Figure 1.2 Conceptual framework of the research.

considered as second. To achieve balance, agriculture education must strive for curriculum that is not only relevant to the country's economy but importantly be of reasonable quality to meet the learners' expectations, learning experiences and interests.

In summary, for the success of agriculture through education, this study's conceptual framework advocates that the balancing act could be supported or stabilised by having the desired agriculture curriculum: one which addresses both needs – individual educational development (as the first priority) and economic relevance (as the second priority).

1.7 Why am I Interested in Quality?

Given the tensions that are pulling at the two E's, what made me have a profound interest in the subject and thereby embark on this particular piece of research? It is none other than the culmination of the experience of teaching agriculture in a secondary school since 1996, while also being on the committee for the national curriculum development until 2007. Since my present appointment as a university lecturer in technical education teacher-training, I am no longer involved in curriculum development. However, my experiences saw that a well thought out curriculum for agriculture must have a strong element of relevance, particularly for students themselves, besides economic-related consideration. On the students' personal level, they should first see the values and relevance of their learning for their own life benefit with what counts as extrinsic importance being second.

My interest is further strengthened by the vision of Brunei Ministry of Education which prioritises quality. It stated that 'quality education towards a peaceful, developed and prosperous nation' is an official national priority. Furthermore, the Ministry's Strategic Plan as mentioned earlier also highlighted the same priority on quality. It stresses quality education besides excellence in teaching and learning in regards to achieving Brunei's Vision 2035, which is 'to see Brunei Darussalam being recognised everywhere for the accomplishments of its well-educated and highly skilled people'. This shows how strong the quality focus is for Brunei's education system. A similar desire was also expressed in another document in that 'by 2035, Brunei Darussalam is recognised everywhere for (1) the accomplishment of its well-educated highly skilled people, (2) the quality of life, and (3) the dynamic and sustainable economy' (National Education System the SPN 21 booklet, 2008:2). Indeed, for Brunei Darussalam quality education is an overriding priority.

1.8 Why do I Care about Agriculture Education's Quality?

I am not only interested in educational quality but specifically learning quality in agriculture with regard to students' overall understanding through the provision of learning experiences and best teaching practices. This motivation was driven extrinsically due to the poor student performance in previous public examinations and my desire to improve it. The agriculture results in public examinations were not encouraging. The Agriculture Ordinary Level results obtained from 1996 to 2000 were at an all-time low (Jabaidah, 2002:12), and it is likely that students had difficulty understanding theoretical concepts. This could be attributed to students experiencing liminality (as in Meyer & Land, 2003, Latin 'limen' means threshold), 'a suspended state in which understanding approximates a kind of mimicry or lack of authenticity'. Interestingly, in a previous study of mine, almost all students experienced 'fun and enjoyment' when doing practical activities outside classroom but not when studying theoretical concepts inside it (Jabaidah 2002:129). Why didn't students enjoy learning theory? From this present study, prospective findings might illuminate this issue regarding mastering agricultural theoretical concepts. This is one aspect of inquiry included in this study in order to shed light if not the truth about the uniqueness of agricultural learning.

Another reason why agriculture education is the subject matter of this study is that in my role as an agriculture educationalist, I tend to get influenced and concerned by the country's economic priorities, in particular the Agro-Vision 2023, which is 'to focus on the requirement of more skilled human resources in the area of the agriculture sector' (Department of Agriculture and Agrifood, 2008). There is an overarching objective that the required skilled workers in the future be generated from students who have studied agriculture previously in school. The future adult workers need to be prepared in the present for tomorrow. And where else should it all begin if not from schools?

1.9 Structure of the Thesis

To navigate readers, this thesis has been structured according to the following chapters:

- Chapter 1 introduces the context of this study, its significance, my personal motive, and the guiding conceptual framework for carrying out the research.
- Chapter 2 consists of a literature review on agriculture education pertaining to quality curriculum design and learning.

- Chapter 3 consists of a literature review on the threshold concepts framework and its potential for curriculum innovation in agriculture education, and its implications.
- Chapter 4 describes the chosen research design and the methodology employed in addressing the research questions.
- Chapters 5 and 6 present the results of the analysis and the findings, case by case and across cases, respectively.
- Chapters 7, 8 and 9 discuss the key findings yielded from the results of the analysis in answers to the three research questions.
- Chapter 10 presents the data, analysis and findings from the teacher cases and triangulates the findings with the students' findings.
- Chapter 11 presents the conclusion and outlines considerations for course design and the implications for practice and future research. This chapter is followed by the appendices and a list of the references cited in this thesis.

Chapter 2

REVIEW OF LITERATURE: AGRICULTURE EDUCATION

There are two chapters in this thesis that provide a literature review, owing to the inter-disciplinary nature of the study between agriculture education and the threshold concepts framework. This chapter will present the key considerations regarding quality in agriculture curriculum design and learning, and what is practised in some parts of the world. I will also review documents pertaining to agriculture education and possible directions for quality curriculum design.

2.1 Why Quality and Relevance in Agriculture Curriculum Design? Demarcation between Economy and Education: Where do we Draw the Line for Agriculture Education in Brunei Darussalam?

Why is an emphasis on quality and relevancy necessary in agriculture curriculum? There are variations in the purpose of agricultural education according to literature. Some have indicated the profound needs of their country, and others had distinguished it from schools and higher learning. Countries such as South Africa and Swaziland advocate that agriculture education be aligned with the needs and aspirations of the country. For example, Venter (2003, cited in McDonald & Van Der Horst, 2007) argued for relevance and the appropriateness of curriculum for national and social demands.

Similarly, South Africa's Ministry of Education National Plan 2001 outlined the need 'to produce graduates with skills, and competencies to meet the human resource needs of the country' (McDonald & Van Der Horst, 2007:2). Mbingo, Dlamini and Dlamini (2002) argued that curriculum reform should focus on the socio-economic needs of learners and that it be society-compliant.

These various viewpoints demonstrate to some extent a prioritisation of the country's economy over the learners' education. Should economic needs determine education policy? For what purpose does agriculture education serve Brunei Darussalam? Is it for the economy or more for educational development? The tension of agriculture education being trapped between the two E's (the country's economy and education) has grappled me. Although agriculture education is expected to provide a skilled workforce for the agricultural sector to overcome problems with self-sufficiency, food security and productivity, educationally it should serve to provide training as high as possible to the university level.

From my educationist's point of view, it is not just the economy which is at issue, but more importantly the purpose of education for the learner; what is being most valued and does the curriculum suitably match the learners' cognitive ability? Students would feel that their learning was valuable if they believed that they accomplished something meaningful. Concurrently, they should also realise that agricultural knowledge is useful for their future career that could satisfy the needs of the economy. Hence, striking the right balance to the two E-factors has undoubtedly been a difficult judgement to make.

There are also presumptions of a poor image being associated with agriculture. Although there is no empirical evidence to support this argument in a wider context, the students in my previous study perceived it as dirty, laborious, and low class (Jabaidah, 2002). This could have an impact on the decision to pursue a career in this sector. Additionally in that research, the below average public examination results in secondary school agriculture did not help improve the image. Given this stigma, would one want to consider working in agriculture in the future? Though there is no objective evidence for these presuppositions, they are some of the factors that may have influenced agricultural development in Brunei Darussalam.

In regards to quality and relevance, a question springs to mind – are we providing the right curriculum to students? And how do we know if it is right and befitting of their conscience? This is something that needs to be pondered. Could the point made in the following quotation lead to an answer?

> We are not concerned with showing that any particular subject is to be taught for reasons intrinsic to the subject ... *Think more about the pupils* and less about the internal logic ... of your subjects ... To help children to live a full life rather than in relation to the short-term needs of the economy ... So we should start asking question 'What kind of society should schools today be helping pupils to live a full life within?' ... to enable them to live successfully and contribute fully to such a life? (A utopian cultural core of curriculum, Anon).

The above quotation clearly implies that education should focus more on *liberating* the learners to live a full life rather than be solely for the sake of economy. Does this mean that we should defy economic considerations for the sake of education first? Is there a short cut to this dilemma? Perhaps quality curriculum design with relevant content could provide the right experience for successful learning to take place, and thereby ensure that students have a strong interest in the subject and make them aspire to work in the agriculture sector.

2.2 Is Agriculture Education in Brunei Darussalam Fit for Purpose?

In the discussion so far, we admit that there are problems regarding agriculture education in Brunei Darussalam. But is agriculture education currently fit for purpose? This is a tough question. Trying to tackle it, I re-emphasised this question as: what is the purpose of agriculture education for Brunei Darussalam? Fit for purpose here means its relevancy. Is there relevance across various stages/levels of agriculture education? Is it for educational, employment or economic purposes as has been argued in the earlier part of this section? But doesn't education lead to employment and economic development in the end? If so, at what point or stage should we start instilling that education is for the future employment of a learner? When is the drop-off point that balances education and the economy? Unfortunately, there are no clear-cut answers to these questions. To address such a quandary, I have the opinion that it is important to look at the position of agriculture in the education system with respect to learning development needs. This could be assessed at various stages as will be discussed in the next section.

2.3 Where to Position Agriculture Education in Brunei Darussalam's Education System?

Undoubtedly, this question is a headache for an agriculture education planner, yet it also grapples me. It is a difficult question to answer in that there are no previous studies on this issue. The starting point could be looking at stakeholders/consumers or the recipients of education relational to learners' cognitive development with respect to the aim of education at various levels and stages. One has to understand the purpose of each educational level in regards to a child's development in the context of Brunei Darussalam, and to compare this against world standards and global trends. Based on my academic experiences and relevant sources, such as the UNESCO website and the Brunei Ministry of Education SPN 21 booklet (2008), I list a summary of the purposes of various education levels (Table 2.1) and discuss them further in the next section.

Table 2.1
Purposes of Education against Various Levels of Education

Levels	Purpose of education	Scope and likely contents for agriculture
Primary Education	To provide groundings/basics to education (UNESCO).	- Anything related to everyday life, for example, nutrition and health (already covered and integrated in science subject).
Secondary Education	To consolidate/strengthen knowledge gained during primary education.	- Generalised/universalised.
▪ Year 7 - 8 Lower Secondary Education (LSE)	To develop aptitude, interests, personality, attitudes and values e.g. self-confidence and esteem, self-reliance and independence (SPN 21).	- For the agriculture subject, to spark/initiate/stimulate interest. - Basic topics from three main core areas: plants, animals and soil.
▪ Year 9 - 11 Upper Secondary Education (USE)	To diversify education for further studies or advancement to higher education and for informed choices towards a milestone destination in career.	- To diversity the knowledge. - For agriculture, more scientific-based content is needed. - Agriculture topics are common to all with no specialisation choice yet.
Post-secondary Education ▪ Diploma level (Alternative education pathway parallel to A-Levels)	Alternative pathway equivalent to advance level leading to higher education. Not yet for direct employment.	- Diploma is a $2^1/_2$ year programme inclusive of 6 months attachment of a work placement. - May be a common curriculum at the start, then progressively specialising towards end of programme, such as in agriculture science, biotechnology, fisheries studies, etc.
Tertiary Education ▪ University level (Not yet offered in Brunei Darussalam)	Very specialised and for direct employment in a specific occupation at the end of education.	- Very specialised in various agricultural branches for direct employment/profession. Probably a programme with a common foundation in the first year followed by specific specialisation thereafter.

Source: Holsinger & Cowell (2000), UNESCO (2008), SPN 21 booklet (2008), and my own experiences.

2.3.1 Positioning agriculture education in primary education

The UNESCO's description of the purpose of primary education is 'to provide grounding or basics to education' (www.unesco.org, 2008). According to the literature, the offering of agriculture at primary education level is practically unheard of. Generally, only the science subject is mentioned, and a separate subject of agriculture is considered to be unnecessary. It may well be correct to argue that agriculture is essentially a science-based subject, and, therefore, some primary science curricula content provides a sufficient grounding in basic agriculture. For example, the related topics that are relevant to daily needs of people such as nutrition and health (see Holsinger & Cowell, 2000), and primary science topics such as the life cycles of insects, plants or animals (e.g. chicken is usually used) would indirectly introduce agriculture to children. Science teachers' lessons on the life cycle of plants which demonstrate the seeds' various growth stages are actually agriculture knowledge in disguise. In fact, what appear to be science lessons in primary curricula are actually anchored in agriculture knowledge.

2.3.2 Positioning agriculture education in secondary education – lower secondary, upper secondary and post-secondary

Holsinger and Cowell (2000) stressed that secondary education is the continuation of primary education. Therefore, the purpose of secondary education is partly 'to consolidate or strengthen the knowledge gained from primary education' (UNESCO, 2008) and at the same time 'to create interests and personality' (SPN 21 booklet, 2008:12). Although there is no proper divisionary line between the lower, upper and post-secondary purposes of education, the International Institute of Educational Planning (IIEP) at UNESCO mentions on their website that:

> For secondary education, *quality must be viewed from the standpoints of the individual*, the family, the community, the nation and the world at large. *Secondary education must prepare the youth for making informed* further education, career and life *choices*. It must contribute to the full emancipation of the individual through the development of his/her potentials and his/her ability to be valued by, and to value the world around. And for adolescents themselves finding their education of *quality and of relevance*. (Emphasis added).

This implies that education for the *Lower Secondary* stage is still provided in a more generalised or universalised manner, focussing on individual potential and development. Giving students choices in the form of optional subjects to acquaint themselves with various areas can open up more opportunities to inform further choices in order to suit learners' inclinations and personal interests. In Brunei Darussalam, the Year 7-8 Lower Secondary Education curriculum provides an opportunity to choose Agriculture, Design & Technology, Home Economics, Information Communication Technology, Commercial Studies, Music or Art (SPN 21 Booklet, 2008). However, agriculture is only offered in some secondary schools due to a limited number of specialised teachers and the lack of facilities. Its main purpose is mainly to initiate students' interest in the subject, instead of career development.

Nonetheless, there is a slightly different purpose for students in Year 9-11 in the *Upper Secondary Education* where the purpose is mainly to diversify students' education (see Table 2.1). This stage is considered as the starting point to further education and a future career; 'to prepare students for the transition to higher education and possible scientific and science-based studies' (Holsinger & Cowell, 2000). The authors highlighted the common misconception of the purpose of secondary education, saying that the 'increasingly commonplace view that general secondary education is the best preparation for entry into labour markets and for further training is not well understood ...' (p.31). To overcome this, Dlamini (2003:38) suggested that education at this level should serve two purposes: to give the curriculum a content mix that provides both occupational (for potential school leavers) and academic (to further higher education) scope. He stressed that this diversified view of education caters for both types of student, allowing for some crossover between future studies and occupation purposes.

The Brunei-Cambridge General Certificate of Education (BC GCE) Ordinary Level Agriculture syllabus that is presently in use has scientific content comparable to a biology course. Quite possibly this stage also serves a purpose of employment preparation as not all can pass the Ordinary Level examinations to enter sixth form education. It is quite clear, however, that the main purpose of education at this stage is to provide education to advance students to next level of education – the A-Levels or tertiary level. Thus it seems that even if at this point in time initial interest in an agriculture career as a future choice exists, it is not sufficient to secure employment. Potentially at least five more years is needed to develop a career in agriculture as higher education is still required to strengthen knowledge and skills to venture into an agriculture business and entrepreneurship.

These positional purposes need to be well understood or else educational purposes at various levels tend to be mixed up with employment preparation. Although there are some vocational aspects in the learning activities of agriculture at schools, these are for reinforcement purposes in order to assist students' agricultural understanding of the various processes involved, and are not intended for immediate vocation. However, there is no harm if students relate their learning to employment at this stage as this is simply an indication of a deeper interest in the subject, rather than an ambition for immediate vocation. Indeed, work will only be necessary when students can no longer be in school or voluntarily decide to quit school in order to seek employment.

Thus, there seems to be the need to diversify curriculum to include both common core and specialist knowledge to cater for the different destinations of students after completion of general secondary education. Similarly, Briseid and Caillods (2004:59) emphasised in relation to trends in secondary education in industrialised countries (such as the UK, the US, France, etc.) that:

> The greater emphasis in *lower secondary* education is on providing basic and general education rather than on preparing students for the world of work. The emphasis in *upper secondary* would be more directed towards preparation for higher education and for securing skilled workers for the workforce. For these reasons *lower secondary* education generally tends to be comprehensive, whereas *upper secondary* tends to be more diverse and offer more options.

For those students strongly inclined towards agriculture after completing the Lower and Upper Secondary Education levels, they may well proceed to continue courses at a *post-secon*dary level. The courses offered are relevant to current and future needs, and are alternative pathways to higher education in parallel to advance levels or sixth form education. The emphasis is still not on direct employment but for providing a pathway to the university level, although there may be some who pursue agriculture careers at the conclusion of this stage. By the end of this stage, a strong demand of specialisation is inherent and the pathway is already clear if students decide on agriculture as a future profession. As a result, a certain degree of course choice must be available, such as in fisheries studies, forestry, food processing and biotechnology to further bridge specialisation towards a university degree programme.

2.3.3 Positioning agriculture education in tertiary education

The purpose of higher education is to facilitate direct employment. Unfortunately at present, Brunei Darussalam has no university programmes that cater for various agriculture specialisations in order to sustain a workforce. Due to a manpower shortage and infrastructure limitations, it could be a long time before the country is in a position to consider offering it at local universities, and therefore may have to continue sending students overseas. Whatever the direction taken, it is of utmost importance that there is continuity of agriculture education up to the university level in order to convince the wider community, students and parents alike of the worthiness of agriculture courses in Brunei Darussalam.

The above sections have discussed the purposes, whether broad, diversified, universalised and specialised, of the various education stages and linked them to the learning of agriculture in Brunei Darussalam. The next section will discuss the nature of the agriculture subjects that readers need to be aware of before I go further in touching upon the curriculum.

2.4 Nature of Agriculture – When is Agriculture Really Agriculture?

Another anecdote I have is the question of when is agriculture learning actually considered agriculture by the learner? To answer this question, we need to look deeper into the nature of agriculture and its definition. One simple definition is that agriculture is defined as the production of food, plants and animals from the soil. However, agriculture as an *industry* gives a more comprehensive definition which attests to the broad knowledge required to be in expert in it:

> Agriculture is a field that encompasses the production of agricultural commodities, including food, fibre, wood products, horticultural crops, and other plant and animal products. The terms include the financing, processing, marketing, and distribution of agricultural products; farm production, supply and service industries; health, nutrition and food consumption; the use and conservation of land and water resources; development and maintenance of recreational resources; and related economic, sociological, political, environmental, and cultural characteristics of the food and fibre system (National Council for Agricultural Education, 1999:2).

Agriculture has many characteristics that can be attributed to its nature. Firstly, it is a concrete multi-disciplinary subject (encompassing science-business-technology) due to its vast and wide-ranging content; and the concrete learning style required for it. If this is so, does this mean agriculture is not a discipline, since there is also science, business and technology attached to it? As mentioned, the core business of agriculture is in commodity production derived from the soil; however, production alone is not sufficient in order to be successful in the real agriculture world. We need science in order to understand and explain what happens to agricultural plants and animals. We also need business and technology when commodities are produced. Agriculturists need to know what to do with these commodities, such as selling and marketing them and also processing them if there is excess in mass production which requires processing technology. Even during cultivation the need for technological knowledge in relation to machinery, implements, tools and equipment (including various cultivation techniques and systems such as in hydroponics, fertigation, irrigation, biotechnology, and research technology) are all necessary. All this calls for technology know-how and an understanding of how machines and equipment work. And these technology areas in agriculture must complement science and business aspects in order to be a successful agriculturist in the real world.

Secondly, agriculture is also an applied science and therefore is considered a hard and live science. It is an applied science because it is the application of science knowledge to the world where one gets to practise it in order to reap its benefits. It is live as agriculturists interact and deal with live plants, animals, living nature and the environment. Thirdly, along with its scientific content it is also wordy in the sense that vast terminologies and descriptive presentations are required to describe the knowledge. Knowing that agriculture possesses these vastly diversified characteristics poses a challenge for curriculum developers.

In regards to agriculture and quality, this means that learning has to have the right curriculum, content, concepts, experiences, and also provision for the right application of knowledge to real world. This section explained the nature and attributes of the agriculture discipline and why that it also has science-technology-business components; and the difficulty which may arise due to these many characteristics. The next section looks further into science in relation to agriculture learning.

2.5 Science alongside Agriculture

Another aspect to agriculture is its connection to science. As mentioned before, the offering of agriculture as a subject in primary education is almost non-existent due to co-existing agricultural topics being subsumed in science subjects. In contrast, at secondary education level, agriculture is always offered as a single separate subject with possession of more science content, hence dubbed as agriculture science. A tendency is that whoever can do well in secondary school science might also do so in secondary school agriculture (Jabaidah, 2002). This can be attributed to the fact that agriculture is actually the application of scientific knowledge because agriculture is a branch of applied biology. Although agriculture is related to science, not all its content is scientific due to its curricular co-existence with other multi-disciplinary topics. So, can students' understanding of agricultural concepts be helped by science? This study will also try, among other things, to examine this relationship.

In retrospect, my previous study findings showed that there was a tendency of the Ordinary Level students who took agriculture along with the biology subject in Upper Secondary Education to score very well in the latter (Jabaidah, 2002:155). My previous findings indicated that students found it is much easier to study genetics in biology because they can relate to agricultural topics on breeding. Content overlap between agriculture and science subjects allowed students' scientific understanding in one to be applied to the other, thus resulting in a much better understanding of both subjects. Similarly, Thompson and Balschweid (1999:23) reported that less than one-half of all agricultural science teachers in Oregon in their study indicated that students received science credits due to agriculture classes. Furthermore, Balschweid, Thompson and Cole (2000:37) also reported that 'teachers believe that integrating science [into agriculture] assisted students in better understanding science concepts and their application to agriculture'. It was believed that the infusion of science concepts into agriculture or vice-versa mutually benefitted both programs (Boone, Gartin, Boone, & Hughes, 2006:79).

In science, those who can do well in theory might also excel in practical experiments. It seems that the theory part helps students perform better experiments. In contrast, not all those who are good with agricultural theory will also do well in practical activities. In fact, there was a tendency for students that did not perform well in theory to do surprisingly well in the practical activities because they enjoyed learning more by doing (Jabaidah, 2002:105). Could this mean that in agriculture, practical activities come first before the theoretical parts for a better understanding of the subject? That is a larger issue. Essentially, you need both to be integrated but definitely not a load of theory first. In science, learning theory should be taught first before conducting experiments, although this may not always be the case.

An understanding of how plants grow and function should allow for a better understanding of agriculture. Students need to know what happens inside plants as they functions. Some science concepts that are useful in agriculture have been mentioned in Pratt (2005:11-19), including: (1) the cell (the building block of growth), particularly cell structures and how they functions; (2) differences in cell structures and between plants cells and animals cells; (3) photosynthesis with respiration: the photosynthesis process and the utilisation of sugar produced from the photosynthesis process, and also the absorption of other elements from soils; and (4) transportation (through water) in plants, and water as the main constituents of plants, and that all processes including photosynthesis and respiration take place in the presence of water. It seems that all of these concepts need to be understood by students learning agriculture. Could they be providing us to some clues as to the importance of key concepts in agriculture? Could knowing these properties and processes help students' understanding agriculture better? Is it the concepts or processes, or both? This study endeavours to elicit some empirical evidences to answer these questions.

2.6 Curricula for Agriculture Education in Brunei Darussalam

Presently, agriculture education in Brunei Darussalam is only offered at the secondary and post-secondary levels of education. The prepared curricula for the courses are listed below.

Table 2.2
Curricula for Agriculture Courses

Secondary Level	Post-secondary level
Lower secondary (Year 7- 8): - Normal level I - Level II - Specialised Applied Programme or PMV (Program Menengah Vokasional) *Upper secondary (Year 9 - 11):* - Brunei-Cambridge General Certificate of Education (BC GCE) Ordinary Level Agriculture 5038	BDTVEC National Diploma in: - Agriculture Science - Fisheries Studies - Biotechnology - Food Technology

For the agriculture subject in secondary education there are two stages: Years 7 and 8 students in the Lower Secondary Level and Years 9 to 11 students in the Upper Secondary Level. The syllabus for the national curricula is locally prepared by the Ministry of Education, except for the BC GCE Ordinary Level Agriculture which was prepared by the Cambridge Examination Syndicate. The committee members for the locally prepared curriculum consist of the Curriculum Development Department's agriculture subject specialists, schools' agriculture practising teachers, other officers within the education ministry and also invited specialists from relevant departments such as the Department of Agriculture and Agrifood, the Department of Fisheries, and the Department of Forestry.

Most of the agriculture curricula is prepared for a single subject, except for the Years 7 and 8 Specialised Applied Programme. For this programme, agriculture is studied as part of elective modules within a group of compulsory combined subjects (Design & Technology, Home Economics and Science) to form what is called Science and Technology. The curriculum of these various combined subjects is integrated under the science and technology approach and is project-oriented, focusing on producing something by the end of each module to promote entrepreneurship abilities in students.

The Brunei-Cambridge General Certificate of Education (BC GCE) Ordinary-Level Agriculture 5038 syllabus (2008) besides promoting the subject as an applied science, aims to stimulate interest and awareness, and to prepare students for advanced studies in agriculture by laying out a foundation for further studies. Among the emphases as stated in the syllabus is for the learning to be treated practically as far as possible through work, including experiments, demonstrations or visits, and for students to participate in the school gardening activity. This emphasis promotes the practical aspect of learning including information handling and problem solving with questions on knowledge and understanding. This appropriately matches Holsinger and Cowell's (2000) reference to learning at this level, which is to prepare for advancement to higher level education and for future scientific studies.

The career aspect is also emphasised in the syllabus, but not for direct involvement, but rather for awareness and stimulating positive attitudes for a future occupation. This implies that the academic/education trajectory is still prominent at this stage compared to the economy. Additionally, the absence of a whole topic on farm business management from the syllabus reflects more emphasis on academic rather than occupational content, although students are required to briefly study the need for good management practices. The other emphasis was on the value of agriculture to family and community, less so towards country or the economy. The curricular content has an equal number of topics for plants and animals, where the sequencing of plant topics preceded the soil and general agriculture topics. This is followed by three topics on animals, and concludes with a breeding topic (for both plants and animals), and finally settles on farm structures, tools and machinery.

Presently, eleven secondary schools offer agriculture at various locations in Brunei Darussalam: six in Brunei-Muara District, three in Tutong District, one in Belait District and one in Temburong District. These schools include: (1) Sayyidina Hasan Secondary School, (2) Sayyidina Husain Secondary School, (3) Masin Secondary School, (4) PAP Hajah Masna Secondary School, (5) Pehin Datu Seri Maharaja Mentiri Secondary School, (6) PIHM Serasa Secondary School, (7) Raja Isteri Pg Anak Saleha Secondary School, (8) Muda Hashim Secondary School, (9) Tanjong Maya Secondary School* (*since 2008, replacing the PDN Pg Jaya Sengkarai Primary School which was its temporary location), (10) PAP Rashidah Secondary School, and (11) Sultan Hassan Secondary School.

Meanwhile, agriculture at the post-secondary education level is a two and a half year diploma programme first offered in July 2008 to a students' cohort in the National

Diploma in Agriculture Science programme. A year on (2009), two new programmes were subsequently added in the field of Biotechnology and Fisheries Studies, with Food Technology being in the pipeline. It is understood that many more new programmes are to be offered in the near future.

The curricula for these diploma programmes are locally prepared using the method called DACUM, an acronym for Developing A CUrriculuM. The Programme Development Committee usually generates a programme guide with input and feedback solicited from industry and the related people to ensure the content is relevant to the needs of the industry and job requirements. Normally, the curriculum committee consists of school instructors as well as the people from industries and some various officers from the Departments of Agriculture and Agrifood; the Department of Fisheries; the Department of Forestry; and the Department of Recreation, Park and Environment.

In the first stage of its curriculum development process, the school instructors committee will prepare a draft curriculum to present to the second committee which is made up of industrial people and experts from selected government departments. The panel members from this second committee will then review and give feedback on the content to be added, removed or amended as necessary. Thereafter, a series of meetings are held between both committees to make changes until both committees are finally happy with the overall content. Once the finalised document is ready, it is submitted to the Brunei Darussalam Technical and Vocational Education Council for approval and endorsement. The curricula will be revised every five years to make its content current and viable in line with the needs of industry and job employers. In some cases, the revision may be necessary within a period of less than five years as and whenever required, if the need arises.

2.7 Document and Curriculum Analysis Related to the Cases of this Research

This section presents curricular analysis and discusses policy documents related to agriculture education including a review of course content, goals/aims and outcomes in the presently used agriculture curriculum related to the cases investigated in this study. The significance of this activity is that assumptions of the interview data and the findings from this study may influence policy-making in future curriculum innovation. This is useful for addressing the issue of the quality of agricultural education in order to satisfy both education and economic needs.

However, only a few policies and curricular documents produced by the government were found useful and relevant to this investigation. A policy is a plan of action or set of aims decided by a group or organisation in which the document consists of a principle or set of principles on which to base decisions or conduct. Unfortunately, no policy statements could be found to reflect anything specific connected to agriculture education, except in the general terms related to the education sector. The policy, as stated in the Ministry of Education's Strategic Plan (2012) that embodies the Brunei Vision 2035, is 'providing high standards of secondary and tertiary education, including vocational schools which will produce experts, professionals, and technicians required in commerce and industry'. This policy emphasises the future long-term human resource vision in the employment sector through provision of high quality education over the coming two decades.

Secondary agriculture curriculum review

This curriculum provides ample learning opportunities for development of various knowledge and specialism in the area of agriculture. However, the aim of the programme or goal of the education was not stated within this document upon which the framework for guiding the curriculum is based. This could be due to the curriculum was being prepared by the DACUM approach that is subject to industrial changes and needs, allowing room for frequent revision of the guide to be made. However, the absence of such aims from the syllabus can be solicited from the vision and mission of the institute where this programme is offered. The vision is 'to maintain a centre of excellence in training, education and research in agriculture discipline' with the mission 'to produce quality and highly trained future workforce for the country through provision of high training and research,' implying that the purpose of education at this stage is strongly leveraged towards career trajectory.

Content analysis of the topics as outlined in the programme showed that the topics are broadly categorised under various subdivisions as listed in Table 2.3. My analysis shows that more weight is given to plant than animal topics in the content. However, the most prominent emphasis is on students carrying out project work and to research special skills in the advanced topics. The smallest topic is on soil which carries only one unit value. Is this adequate for students to know about soil? This seems questionable.

Table 2.3
Content Curricular Analysis of Agriculture Science

Area	Topics	Units Value	Total
Plants:	(2.1) Plant science (2.2) Field crop husbandry (2.4) Annual horticulture crops (2.5) Perennial horticulture crops	0.5 1 1 1	3.5
Soil:	(2.3) Soil and water management	1	1
Management:	(2.6) Farm management * Enterprise planning	1 1	2
Advance topics/ special skills:	(2.7) Agricultural research methods (2.11) Individual research project (2.12) Share faming project	1 2 2	5
Animals:	(2.8) Animal science (2.9) Poultry husbandry (2.10) Husbandry of ruminants	0.5 1 1	2.5

NB: The value of one unit is equivalent to a certain number of hours of teaching. The above analysis does not include other core subjects such as Language and Communication, Applied Computing, Mathematics, and Common Skills. * Enterprise Planning is treated separately from agriculture courses but is added as an essential course for this programme.

2.8 Possible Directions for Quality Curriculum Design for Agriculture

Besides academic development, schools are facing challenges to prepare students for life: careers, and societal and global participation. The Evangelisto model of the comprehensive curriculum planning, calls for a curriculum to be 'comprehensive, systematic and relevant to the students' needs for their future' (http://www.hiceducation.org/edu_proceedings/Tony%20Evangelisto.pdf). It reminds that it is not easy for educators and curriculum developers to determine what to teach and what to ignore. The model, therefore, emphasises *activities program* as a means to extend and solidify classroom learning in which students will have the opportunity to use and apply their knowledge into practice. Such a program empowers students to succeed in school and to formulate future studies and appropriate career plans, the model argues.

The Victoria Department of Education and Training, Australia (http//www.sofweb.vic.edu.au/blueprint/fs1/guidelines/phase2/Design_options.htm), in predicting what might a future curriculum look like advocates *effective learning* by creating a curriculum that allows students to think or teaching students to learn to think. They underscore the need to develop a curriculum program that recognises and responds to the diverse needs of students such as via project-based learning, be actively involved in problem-solving and learning in a range of contexts. In their view, this approach helps students make connections between different contexts and the ability to apply the skills creatively to new problems.

In Finland, ‘Less is more. Teach less, learn more’ (Sahlberg, 2011) was used to create their outstanding education system. It prioritises professionalism over marketisation in the learning approach in a more globalised world ‘by giving more attention to creativity, problem-solving, teamwork and cross-curricular projects in school’ (OECD, 2010:122). Students are inculcated ‘with minds associated with innovators: creativity, flexibility, initiative, risk-taking and the ability to apply knowledge in novel situations’. While their ‘curriculum framework and instructional guidance is designed to encourage an inquiry-based approach to learning’ (ibid., p. 130).

Similarly, in Singapore the curriculum ensures that teachers will teach less so that students can learn more. Their curriculum content has been reduced by some thirty per cent to allow sufficient time for more creative problem-solving approaches (refer to www.oecd.org). According to them, a reduced content curriculum gives students more space to think and communicate their thinking as they develop an understanding. This allows their students who come from various and diverse backgrounds to experience *differentiated learning..*

In Tanzania and Columbia, the *diversified education* has achieved the highest gain in achievement leading to higher performance in general academic subjects, particularly students coming from socially disadvantaged communities. Holsinger (2000:7-8) proposed the idea of a diversified education in which education allows for the inclusion of vocational into academic subjects, thus encouraging the existence of both academic and vocational education within the secondary education system. He saw this as allowing the provision of academic grounds or the basics in preparation for possible future studies as well for transferring competences and skills for future occupations. He emphasised that upper secondary education is where both academic and vocational education is needed: academic education for preparation of future further studies, and vocational education for attaining the skills and competencies for future occupations. This seems to imply that students are given more opportunity upon completing their general secondary education not only to study further but also fulfil the demands of the workplace, if they wish to do so.

2.9 Curriculum Content for Agriculture Program

The National Research Council (1988:4) mentioned that to reflect a contemporary image of agriculture 'the focus of agricultural education must change – a reality within agriculture and of changes within society', which calls for the need and changes in '... developing the curriculum, revising the focus and content ...' to reflect the broad range of opportunities in today's agricultural industry. They further emphasised, 'if agriculture industry to survive in the country it needs to build on programs and approaches of the past, but goes beyond scope and content' (p. 1).

One recommendation put forth by their committee on Agricultural Education in Secondary Schools was to revise the focus and content of Future Farmers of America programme and activities. They also recommended the quality in the vocational agriculture programme be 'to sustain those that conform but to upgrade (for outdated curriculum), consolidate or phase out those do not meet educational needs' (p. 4) in line with the students' interests and aspirations, both in their academic advancement and for future employment. These recommendations, in their opinion, were necessary with regards to the relevance and scope of the *broadened curriculum* so that students are prepared effectively.

Facing socio-economic challenges (including poverty and unemployment), Swaziland encountered the problem that the curriculum is getting increasingly unmatched with socio-economic development (Mbingo, Dlamini & Dlamini, 2002). There is the country's need 'for innovative and participatory curricular reforms to equip teachers and students with relevant and emerging knowledge and skills to face the challenge of today's society' (p. 273). This implies that they need an agricultural curriculum that is both useful academically to learners and also economically to the country.

They proposed 11 new areas in addition to the 18 existing areas for secondary agriculture curriculum; of which fifty per cent of the curricular content is attributed to the production area with the reminder distributed to business management, entrepreneurship, and IT (information technology). According to them the inclusion of these new areas is to ensure relevant curriculum that responds to the challenges of today, particularly for *school leavers* after secondary education. The 11 new areas are: (1) honey bee keeping; (2) baby vegetable production; (3) mushroom production; (4) floriculture; (5) entrepreneurship; (6) information & technology; (7) business management; (8) fish production; (9) agroforestry; (10) food processing; and (11) landscaping. The 18 existing areas are: (1) broiler production; (2) egg production; (3) indigenous poultry production; (4) hatchery enterprise; (5) beef production; (6) goat production; (7) sheep production; (8) dairy production; (9) pig production; (10) rabbit production; (11) vegetable production; (12) nursery enterprise; (13) sugar cane plantation; (14) field crops production; (15) fruit production; (16) farm machinery; (17) water harvesting, irrigation & storage; and (18) farm structures. The additional new areas (such as the business management, entrepreneurship and information technology), they said, are to encourage students to be innovative and to learn to take business risks in addition to agriculture production.

Further, Dlamini, Mbingo and Dlamini (2003:38, emphasis added) argued that the Swaziland Government held the view that ' ... in addition to academic subjects, agriculture, home economics, technical and commercial subjects be taught to primary and secondary school pupils *to give a broad educational background which equips school leavers to live more productively'*. This implies that socio-economic compliant curriculum, including alleviating poverty, is most relevant to their secondary students who intended to leave school for employment. They further stressed (in relation to the school leavers issue) that 'given the dynamic nature of the global agricultural industry, the need for curriculum reform in schools has never been greater to address the inadequacies of the agriculture curriculum in relation to present and future prospects of school leavers' (ibid.). However, they also realised that there should be the provision of 'broader science and technical foundation, more management and business skills, as well as specific job competencies' in order to cater for all.

Brunei Darussalam may not put so much particular emphasis on attending to the school leavers' needs as the ultimate aim of secondary education, but more importantly for continuation to the next level. The solution may be to balance both purposes: to give the curriculum a content mix that provides both occupational (for potential school leavers) and academic (for furtherance of higher education) scope.

2.10 Globalisation and Agriculture

'There is a need for education decision makers to renew the learning contents of secondary education so that it can impact in a holistic way, the relevant knowledge and life skills that will empower young people to engage in productive and self-fulfilling life and work, and to develop positive attitudes and values in dealing with the paradox and conflict generated by change' (Holsinger & Cowell, 2000:83). As the world is facing globalisation, there is the need for a diversified pool of talented people in various disciplines and professional areas as an integral part of the economy. Schools are challenged to give the best and highest quality education to prepare our generation for the new and difficult challenges ahead of them. We need to develop global thinkers, actors and individuals who can survive against all adversity.

Change in school is also inevitable as the world we live in is changing. ‘For the world has changed, and we must change with it’ said Barrack Obama (2009) in his inaugural speech as the new president of the United States of America. School systems need to reflect these changes through the way curricula is formulated and developed: the goals, objectives, learning outcomes and content. The new era of responsibility is to call for educationists to strengthen efforts to find ways to tune in with the challenges of globalisation and change by conciliating teachers, curriculum developers, agriculture experts and the like.

Agriculture is becoming increasingly industrial, unlike traditional subsistence farming, and thus the need to address this in education. World agriculture nowadays is also facing the globalisation effect; therefore it is very hard and challenging for an educationalist to align economic reformation perspectives in teaching and in school curriculum. However, Young (1998) made it very clear that ‘we are entering an era of education-led, or, more broadly, human resource-led economic growth’ (p. 69) and when ‘it is *national systems of education and training* rather than *national economies* that will determine the fate of nations’ (Reich, 1991, cited in Young, ibid., emphasis added). However, Young also argued that ‘no concept of personal and social development for the 14-18 age groups would be adequate without incorporating an understanding economic and technological change’ (p. 103).

Given that this study is about agriculture education, its educational aspect is mostly related to humankind in society, hence the need to broadly view it through humanistic and social science perspectives in education. The sociology of transformation in South East Asia as discussed by Evers (2005) included education, the economy, and society, undergoing globalisation due to info-communication technology, both at the local and social transformation. Power (1997, in Evers, 2005:5) defined economic globalisation (and is agreed by most writers, as Evers noted) as ‘the progressive integration of the economies of nation across the world through the increasingly unrestricted flow of global trade and investment’. Evers also mentioned that knowledge factors (following Max Scheler, 1924/1960), which could be in the form of *ideal* (or spirit: ideas, values, predispositions, knowledge) and *real* (social or material conditions), determine the selection of knowledge that is created, formulated and believed to be *relevant*. He concluded that globalisation has ‘established conditions for the rise of a knowledge-driven world economy and society’ and ‘knowledge governs economy and society’ (not the other way round, but both equally influential), and finally that ‘when the ideal and real merge, knowledge becomes a reality – a real factor, as the new sociology of knowledge to contend’ (ibid., p. 12).

Changes to industrial economies thus could influence the basis for a new curriculum. The changes stressed by Young (1998:74) include the ‘globalisation of economies and the massive increase in the potential for competition that goes with it and the productive potential of information-based technologies’. To meet the globalisation challenge ‘it asks for an in-depth interrogation of curricula, particularly in terms of their relevance and appropriateness for national and social demands’ (Venter, 2003 cited in Mc Donald et al. 2007:5). To tackle such issues, Young advised *increasing flexibility* (the opportunity for individual students to make choices and combine different kinds of learning in new ways) and *improving coherence* (the sense of clarity that students need in order to know what they need to learn and where a particular course of study or cluster of modules will lead them).

Conroy (2000:75) suggested the need for *broad-based curriculum* beyond production to cater for broader career choices apart from farming and to negate students’ and the public’s perception that agriculture is mainly farming. Meanwhile, Osborne and Dyer (2000:58) stressed the need for ‘more science integration into agriculture’ to make knowledge more effective, and to esteem course reputation to cater for professionals and higher learning. Others had suggested curriculum provision for learning life sciences, including agricultural and food systems, that would ‘help students apply academic concepts in real-world settings outside of the classroom, make connections to their communities and future careers, and prepare to live and work in a global society’ (Knobloch, 2008:537). The next chapter will discuss the literature review on threshold concepts and how its potential could relate to the idea of quality learning in agriculture.

Chapter 3

REVIEW OF LITERATURE: THRESHOLD CONCEPTS

This chapter aims to explain how and why my research questions relate to literatures, and why I wish to know about threshold concepts and its potential for curriculum innovation in agriculture education. It also tries to explain to readers why threshold concepts research offers some useful ways and benefits in contributing to various disciplines, before I finally discuss how threshold concepts can enhance quality curriculum in agriculture education.

3.1 Connecting for Understanding

Not all students can see the connection between concepts and receive meaningful learning, particularly among those who are not so successful. Some students at the secondary level do not understand in depth what they learn at school. They fail to get a deeper understanding and therefore are unable to think in an agricultural way. This failure not only jeopardises the relevance of their learning but eventually also the quality of final graduates. For most of them, the ability to make connections in their conceptual understanding is unlikely to happen at this stage. Clear understanding may only take place at the university level as most research have shown. Could such a lack of understanding emanate from the failure to integrate various concepts? If so, what are the likely concepts that could help integrate agricultural understanding? These questions are critical in curriculum design when considering quality and relevance in agricultural learning.

An ability to connect thoughts and ideas within any existing knowledge is therefore central to understanding. Bartlett (1932, cited in Newton 2000:15) described understanding as 'a mental attempt to connect something that is given with something other than itself'. Newton (2000:39) emphasised that 'understanding cannot be transmitted but has to be constructed by the learner'. He argued:

> Understanding is not something that can be passed or transmitted from one person to another. No one can make the connection for someone else. Where there are connections to be made, the mental effort has to be supplied by the learner (p. 2).

The connection between sub-concepts is thus vital for students' understanding and mastery of a subject as a whole rather than in disconnected parts. Making sense of understanding can transform their views about the world. This determines the usefulness and functionality of the acquired knowledge so as to be applied to any related context, real world setting, or situation, presently and in the future.

Interestingly, a transformation-related ability to connect various concepts is usually seen in the most successful students. For example, when I asked a top student what he did that made him the best student of his group, and whether he had done a lot of extra reading on top of what had been given or if there is any particular references or journals that he frequently read, his answer was none of the ones proposed. Surprisingly, he said he was able to connect between what was learnt from one course to another in the whole programme. This is really fascinating as it seems that the key to successful study is not based on the quantity of knowledge gained but rather on knowing how to go around it connectively in forming a bigger picture to grasp the whole course.

Similarly, another student who was concerned about securing a place at Cambridge University managed to get 22 A's in his Advance Level Examination, far exceeding what was required. When asked how he coped with his study and exams, he responded that he only studied ten minutes for each of his subjects and spent up to 12 hours studying daily in total. How was he able to do this? He explained he was able to link many kinds of knowledge together and claimed that everything just clicked. This seems to suggest that knowledge in isolation or in a discreet manner seems unworthy of its function, as only when pieced together common-sense thinking develops. Integrated knowledge becomes more powerful, and the transformed understanding provides extremely useful functions. And it seems that the brain can internalise far more factual information when it is integrated in an orderly manner. This seems like an analogy of the data in a compressed file stored in a computer which allows more data storage as the linking factor causes data compression to be logically grouped together. This suggests that perhaps understanding in an organised, logical, sensible manner would allow human brains the capacity to process, compress and accept much more knowledge and information due to more storage space being freed up as a result of this increasing compression within the deeper structure of brain cells, which also gives ease of information retrieval when needed. Indeed, Davies (2003:6) stressed that 'the power and value of the threshold concept can only be recognised by a student if they can see how it is able to act in an integrative way'. This is amazing, and something worthy of investigation.

Students' successful learning from research suggested that learners need the capability to understand and relate the various concepts embedded in a discipline. This emphasis is even more crucial in agriculture due to the multiplicity of knowledge that is required, including science, business and technology, which calls for efficient utilisation and application to the real world. Recent studies about forming deeper understanding in disciplines have more influence from the threshold concepts research (Meyer and Land, 2003). In threshold concepts understanding, once threshold conception is mastered it organises thinking and holds other smaller concepts to bigger ones to be properly arranged in the meta-cognitive structure of the learner. This provides deeper meaning and understanding. To know how students engage in threshold concepts understanding is thus the epitome of the search for quality that I hope to achieve through this inquiry.

This first section has introduced readers to the scenario of learners being unable to make connections due to misconception versus those that are considered successful. The next section will present more literature about threshold concepts as the tool to approach quality in this study and its connection to this investigation.

3.2 Threshold Concepts and Threshold Conception

Interestingly in relation to any discipline or subject, Meyer and Land (2003) stated that there are threshold concepts that help to bind understanding of various concepts together. It is not just a single threshold concept but a web of concepts linked together which students must master to get to the overall understanding of the subject. Davies and Mangan (2006b:7) view 'threshold concepts within a discipline as forming an interconnected web' and not merely a set of isolated concepts.

So, what does concept and threshold mean? In simple terms a *concept* is a general idea or notion after something is presented. It can also be considered as an idea that formed from inference or conclusion (Koba & Tweed, 2009:119). Sfard (1998:5) wrote that 'concepts are the basic units of knowledge that can be accumulated, gradually refined, and combined to form ever richer cognitive structures'. Donald (2001, cited in Land's presentation, 2010) defined a concept as 'a unit of thought or element of knowledge that allows us to organise experience'. So, broadly defined, a concept is simply a unit of idea comprising knowledge or even experience that leads to understanding.

Threshold, on the other hand, is the door way or the crossing at the door step of an entrance. Threshold comes from the Latin word ‘limen’ in which liminality means the ‘suspended state’ (Meyer & Land, 2003:10 & 2006:16). It is also described as the ‘incubation period or the period of uncertainty or being stuck in the bubble’ (Osmond & Turner, 2010:352). In Meyer and Land’s words (2003, cited in Cousin, 2006c:139), liminality is ‘a suspended [or transformative] state in which understanding approximates to a kind of mimicry or lack of authenticity’. Precisely, Meyer and Land (2003:1 & 2006:xv; added emphasis from Land, 2010) define a threshold concept as:

> Akin to a portal, *a liminal space*, opening up a new and previously inaccessible way of thinking about something. It represents a transformed way of understanding, or interpreting, or viewing something without which the learner finds it difficult to progress, *within the curriculum as formulated.*

Taken together, it can be said that threshold concepts are *transformational ideas* that allow the understanding of something, which in the words of Meyer and Land (2003) are concepts that have a binding effect or connectivity which links, binds, and is capable of tying up together the network of concepts in a discipline to cause ‘transformational effects in learning’ (Harvey & Green 1993, cited in Watty, 2003:215), ultimately determining quality education.

Threshold *conception* on the other hand is *how the conception is conceived* in the learners, the ‘underlying game’ (Perkins cited in Land, Cousin, Meyer & Davies, 2005:61), and the *how the learners get to the understanding*. It is a ‘penny drop moment in learning theory which only happens after a period of gestation process’ (Cousin, 2006b). This suggests that it is a kind of a belated realisation of something after a period of confusion or ignorance in learning has taken place. Conception is only reached after overcoming the barriers to understanding (Perkins, 1999), which is essential in making progression to the next level of understanding in learning. Confusion caused by an inability to remove the stumbling block in learning will hamper learners from progressing, and thus the learner will be in a state of liminality, or ‘stuck in-between threshold’ (Perkins, 1999) or in a suspended state as per Meyer and Land (2003 & 2006).

Threshold conception is thus a moment almost like the onset of understanding as everything clicks, fits and falls into place, as learners are beginning to make sense and connect what has been learnt which enables them to use or apply that knowledge to a suitable context. As when this happens, ‘students feel they are part of the subject by thinking in a scholarly way in the discipline’ (Davies & Mangan, 2006a:1). Meyer and Land (2006:xvi/42) expressed the threshold concept as the ‘episteme of a discipline: the way of thinking and practising that epitomises the type of analyses conducted by scholars of that discipline'. They also claimed that 'within each discipline, field or profession there are threshold concepts which integrate and define the scope of the academic community with which a student is engaging' (Meyer & Land, 2003). It is thus the height or pinnacle in the understanding of higher order thinking wherein everything fits together and forms an overall picture or deeper understanding within disciplines, and which informs direction towards a particular purpose or goal of education that wishes to achieve.

Both threshold concepts and threshold conception are almost like a key to unlocking a door or pathway to a mysterious secret garden that offers a wealth of beautiful knowledge to facilitate further understanding. 'On acquiring a threshold concept a student is able to transform their use of the ideas of a subject because they are now able to integrate them in their thinking' (Land, Cousin, Meyer & Davies, 2006:195). It results in thinking where everything makes sense and fits nicely to occasion a transformation. Indeed, this has been expressed in the threshold concepts definition as 'akin to a portal or doorway opening up a new and previously inaccessible way of thinking about something' (Meyer and Land, 2003). It therefore emphasises the importance of making connections in the concepts or knowledge learnt and transforming deeper understanding. Threshold concepts are the key to all other concepts as they bridge concept to concept, even theory to practice, and perhaps everything else in a totally meaningful and contextual way. A chemistry analogy is a binding force or covalent bond that holds atoms together forming bigger molecules so that the formed molecules possess functions enabling them to carry out their roles properly, effectively and usefully.

The web of concepts held by the threshold concepts are like an inter-locking device which holds everything together in place in order to stabilise it and function properly within the concepts' web. They then form a group of massive knowledge systems that determine the scope of a particular understanding within a discipline or community. Specifically, the threshold concepts learning outcome has been defined by Meyer and Land (2003:1) as 'transformative gateways that lead ultimately to *ways of thinking and practising* which are routine to individuals who are inside a subject but alien and difficult to grasp for individuals who do not regard themselves as part of that subject community'. They wrote that 'a threshold concept represents a transformed way of understanding, or interpreting, or viewing something without which the learner cannot progress' (Meyer & Land, 2006:xv), and this transformed understanding may occur immediately or after some time, in the people of a particular discipline depending how they experience the phenomena within that discipline.

In agriculture learning, it is important that knowledge be functional and to evidence a learner's capability in understanding and applying the knowledge to practice on what is known through hands-on activities and manipulative skills. Agricultural knowledge diversity and its multi-disciplinary nature require a collective deeper understanding for operation. It is therefore is imperative for learners to link the vast various concepts (science, business and technology) embedded within it in order to really utilise/practice the knowledge. The related network of concepts must form the building blocks for grasping multi-disciplinary concepts and knowledge functionality when students learn agriculture. Only then will they be in a position to exploit and use the knowledge to their advantage in a real world context.

This section has discussed two very important definitions, threshold concepts and threshold conception, and what they mean to me as a novice researcher and also their importance in agriculture learning. The next section will look in detail at the characteristics of the common features of threshold concepts.

3.3 Threshold Concept and its Characteristics

How to recognise a threshold concept? And when is a concept not a threshold concept? These are key discerning questions as not all concepts can be categorised as a threshold concept. Therefore, we need to be able to recognise it based on the five characteristics described by Meyer and Land (2003:6). Their threshold concept features are:

- First, it should be *transformative*, in that once acquired they should shift perception of the subject.
- Second, they should be *irreversible*. Once a student has begun to perceive the world in terms of a threshold concept it should be inconceivable that they would return to viewing it in a more primitive way.
- Third, a threshold concept is *integrative*. Meyer and Land describe this as the capacity of a concept to expose the previously hidden interrelatedness of something.
- Fourth, a threshold concept is *bounded*. That is, it helps to define the boundaries of a subject area. If a threshold concept is relinquished, thinking begins to move outside or beyond the scope of the subject itself.
- Fifth, it is potentially *troublesome* in the sense defined by Perkins (1999). That is, a threshold concept may be counter-intuitive. In grasping a threshold concept a student moves from common sense understanding to an understanding which may conflict with perceptions that have previously seemed self-evidently true.

Just like the web of concepts, the above five characteristics are interwoven. Of these, Meyer and Land (2003:6) emphasised that, ‘the first three characteristics seem mutually interdependent. It is because the concept is integrative that it is also transformative and irreversible’. Meanwhile, Perkins (2006a) claimed that troublesome knowledge can involve difficult, specialist language or be counter-intuitive and alien. In an economic discipline, integrative is the most important in order to think like an economist, whereas ‘*integrative and transformative* were to be the *key attributes* in threshold concepts, and in most cases these would be troublesome’ (Meyer & Land 2003, cited in Davies 2003:5, emphasis added). In the words of Davies and Mangan (2006a) often ‘concepts that are integrative and transformative are more likely to be irreversible because they have opened up a new way of thinking that cannot easily be forgotten’ (p. 3). This poses a problem for teaching a threshold concept as most teachers have difficulty reverting to the stages when they began to learn as students, and thus in turn encountering problems in teaching their students how to understand (Cousin, 2006b).

So how can we identify a threshold concept? Davies (2002, cited in Meyer & Land, 2006:8) wrote ‘one way of seeking to identify a threshold concept in Economics might be to examine discourse on social and economic policy between economists and non-economists’. Here, Davies found that there is a distinctively different way of thinking between the two. He found that ‘an economist is thinking and working within the economist framework of thinking, such as using a concept of general equilibrium when explaining a certain phenomena, whilst the non-economist use a typical common-sense feature’ (p. 7). Learning from this, I will seek to identify a threshold concept or concepts via a case participants’ discourse analysis of interview data as they reflected their learning experiences while seeking knowledge, and also from their teachers’ discourse corresponding perspectives as experienced by their students.

And, when is a concept not a threshold one? Not all concepts would be categorised as a threshold concept if they do not transform one’s understanding, despite being troublesome. For example, Atherton (2008b:1) mentioned the concept or idea of a ‘pi (the ratio of the circumference of a circle to its diameter)’ in mathematics which is just an irrational number usually used in the circle calculation. Atherton remarked that anything that is ritual knowledge is also considered un-threshold, such as the double-entry method in book-keeping. He said that it is just a method, and does not provide any transformational shift in one’s understandings regarding something. A threshold concept should provide something that is ‘beyond understanding’ said Perkins (2006b) in his video conference presentation at the Strathclyde University (http://video.strath.ac.uk/06/140-06-01.wvx). Another example to distinguish a threshold concept from what is not (see Meyer and Land, 2006:6) is to take, for example, the £200 cost and the opportunity cost. Certainly, the £200 cost would mean its monetary value and is therefore self-explanatory, whereas opportunity cost can have different meanings as its hidden meaning could be construed differently by students. But once understood, it can shift one's understanding of economics and determine an individual's behaviour in making choices when purchasing something.

Since no study on a pure agriculture threshold concept was found in the literature, a close example to the agriculture discipline is perhaps photosynthesis, a threshold concept in biology. Taylor (2006) argued that the actual term photosynthesis is not a threshold concept in itself but the idea of water movement and carbon dioxide utilisation in the process is the threshold that provides transformational understanding of the concept. Most students can define or state what photosynthesis means but to explain water movement between cell structures and the absorption of carbon dioxide from air to form solid matter (or wood) would be unreachable thinking. Even among the world renowned science graduates at the Massachusetts Institute of Technology, Boston, USA, difficulty was found (see the video: Misconception and Dead Ends, http://www.youtube.com/watch?v=VeWjMxY5-Kg). 'To see beyond the initial concept is what the problem is' said Perkins (2006b), in his video presentation. So, it can be said that photosynthesis is a threshold concept but not the definition of the concept, rather the understanding of the deeper processes within photosynthesis, such as the osmosis (water movement) and carbon dioxide uptake, forms a holistic view of the whole process. Basically, it is easy for students to define what photosynthesis is, but to see beyond it and understand what is really involved during the complex process is quite troublesome for many.

Thus, a threshold concept is not only difficult for students, but also to explain here. Readers would appreciate that as a novice researcher, it took me some time to understand it. This section has discussed the characteristics that a threshold concept must possess in order to be one, and what is not one. The next section will look further into some of these characteristics, and what distinguishes a threshold concept from a core concept.

3.4 Threshold Concepts and Core Concepts

A threshold concept is a *transformational* to ways of thinking and practicing and is therefore dissimilar to a core concept. A threshold concept is quite distinct from a core concept because a threshold concept is the idea behind something that leads to transformational ways of thinking and practicing, and not just the building blocks of knowledge that leads to progression. Core concepts at the university level, according to Meyer and Land (2006:6, emphasis added), are 'conceptual *building blocks* that *progress understanding* of the subject; it has to be understood but it *does not* necessarily *lead to a* qualitatively *different view* of the subject matter'. This indicates that a core concept is not transformative. Transformative, according to Meyer and Land, means that 'once understood, its potential effect on student learning and behaviour is to occasion a significant shift in the perception of a subject, or part thereof' (which may include a transformative shift in thinking, values, feelings or attitudes) and 'may also involve a performative element' such as in sports science where students are involved in aquatic sports (p.7).

An example that differentiates between a core and a threshold concept given by Meyer and Land (2006) is the concept of gravity:

> The concept of gravity – the idea that any two bodies attract one another with a force that is proportional to the product of their masses and inversely proportional to the distance between them – represents a threshold concept, whereas the concept of a centre of gravity does not, although the latter is a core concept in many of applied sciences (p. 7).

Clearly, a threshold concept is quite tricky and not easy to identify, but what really distinguishes it from a core concept is that it has to affect a transformative outcome to shift perception or thinking. That is, it can occasion a transformation. A threshold concept is the idea behind the concept, not just the concept alone. Besides that, a concept may be a threshold one in a particular discipline but may not in another discipline. This is because a threshold concept in a particular discipline, say agriculture, may not be useful for other discipline, such as economics. Thus, a threshold concept is not only discipline specific, but also knowledge and context specific. The next section discusses why grasping the idea of a threshold concept is potentially difficult.

3.5 Threshold Concepts and Troublesomeness

The threshold concept is potentially troublesome, but not always, as it focuses on conceptually difficult knowledge. This is because 'the difficult concepts are troubling for it to be transformative' (Davies, 2002, cited in Meyer & Land, 2006:10). Davies argued that 'integration is troublesome because you need to acquire the bits before you can integrate, but once you've got the bits you need to be persuaded to see them in a different way'. This seems to suggest that core concepts are still needed before a threshold concept understanding could be reached.

Perkins (1999, cited in Meyer & Land, 2006:11) observed that troublesomeness often occurs in mathematics and science due to 'a mix of misimpressions from everyday experience (such as objects slow down automatically), reasonable but mistaken expectations (such as heavier objects fall faster), and the strangeness and complexity of scientists' views of the matter (such as Newton's laws)'. He defined troublesome knowledge (cited in Meyer & Land, 2003:7 & 2006:9) as 'knowledge that appears counter-intuitive, alien (emanating from another culture or discourse i.e. foreign or comes from a perspective that conflicts with our own), or incoherent (discrete aspects are unproblematic but there is no organising principle)'.

Moreover, Meyer and Land (2006:9) stressed that threshold conception is not merely an issue of cognitive organisation and perspective, but that such concepts themselves are often problematic or troublesome for learners. This suggests that it is the concept itself that creates the problem, and we should not solely condemn learners for their cognitive failure to understand. It is interesting how Perkins discussed troublesome as problems of acquisition of the concept, while Meyer and Land focused more on the concept itself as creating the problem (i.e. the counter-intuitive idea behind the concept); when in fact both may equally be responsible for the troublesomeness.

So what could be the possible reasons for the rise of troublesomeness? One reason could emanate from an inability to link the concept with real world (Meyer & Land, 2006:15). According to them, in an economics discipline a threshold concept functions as a way of thinking and practising which draws from contextual problems and situational issues, such as in the relationship between inflation and unemployment but where students do not see the link between it and the real world. 'Not seeing the link is a threshold issue', they stressed. In another example they argued that students 'do not understand the basic logic' and 'do not have a feel for the big picture' in relation to the concept of sampling distribution in statistics in Kennedy's study (1998, Meyer & Land, 2006:9). Another pattern they noticed is where 'students *fail to make connection to the world around them'* (Perkins, 1999:8, cited in Meyer & Land, 2006:10, emphasis added) in that students learning about society in history and social studies 'made no connections to today’s events or family life. Students learn concepts in science but make little connection to the world around them. Students learn techniques in math but fail to connect them to everyday application or to their science studies’. Generally from these, it could be summarised that troublesomeness arises from: (1) not having logic and a holistic picture, (2) a failure to relate it to today and everyday connections, and (3) not seeing the relevance of the real world, for the reasons Perkins mentioned above which can broadly be categorised as counter-intuitive, foreign or alien, and incoherent.

Perkins (1999, cited in Meyer & Land, 2006:9) elaborated on troublesome knowledge further by categorising it according to their forms as characterised by a set of student behaviours: (1) ritual – that has routine and meaningless character, but students fail to understand the complexity of its meaningfulness; (2) inert – that learners just keep it in their minds and fail to make the connection to the world around them and to everyday applications; (3) difficult – troublesome to their intuitive beliefs and interpretations; (4) alien or foreign or comes from a perspective that conflicts with their own and therefore is counter-intuitive; (5) complex due to its paradoxical nature – often due to an inability to detect subtle distinctions (cited in Shanahan & Meyer, 2006:104), such as weight and mass and pitch organisation in music (cited in Meyer & Land, 2006:9); (6) tacit – related to ‘practical consciousness’ (Giddens 1984, cited in Meyer & Land 2006:12) due to the fact that ‘students do not have the tacit understanding of the context in which they are most applicable’ (Shanahan & Meyer, 2006:105). For more detail on this refer to Meyer and Land (2006:9), Perkins (1999:8 & 2006a:37) and Shanahan and Meyer (2006:103).

Also, according to Perkins (2006a:41, also cited in Meyer & Land, 2006:xvi) some concepts are often double trouble when they function as ‘categorisers on one hand and as elements in activity systems of problem-solving and enquiry, in another’. He added that ‘understanding the concepts as categorisers most often is easy but harder to make it active’ or to apply it. One must learn ‘not simply to know about the game but to play the game knowingly’ stressed Perkins (1999, cited in Meyer & Land, 2006:xvi). This means that a successful student who can overcome the barrier that caused the troublesomeness in conceptual understanding should not only know about the concept in its category but should also know how to relevantly apply the concept in its context to capture transformation. An example of such a categoriser as well an element are the concepts of weight and mass, where according to Perkins (2006a:41) the ‘troubles have as much to do with the activity systems that animate concepts as they do with concepts in their basic categorical functions'.

The specific terminology of each discipline is also a source of troublesomeness as this makes it difficult or alien for learners to be part of that scholarly discipline because they have to use certain terminologies to communicate ideas to each other, and be accepted and understood by the community. This is apparent in most disciplines. For example, biology has specific terminology which should be used to explain its knowledge clearly. Similarly, agriculture has its own unique terminology to describe and disseminate knowledge and therefore grasping it is critical for common understanding in its community, and for it to be utilised and functional.

3.6 What are the Indications that a Learner has Reached a Transformative or Threshold Concept Stage of Understanding?

The literature indicated that a transformative or threshold conception stage is reached when one is unable to revert back to where he/she started as a novice. This stage is what Meyer and Land (2006) termed as irreversible. But what forms or aspects are irreversible?

Since Davies (2003:3) said that a threshold concept 'offers more understanding of experience of the world' if systematically embedded in curriculum design, the desired final outcome of a threshold concept in a learner is '*conceptual change in understanding, learning and experiences'* (Davies & Mangan, 2006, emphasis added). As mentioned and discussed earlier under Section 3.4, it involves 'a significant shift in the perception of a subject, or part thereof', including 'a shift in values, feeling or attitude', and even a 'performative element' (Meyer & Land, 2006:7).

Meyer and Land (2006:22-24) wrote that the three states of transformation in a person with respect to the change of state or status between 'transformative or non-transformative or borders' are:

1) Change in state and in thinking – when learners start thinking like they belong to that particular discipline, e.g. students begin to think like economists.

2) Change in identity – gains in new knowledge gives a new status, leading to a new identity typical to a profession.

3) Oscillation between states – 'in-between or stuck in liminality' and unable to transform (i.e. inability to achieve new status argued Meyer and Land, 2006:24), which resulted in mimicry behaviour either 'compensatory or conscious', such as rote learning

and memorising in order to pass assessments.

Inevitably, ‘ways of thinking entails ways of practising’ (Davies, 2006:70). This refers to the application of key concepts from theory into practice whereby a scholar belonging to a particular community ‘has an understanding of how that community thinks and practices’ (p. 80). Given that, he stressed that ‘the act of learning is an act of identity formation’ (p. 71).

This section reminds us what to look for in someone who has (or has not) achieved transformation. There is an irreversible change in a learner’s understanding (or thinking), experience, perception, values, feeling, attitude, performance or practice as well as in identity. The next section will discuss why these ideas about threshold concepts are useful for approaching quality in this study.

3.7 Threshold Concepts to Approach Quality

My pursuit to discover quality characteristics in agriculture learning and its curriculum envisaged this study to detect how people construct ideas of quality. Therefore, the study has adopted an interpretivist standpoint which seeks to look at the world through others’ eyes. Enthusiasm about quality education and learning outcomes compelled me to choose the threshold concept framework as the domain or tool for the means of analysis and also the epistemological approach in this study.

Research has shown that students commonly have conceptual difficulty in any learning because understanding concepts is troublesome. And students most often face difficulty in understanding the hard concepts as they fail to connect between concepts which are needed for mastery, resulting in an inability to make sense of everyday experience. This causes them to revert to rote learning as a strategy to overcome this. As educationalists, what matters most is the art of learning and we need to understand how students understand their learning. A threshold concept investigation is thus useful for looking into this, whereby trying to understand the *meaningful and phenomenal experiences* an individual has in learning agriculture may illuminate content relevance which could become the determining factor underpinning its quality and future improvement.

The threshold concepts framework aims to ‘improve the teaching and learning by identifying and embedding threshold concepts in the curriculum’, stated the threshold concepts team at Staffordshire University, rhetorically (www.staff.ac.uk/schools/business/iepr/etc). In similar pursuit, this is also what this study wishes to aim for in agriculture. Davies (2003:3) wrote that ‘threshold concepts aim to identify and address the needs of students learning if systematically embedded in the curricula and the outcomes evaluated’. Additionally, he expressed that it also offers ‘a more promising basis for curriculum design as it offers more understanding of experience of the world’ (p. 3). And he declared that problems in economic concepts arise because it ‘divorces understanding from experience of the world’ (ibid.). His work has shown that investigating through the threshold concept framework has helped address this issue.

Among other potential benefits of threshold concepts as found in the literature and also based on my understanding that are useful towards this study are as follows:

• Provide insights into students understanding of various concepts in various disciplines (Davies & Mangan, 2006).

• Emphasise the importance of integration/connectedness as happens in most successful students, which helps towards an understanding of the subject as a whole rather than disconnected parts.

• Knowing threshold concepts will help teachers provide student activities and assessments that encourage connection-making.

• Threshold concepts are considered as the ‘jewels in the curriculum’ (Land, Cousin, Meyer & Davies, 2005:61).

The first design principle then is ‘to explore (ideally with students) what appear to be the threshold concepts in need of mastery’ (Cousin, 2006a:5; Davies 2003:3), which is why evidence from this case study’s student feedback is so important for curriculum innovation.

This section has presented some of the benefits of threshold concepts research which justify its use for approaching quality in this study. The next section will present some of the issues facing educational planners with regard to quality curriculum development.

3.8 Threshold Concepts and the Overcrowded Curriculum

Speaking from previous experience, some curriculum developers may think that the more content there is in the curriculum the more equipped and capable students become in their knowledge. Obviously, a better quality does not always correspond to greater quantity. Newton (2000:187) stressed that ’too much content almost inevitably leads to memorisation’.

This suggests that featuring a large number of concepts in the curriculum might inevitably confuse students. A curriculum which does not support better understanding will tend to be overloaded with content, leaving less time for real understanding to take place. Teachers would then rush off to finish and complete the prescribed year's curriculum before the academic year ends. The result is quantity, not quality learning and progression. As a consequence, students have to resort to rote learning as thinking time is hugely reduced. This seems to indicate that although students may pass their examination, it does not mean they actually understand deeper than surface level. They have done so through mimicking understanding by embarking on memorisation (superficial learning). This implies that learning was not sufficiently meaningful and turned untransformative, and therefore could be a huge loss to us in the education sector as they were unable to achieve complete learning outcomes.

It is crucial not to overcrowd the curriculum with too much content as this may burden teachers with the task of delivering vast amounts of knowledge whilst also expecting the students to absorb bulk knowledge without a proper understanding. Meyer and Land (2005) echoed that 'certain concepts were central to the mastery of specific individual subject' and hence these should be the focus. They said when key threshold concepts in certain disciplines are known through research-based evidence, teachers and curriculum planners could make decisions on what is fundamental to grasp the subject. In curriculum development, I believe that it is critical to stick to the fundamentals and essentials by being selective in curricular content. Hence, the less is more approach in curriculum design is often appropriate. Teachers would then have to teach less, and students could have ample opportunities for conceptual thinking and forming deeper understanding, allowing the shift from a teacher-centred to student-centred learning environment. This way, learning will be more focussed on the learners and getting them motivated and being responsible for their own learning.

Cousin (2006a) argued that teachers would teach best by avoiding a stuffed curriculum. In overcoming a stuffed curriculum, she suggested that threshold concepts could be used to define potentially 'powerful transformative points' in the students' learning. Indeed, this is what she meant by threshold concepts being the jewel in the curriculum because they identify key areas for mastery that are responsible for the biggest transformations. In addition to these jewels, Land et. al. (2006:198) wrote that threshold concepts 'allow for richer and more complex insights into aspects of the subjects students are studying; it plays a diagnostic role in alerting tutors to areas of the curriculum where students are likely to encounter troublesome knowledge and experience conceptual difficulty'. Hence, the most important curriculum design principle according to Land et. al. (2006, in support of Davies, 2003) is 'to explore (ideally with students) what appear to be the threshold concepts in need of mastery'. This extols their strong advocacy for curriculum designing to start with a threshold concepts examination in order to avoid teaching an overloaded curriculum. In the following section, this discussion will be related to the idea of agriculture curriculum development.

3.9 Potentials of Threshold Concepts for Agriculture Learning

The potential of threshold concepts research and its capacity to draw together discretely inapplicable concepts is huge. Davies and Mangan (2006a:7-8) mentioned:

> A threshold concept acts as a keystone bringing form and robustness where previously there was a collection of ideas ... to create links with a broader conceptualisation of the topic ... where the inevitable outcome, if threshold concepts work together in a web to define the way of thinking and practising in a subject ... .

Thus, it could be used to provide a useful way of examining quality and relevance in agriculture learning. The existing multitude of concepts which form the agricultural knowledge that students need to integrate, understand and master in the discipline is overwhelming. Challenged by such scope and depth, agricultural concepts' integrativeness would be hugely intimidating to students. This diversity creates more opportunities for failures than experts if students are not guided properly.

Another example of the potential benefit of threshold concepts as cited in Meyer and Land (2006) is in veterinary science (a branch of science closely related to agriculture). They stated that 'concepts with severe conceptual difficulty were quietly trimmed off from the curriculum' (p. 8), allowing planners to selectively choose certain concepts for exclusion.

An inquiry into how teachers perceive the impact of threshold concepts on the experience of their students would also be useful to curriculum planners. Meyer and Land (2006:9) wrote that 'conceptual troublesomeness for students assumes significant pedagogical importance' in the curricular structure. The research findings would equip teachers' to provide a better understanding and encourage learners to make connections and more applications. Teachers would know where to emphasise and make reinforcement by providing more guidance and spending more time on the difficult or troublesome concepts. Understanding learners through threshold concepts thus allows for everyday experience to make sense which will help prevent students from rote learning. Davies & Mangan (2006a) argued:

> If the theory of threshold concepts to be useful in guiding teaching and improving student performance, it must be translated into principles that can inform the design of teaching and curriculum. Threshold concepts provide a way of describing the desirable overall learning outcome for students: they have learned to think and practice in the manner of scholars of a discipline, using a coherently structured body of ideas and procedures to analyse problems as they are defined by that discipline (p. 1).

3.10 Threshold Concepts in Agriculture and Other Disciplines

Threshold concepts research has received international interest and has been expanding since 2003. It started in the field of economics, and then other disciplines joined in. However, despite much research across many disciplines, threshold concepts research in agriculture is very rare. In fact in 2008 when this study was at its inception, I had not sighted any literature on agriculture, and it seemed that this study would be the first of its kind. However, at the time of writing this thesis, a conference paper on everyday threshold concepts in sustainable agriculture was published in March 2012, the only one found in the literature.

In that study, Nguyen (2012) described a one-year fieldwork carried out from April 2010 to 2011. It concerned agriculture promotion at the public and national level which aimed at increasing participation and mobilising stuckness in adopting knowledge and cooperation within agricultural extension workers and between farmers in the Mekong Delta in Vietnam. The findings claimed that the threshold concepts found from two cases – the Participatory Agricultural Extension (PAE) and Integrated Pest Management (IPM) – were not from discipline nor modelling categories but everyday threshold concepts (a type of basic threshold concepts in Davies and Mangan, 2008) whose foundations arise from everyday and personal experiences, based on the 'workers' *peripheral position* in dealing with their daily practical experience and reflections' (op. cit., p. 9, emphasis added). These concepts were: (1) Participatory Agricultural Extension (PAE), (2) farmers are experts (in the PAE cases) to address stuckness in learning, practising and participatory sustainable development; and (3) caring (in the IPM cases) to change farmers' minds and practice in pest and crop management. Nguyen mentioned that the root cause of stuckness was mainly due to the way they perceived themselves in relation to carrying out their roles in the projects, which relates to neither a discipline nor modelling threshold concepts but rather an everyday threshold concept.

Although none so far have specifically studied the agricultural threshold concept in the academic or discipline category, the threshold concept potentials and significance especially in addressing overcrowdedness in curriculum design and other disciplinary areas shown in the literature, is promising. Thus, within the framework of discipline threshold concept research, no pure agricultural threshold concept study could intentionally be mentioned in this section, but could be drawn from other disciplinary areas as examples. Threshold concepts from other disciplines come in different varieties and are not easy to categorise and understand. They range across disciplines starting with economics, then spreading to other disciplines such accounting, biology, physics, chemistry, sport science, engineering, automotive, mathematics, music, nursing, and even languages and philosophy. The list keeps growing over time, but I will only mention a selected few of these in this section.

Threshold concepts examples in economics are opportunity cost (the value placed on the best rejected alternative or opportunities when an individual makes choices), elasticity and price. These must be fully understood by students learning economics. The concept of opportunity costs (according to Meyer and Land, 2006:6) related to the issue of making a choice (i.e. between 'choosing scarce resources or alternatives when these are limited, which requires people to compare between choices and scarcity of such opportunity') is troublesome and 'suggestive of ritualised form of knowledge (routine and rather meaningless character)', but could also be due to a clumsy (troublesome) language usage that contradicts with everyday language, or because of a student's inert knowledge that 'sits in the mind's attic' (p. 103), 'unrelated or unconnected to everyday or real world connection' (p. 107).

In accounting, depreciation and the relationship between profit and cash seem to be the cause of troublesome conceptual difficulty. Previous studies on accounting threshold concepts suggest that threshold concepts need to be placed within a context to reduce its troublesomeness (see Meyer & Land, 2006:xx; Lucas & Mladenovic, 2006:148). In pure mathematics, the concept of limit, as in differential and integral calculus, proved to be one of the most abstract and troublesome functions because the word 'limit' has a definition different from that used in everyday language.

Another obvious trend I see is the concepts that are not so observable or invisible to our naked eyes, something that could be abstract in nature and cannot be easily imagined. Such concepts in biochemistry are the molecular and macromolecular structures, and the behaviour of these molecules (see Loertscher, 2011). Similarly in biology, the concepts in the complex process of photosynthesis or osmosis, basically anything that happens inside a living cell. Threshold concepts research in science subjects such as biology (which have a strong root connection to agriculture) show interesting findings. Taylor (2006:98) found out the most troublesome concepts are associated with 'process concepts and abstract concepts'. A process concept, such as the process of photosynthesis (not the term and definition of photosynthesis itself), is troublesome due to the dynamic nature of biological knowledge that incorporates change as an integral component. Abstract concepts such as what happens in cells and between membranes, the DNA structure, for example, are troublesome, as these cannot be easily visualised by normal eyes. Astonishingly, part of these process concepts Taylor mentioned were related to plant science – 'the biochemistry of photosynthesis in plants, and water uptake in crops' – and was specifically associated with agricultural botany. To me, this represents the closest to agriculture concepts under the threshold concepts investigation so far. Further, Taylor argued that 'while appearing very different, these areas all rely on an understanding of the fundamentals of osmosis – the movement of water across a membrane' (p. 88). She added 'an appreciation of the significance of this water movement opens door to many other concepts within plant and animal biology from the sub-cellular to the whole organism level' (ibid.). It implied then, as Lawson (2003, cited in Taylor, 2006:94) that 'objects or processes which cannot be viewed directly prove much more difficult to teach and to understand', such as molecular biology and biochemistry. Taylor also suggested that 'abstract concepts should be *learnt integratively and viewed holistically* as forming a larger understanding of living systems contextually' (p. 88 & 98, emphasis added), and that students should be given the opportunity to 'appreciate the concept first, after which they, or the teacher, assign a word, or technical term, to it. Only then will they successfully cross the threshold and begin to function in their scientific environment' (p. 95).

Hence, from my acquaintance with literatures and ranges of troublesome knowledge in various disciplines, it seems that concepts which appear to be troublesome or difficult in most disciplines are those that seemingly having operations which I come to understand as operational concepts or concepts that have life or functions. These are the concepts which can change due their dynamicity and can fluctuate under certain circumstances, conditions, and contexts; such as that seen in gravity, opportunity costs, price and demands, and so on, or explicitly what Perkins (2006a:41) claimed as ‘animate concepts within activity systems’.

Also as mentioned in this chapter, the existence of troublesomeness in the concepts is attributed to the unfamiliarity or alienation or foreign knowledge to students which has resulted in the failure of students to relate to their everyday examples and reality of real-life practices in our world. The feeling of familiarity is interrelated to ‘recency and frequency of previous encounters; it influences difficulty which further influences the feeling of correctness and confidence’ (Efklides, 2006:52). Other examples consist of concepts which are hard to describe, but are rather performed tacitly (by doing and feeling) e.g. dancing, driving skills, etc., or anything that needs doing or feeling by bodily movements.

Troublesomeness associated concepts are persistent across various disciplines due to the nature and complexity of the concepts. Hence, this implies that teachers/curriculum planners should do more in pedagogic approaches to address conceptual troublesomeness, so that students’ failure to ‘link to ways of thinking and practising within these disciplines’ (Meyer & Land, 2006:16) can be minimised.

3.11 Troublesome Knowledge and Constructivism Methodology

Is there any relation between troublesome knowledge, threshold concepts and constructivism? Do they support each other? The idea of threshold concepts as a *way of thinking and practising* in disciplinary areas was first coined by Meyer and Land (2003). However, linking this to ways of thinking and practising besides concepts integration also requires knowledge construction. Perkins (2006a) being a constructivist advocate, emphasises that constructivism can offer better *ways of teaching and learning*, particularly with troublesome knowledge. There seems a subtle distinction between thinking and practising that is embodied in the threshold concept transformative way, and the teaching and learning practices that are in constructive engagement in order to get there.

The ‘threshold concepts are pivotal but challenging concepts in disciplinary understanding’ (Perkins, 2006a:43) and that ‘constructivism is the answer when the question is how to deal with problems of understanding’ (ibid., p. 33). Perkins linked constructivism to threshold concept when he said it could be treated ‘as a toolbox for problems of learning’ (ibid., p. 45). ‘Constructivism is the approach to the psychology of learning emphasising the active role of the learner in making sense of his/her world' (Atherton, 2008a:1). Moreover, Perkins (2006b, in his video representation – Beyond Understanding) stressed that relevance is when the student finds it 'engaging, exciting and helps make sense to the world'. This seems to indicate that constructivism can bring out relevance in learning when it is exciting and engaging to students.

Perkins argued that there is a tension of constructivism being mistaken between a methodology and an ideology. He argued that constructivism is not an ideology that must be used in every lesson. Rather, it is a *methodology of teaching* that should be regarded 'as a toolkit' (Perkins, 2006a:34) for delivering successful lessons, and used only when it is pragmatic to do so – this is what he called the pragmatic constructivism. He believed that lessons which do not warrant a constructivist style of teaching (as there is no need to do so) can be done in any other simplistic way that give similar results. In his opinion, constructivism is pragmatic, especially in dealing with troublesome knowledge whereby students can constructively engage in a variety of learning techniques (active discussion, discovering, investigating, collaborative or cooperative learning, hypothesising, analysing and take viewpoints) and hence assume their roles as 'active, social and creative learners' (Phillips, 1995 as cited by Perkins, 2006a:34). He stressed that students are active learners in these constructivist techniques, instead of just passively listening, reading and working through routine exercises. They socially co-construct knowledge by interacting in a dialogue with others. In constructivists' learning environment, creative learners create or re-create or re-discover knowledge from scientific theories, historical perspectives and so on, he added.

Much about constructivism can benefit threshold concepts learning, but Perkins warned that the methodology takes time to conduct so as to usefully avert conceptually troublesome knowledge towards deeper understanding and better retention; hence his advice for pragmatic using. That typically is when tackling the underlying issue, the troublesome threshold concept is 'inter-tangled with threshold episteme' (Perkins, 2006a:44). Episteme or 'ways of knowing can be defined as a system of ideas or way of understanding that allows us to establish knowledge' which is related to 'manners of justifying, explaining, solving problems, conducting enquiries, and designing and validating various kinds of products or outcomes' (ibid., p. 42) – all of which are familiar modes of constructivism learning epistemology. He stressed that it is not just the threshold concept per se, but also how epistemological it is. Perkins (ibid.) opined that constructivism teaching and learning methodology 'make sense for troublesome epistemes much as they do for troublesome concepts'.

So, what is distinctive about threshold concepts and constructivism then? The threshold concepts are focussing on the difficult or troublesome concepts that act as barriers in the learner's effort to try to progress, due to that knowledge being troubling as it is transformative. It focuses attention and sensitivity on how *learners* are individually different in their learning; some learn with ease and some easily get stuck; and as a consequence provides impetus on what might teachers do in teaching and designing their courses in order to overcome such a problem (Meyer & Land, 2006). 'Teaching and learning are both very complex and challenging processes' (ibid., p. xiv). Constructivism on the other hand, puts stress on *teachers* knowing students' prior knowledge at the beginning of lessons, and knowledge acquisition that is required, before new learning can take place. It emphasises learners being active, constructive and creative. Thus, the distinction lies on the emphasis, between that of the learner's perspectives and the teacher's roles, and whether it be more learner-focussed or teacher-focussed, both are necessary to create successful learning.

Furthermore, both tend to have almost similar goals, but not quite. The threshold concepts deal with the integration of the build-up of various kinds of knowledge through overcoming troublesomeness in order to make progress and be transformed. Constructivism attends to the build-up of knowledge from the existing prior knowledge by employing a constructivist teaching approach through using various learning techniques so that students can progress successfully and achieve better retention. Indeed, both seem to complement the teaching and learning process and to foster higher order thinking. When the threshold concepts have identified the key mastery for learning, subsequent constructivism methodology can pave the way to facilitate better understanding. In either way, it is a matter of *transformed learners* as well *informed teachers* that results in successful learning outcomes. Thus, knowing the conceptual difficulties the learners face can help teachers do something about it through constructivism. Hence, they do support each other. In sum, learning a new knowledge requires integration of concepts (as in the threshold concept framework) as well as the reorganisation or reorientation of existing knowledge (accommodation and assimilation in the constructivism framework) which often is troublesome (in the troublesome knowledge framework) before it can have a transformative effect on an individual.

3.12 Threshold Concepts, Progression, Transformation and SOLO

Obviously, before a transformation or deep understanding can be formed in a learner, there has to be some sort of progression taking place. Progressions are formed when core concepts or the bits of information are gathered (Davies, 2002, cited in Meyer & Land, 2006). An integration of concepts or ideas will lead to a person's transformation if these are being held by a key threshold concept. The phases of change seem like moving from a concept to concepts to relational/integrative concepts (progressive understanding) to transformative concepts (transformational understanding) or *deeper understanding* in an individual.

The relational or integrative phase in the threshold concepts framework may have some convergence with the Structure of the Observed Learning Outcome (SOLO) taxonomy that is given for progression in SOLO, concepts or ideas that relate or connect together but are not necessarily transformative. The SOLO taxonomy talks about some of the progression in the learning cycle of *secondary* education students as having five hierarchical levels as: pre-structural, uni-structural, multi-structural, relational and extended abstract (Biggs & Collis, 1982).

Biggs and Collis (1991:65) described unistructural – is where the learner focuses on the relevant domain, and picks up one aspect to work with; multistructural – the learner picks up more and more relevant or correct features, but does not integrate them; relational levels – the learner now integrates the parts with each other, so that the whole has a coherent structure and meaning. They mentioned that these levels of the learning cycle repeat within all modes therefore could be used *to evaluate learning quality*, or *to set curriculum objectives* as the 'hierarchy can tell us how far learning has progressed' (ibid., p. 64). Eventually, Biggs also claimed that SOLO is 'useful in assessing a student's progression in terms of its quality not by quantity of how many bits of this and of that they got right' (Biggs BlogSpot, 2011).

On another note, it must also be remembered that, both SOLO and the threshold concept, are focussing on learning outcomes, but SOLO is concerned mainly with what students can do in learning, or when they are trying to understand as they *progress* in their learning cycles, in order to measure the quality of any learning in subjects. It is also useful for assessing the quality of students' responses which could help teachers identify students' progression (or problems) in understanding which may signal the need for intervention, therefore creating a more useful tool for focussing on assessment *during* learning, they claimed.

Threshold concepts on the other hand, concerns what students have become – typical of a scholar belonging to a particular community or discipline – as embodied in student thinking and practice. This means that it measures the overall quality of a specific discipline or goal of the particular discipline at the end of an undertaken course or training, which foresees if they have become the intended expert or someone of a particular community. Therefore, the threshold concept is more concerned with the connecting idea that transforms ways of thinking and practising and therefore operates at a discipline/professional level or at a higher level of education as an outcome. It is thus the overall thinking that regards someone belonging and being capable of thinking at a discipline level as a result of conceptual transformations derived from the embodied learning experiences. This means that both the SOLO and threshold concepts are talking about the same thing (i.e. learning outcomes), but they do not operate at the same level of learning outcomes: formative during the progression process and summative after transformed understanding has been achieved, respectively. The duo could therefore serve as being complementary to each other in assessing learning outcomes in learning and the overall transformed understanding. The hierarchy of SOLO in a learning cycle repeats and operates within or during learning tasks. Whereas the threshold concept involves a whole person, as in the overall end result of learning outcomes in a discipline, as becoming a scholar belonging to that particular discipline or community.

In comparing both learning theories, it seems that SOLO could be a subset of threshold concepts. The relational level in SOLO seems parallel to integrativeness in the threshold concept, but on a much lower level of understanding. Similarly, the transformative stage of the threshold concept level could also be at the same level as SOLO's extended abstract level of understanding, but at a much higher end when looking at a specific discipline outcome. My speculation is that after a student's numerous encounters of achieving SOLO's relational level, it could grow into a transformative threshold concept stage in its extended abstract level. Rationally, when sufficient attainment of SOLO's relational levels of understanding has been accumulated into one's thinking, or attained integratively in the case of threshold concept framework, we would expect the learner to achieve a transformative stage of understanding as the consequent end result of a course or programme. Davies and Mangan (2008) called this a discipline threshold concept which underlies transformation in thinking, practice and identity.

But above all, it seems logical to conceptualise that the integrative/relational structure of understanding precedes the transformational/extended abstract thinking that is taking place before one becomes a transformed individual at an expert level. This is to say that (like Davies, 2006), the parts need to be integrated first, in order to be transformative and to be able to think at an extended abstract level. However, all these could depend on the level of education one has studied and the kinds of educational information received, since most research showed that more students were able to reach an extended abstract level at higher education level than at a lower level. This affirms that, ‘to theorise and hypothesise at rational level is very much of higher order thinking in SOLO’ and more suited to higher level education – starting 19 years and above of age or at a post-formal cognitive development stage in Piaget (1896 – 1980, cited in Biggs & Collis, 1991:66, Table 5.2).

3.13 Relational Stage in SOLO similar to Integration in Threshold Concepts?

As mentioned above, the relational level in SOLO progression learning cycle (at formal stage age 16 years and above, Biggs & Collis, 1991:66, Table 5.2) seems parallel to the integrative level of understanding in Meyer and Land’s threshold concept theory. Although, they perhaps have slightly different purposes and are not necessarily transformative, Biggs and Collis (1991) noted the relational level in SOLO at the formal stage as the ‘working understanding of the discipline of physics’ (p. 66), and there seems to be some equivalence of this level to the threshold concept level of thinking attainment in disciplines, although not quite. And interestingly, they postulated that this stage of level occurs before reaching post-formal stage (at 21 years of age and above, the age where usually most university students expected to almost complete their education). Could this attainment be too early than predicted in the SOLO? But this seems to show also that some learners at post 16 years of age have started developing inline thinking along a discipline transformation (if and provided, they successfully overcome the barriers to learning) until they reach up to 21 years of age. This period (16 – 21 years of age) seems to indicate where liminal states do mostly occur and persist. Could this be happening to this case study as well?

This seems to be a breakthrough point in what Biggs and Collis wrote about SOLO in relation to the threshold concept idea. The relational stage (denoted as ‘R’ in Biggs & Collis, 1991), the crossover between the previous and new concept development, seems parallel to the threshold concept in Meyer’s (2003) work with almost similar attributes of understanding critically. The 'R' or relational level in the SOLO taxonomy which classifies the outcomes of learning, they said, is the crossover whereby if students cannot do this they will fail to progress in their learning. They also described this stage as that where the learners can 'integrate the parts with each other, so that the whole has a coherent structure and meaning' (p. 67). In Biggs and Collis' work, it seems that progression is very much to do with the integration of ideas, which is similar in notion to the threshold concept work, but they did not discuss transformation much at all. Additionally, this idea seems also akin to the idea of liminality in Perkins, or the in-between stage of difficulty of being unable to move forward and make progress due to an inability to make connections as in the threshold concepts theory. A breakthrough point from their work perhaps, is the learning needed to understand agriculture at a lower level education is close to SOLO (since SOLO was researched at secondary level), which may develop to higher level thinking in the threshold concept's idea (which is mostly researched in higher education). These two phases; students' ability to relate/integrate ideas to make progression at a lower level and then be transformed into discipline experts at a higher level could invoke the agricultural students' learning journey in this case study.

3.14 Multimodal Learning and the SOLO Taxonomy – its Potential Implications to Agriculture Curriculum Design

As previously stated, the sole focus of this study is on secondary education, the issue of quality teaching and learning in the curriculum, and to improve learning outcomes arising from policy concerns to diversify education to match agricultural academic and economic purposes. The prevalent misunderstanding of secondary education as being the best place for introducing career and further training (Holsinger & Cowell, 2000:31, mentioned in Chapter 2) should also be kept in view.

Biggs and Collis (1991:57) argument that 'nowadays secondary education is getting de-contextualised and that academic intelligence is getting far away from everyday intelligence' should also be a concern. In contrast to academic intelligence (schooled intelligence), they wrote that everyday intelligence have the following characteristics:

- It is *context* specific – such as general skills in sales can only be demonstrated in the context in which they are learned and practised.
- It makes use of *concrete* aids and relatively little use of the abstract algorithms, or even the symbol and notational systems themselves that are taught in school.
- It is frequently *socially* mediated, whereas academic intelligence and problem-

solving functions within contexts that stipulate the *solitary* involvement of the learner and that exclude shared problem sharing.

- It *functions on directly experienced problems* that are of existential moment to the individual. Schooling, on the other hand, deals with a codified abstraction and formalisation of what others have already discovered. 'This disembodied and depersonalised character of school learning creates motivational problems. Codified knowledge does not often provide its own motivation for learning, except in that special case we call intrinsic motivation' (p. 58).

They added, 'differences between academic intelligence and everyday intelligence, and forms of knowing, involve essentially the concreteness or abstractness of what is known, which is also at issue in descriptions of cognitive development' (ibid., p. 59). Failures to relate these two types of intelligence resulted in students tending to compartmentalise their schooled knowledge from their experience where explicitly they expressed 'much of the content taught in school is de-contextualised, abstract, impersonal, and almost by definition, not within the student's direct experience' (p. 69). They proposed that the concrete-symbolic mode which occurred at secondary level of education at around the age of 14 years may not develop at all (Biggs & Collis, 1991) in order to reach a formal stage at 16 years of age (the age of some students in this study). Perhaps, this view helps us to understand why learning may conflict for so many secondary students and why they have failed to progress further up to the next level. This could also be attributed to the troublesome knowledge (Perkins, 1999) discussed in the previous sections.

These imply that everyday intelligence characteristics are useful and important in the curriculum so that students can relate their learning accordingly. And if we want to make the education fit a purpose, we need to consider these implications in designing a new curriculum so that the gap between academic and everyday intelligence can be reduced. The connection and importance to life can motivate learners to relate their learning experience to the real world outside of school. This could be done by providing learning with more examples of real life experiences taken from everyday knowledge.

Another potential implication of knowledge getting compartmentalised is when the language of instruction is not in the students' own mother tongue (Biggs & Collis, 1991; also a source of troublesome knowledge in Perkins, 1991). They noted students from Southeast Asian countries (hence including Brunei Darussalam) even made school learning likely to become more remote from real life. Similarly, Jabaidah (2002:93) also mentioned that topping the list of the agriculture teachers' concerns was the inability of their students to use the English language to express their thoughts in answering written questions, although this inability was not displayed when students did practical activities where not so much writing was required. In the words of Biggs and Collis (1991) this could be explained due to the unrelated learning and being unable to connect to what made the learning 'become focussed on the concrete and literal aspects of the task, which are seen as discrete and unrelated to each other, and rote memorisation tends to become a major strategy for learning them' (p. 69).

'The learning cycle in the SOLO taxonomy would be useful in setting curriculum objectives', wrote Biggs and Collis (1991: 65). Thus, it could be possible to see where much of the stress associated with curriculum development could be emphasised since the majority of my case study participants are of the 16 to 19 years range (formal learning stage). A sound theoretical and concrete form of knowledge at this stage is needed so that students can think like agriculturists and take their place in that profession in the future. According to Biggs and Collis (1991:70):

> A professional person is one whose role in the community requires informed action, i.e. skill in carrying out the role and a theory guiding its deployment. One of the most difficult features of professional training is the integration of the practicum with theory.

Thus it is not just a matter of being able to make progression by integrating ideas as in the SOLO learning cycles but also the transformed understanding as in the threshold concepts thinking as well. 'Underlying game' (Perkins, 1999) or deeper understanding in agriculture is not only by knowing, but also putting it into practice. Knowing alone is not sufficient, said Perkins (op. cit.), but knowledge gained from agriculture learning needs to be functioning in order to see its outcomes. Finally, the last part of the chapter will draw on these works and how the research about threshold concepts can assist agricultural curriculum in achieving quality teaching and learning.

3.15 Unlocking Agricultural Potentials

Unlocking an agricultural potential in the youth is challenging since teaching and learning is complex, and that we are dealing with individual developments while also confronting societal and global challenges. Teachers' employment, professions, roles and responsibilities are created to teach, facilitate, ease and help learning to take place smoothly. Meyer and Land (2006:xiv) stated that:

> As all teachers know, teaching is a complex and often challenging process, because learning is a complex and challenging process. Nor, we wish to say at the outset,

> would we really wish for it to be otherwise. When knowledge ceases to be troublesome, when students sail through the years of a degree programme without encountering challenge or experiencing conceptual difficulty, then it is likely that something valuable will have been lost. If knowledge is to have a transformative effect it probably should be troublesome, or at least troubling, but that does not mean it should be stressful or should provoke the kinds of anxiety, self-doubt and frustration that can lead students to give up.

This implies that the roles and responsibility of teachers or even curriculum planners are extremely crucial in providing students opportunities for meaningful learning experiences and equally as giving as much challenge as possible so they would feel the satisfaction and confidence in learning in order to reach greater heights.

Challenges associated with troublesome knowledge often form barriers towards achieving deeper understanding, and hence prevent one's learning from being successful. Learning and progressing are very challenging processes. It is high time for the agriculture curriculum to be research-based so as to enhance learners' education. Teachers therefore are strongly urged to provide structure and guidance to learners so students can go through the liminality obstacles successfully with pride and ownership and be a successful person.

As learners reach the finishing line, their threshold concepts understanding has been transformed. They are able to integrate, connect, link ideas, concepts or knowledge together. At this point, they are considered successful as they are able to get transformed both in their thinking and understanding. If they fail to achieve this (owing to troublesome knowledge encounters) they are in difficult territory or a liminal state and are unable to see the relevance/connection of their learning to the real world and to everyday life experiences. The learning journey towards transformation will encounter many obstacles. Teachers, based on the guiding curriculum would facilitate via providing the best teaching practices and learning experiences.

In summary, creating the curriculum that addresses the lack of fit for purposeful agriculture learning could be achieved in many ways. Some strategies that could be employed as inferred from the literature in this chapter are as follows:

1. Employ a constructivism technique in teaching by encouraging learners to be active, social and creative, if it is pragmatic to do so (Perkins, 1999).
2. Reduce the gap between academic and everyday knowledge by avoiding the de-contextualisation of knowledge (Biggs & Collis, 1991). In other words, learning should relate well to today's everyday examples and real world knowledge, applications and

experiences. This reduces the lack of fit between theory and the reality of real life practices.

3. Provide more challenging opportunities to students at various learning stages because students reach threshold concept progression differently, in terms of rate and time (Taylor, 2006), to ensure their understanding and interpretations are correct.

4. Do not introduce the threshold concept too early in the introduction of the lesson (Meyer & Land, 2006), but rather let the students learn the bits of knowledge (Davies, 2002) that need to be integrated first before finally mentioning the threshold concept or terminology.

5. Increase teacher's enthusiasm and students' familiarity with the task (Efklides (2006:61).

Education is greatly influenced by the demand of the social and economic situation of the country which will then influence education policy. This makes it necessary to adjust context, organisation, coverage, content and implementation of the curriculum. Globalisation and the knowledge-based economy require the curriculum to be continuously scrutinised and innovated to ensure the best possible learning quality is offered. Some say the content of the curriculum should be broadened, diversified, be comprehensive, and even in context of the lifelong learning perspective at some point to allow for further education and for the world of work (Briseid and Caillods, 2004:59). They remarked:

> A secondary education should be an integral part of the whole education system seen in a lifelong learning perspective. This implies that access, admission criteria, content, organisation, methods and delivery must increasingly be places within this context. For this reason, particular importance is given to achieving a smooth transition from pre-school to primary, from primary to secondary and from secondary to the world of work or to higher education, such that the whole education system provides a good basis for lifelong education and training (p. 58).

The kind of education Brunei Darussalam need is of course different from the requirements of Swaziland (which is geared more on preparation for the world of work to eradicate poverty and unemployment). Brunei's economy stresses attaining a certain degree of self-sufficiency in agricultural production and food security, and the requirement of agricultural employment to be at higher levels. The threshold concepts are the cornerstone of understanding in the learning of an individual – where learning theory nowadays has more emphasis on the learner being focussed on differentiated learning and the learning being directed and experienced individually at a different rate with the importance of getting properly transformed into the level of thinking belonging to a certain discipline. It is thus high time that this investigation on agricultural threshold concept be conducted, and hopefully can help innovate quality curriculum options. Quality teaching may possibly produce quality learners with quality learning outcomes. This will support and give guidance on this difficult journey that the students must go through in learning. This is needed for the sake of our future generations and posterity, so today's students will be the leaders of tomorrow in place of us when we no longer exist. Quality teaching and learning and the curriculum thus give quality students, and quality generations of tomorrow!

Chapter 4

RESEARCH DESIGN AND METHODOLOGY

This chapter describes the overall research design, the philosophical framework, the methodology and methods employed in addressing the research questions. The two terms, methodology and methods, although sounding somewhat similar and inextricably linked, are very different in meaning and can be confused. Cousin (2009:6) distinguishes methods 'as the tools and procedures we use for our inquiries and methodology as being about the framework within which they sit'. The procedures she added, aim to measure effects and to eliminate researcher bias or interference. These research components are further described in detail under the sections that follow. But first, the discussion will turn to the focus and research questions of this study.

4.1 The Focus and Research Questions

This study is about gaining deeper insights into students' understanding in learning agriculture. The focus is on investigating threshold concepts as an analytical tool to determine key concepts perceived as possessing quality and relevance that could be used in future curriculum design. It sets out to investigate what is quality as depicted from their valuable experiences and conceptual understandings in agriculture. These provide the basis for mastery in the students' learning and if embedded in future curriculum could further improve teaching and learning.

This study, therefore, aspires to create quality in the agriculture curriculum innovation and how this can create a wider acceptance among stakeholders (in particular students and teachers) through relevant design. To achieve that, this study is trying to determine what quality learning is in agriculture by looking into students' deeper understanding, and to approach quality through the threshold concepts lens as the tool for detecting useful concepts for the new curriculum. Identification of essential key concepts and incorporation into future curriculum design would enable improving of content relevance and learning quality. With this aspect in mind, this study's investigation is vital as this will help form an appropriate curriculum. In a nutshell, this study is intended to find out what is quality education in agricultural learning and to propose the appropriate curriculum design that suits the needs of the learners in preparation for the remainder of the twenty first century.

The nature of this study is predominantly descriptive and qualitative using the interpretative phenomenological approach. Through the threshold concepts framework it is hoped that quality is achieved through proposing a relevant curriculum design in future. Hence, the following are the research questions:

1. What are threshold concepts in the learning of agriculture that could lead to higher levels of understanding in the subject, if any? (That is, by focussing on critical episodes/experiences, when it clicked for the students.)
2. Is there progression (students' transformation in terms of thinking development from simple to advance or complex knowledge and skills) in threshold concepts understanding?
3. How do students arrive at threshold concepts understanding and what are the implications for teaching and curriculum design?

These research questions are inter-related and sequential of each other. But, the main issue that binds them together is the burning issue of curriculum quality. Stake (2006:17 & 1995:16) argued that in order for the research to be case study like, research questions should be organised around issues. According to him, issues could be used as 'conceptual structures' to organise the research. Issues give the benefit, not only that they help to force attention to complexity and contextuality, but issues around the quintain (or the whole, see Section 4.5.6) and the cases could help define data sources and data-gathering activities. He emphasised that 'the identification of issues draws attention to problems and concerns'. Besides, 'issue questions or issue statements provide a powerful conceptual structure for organising the study of a case' (ibid.).

These research questions therefore were centralised around this curriculum's quality issue as the organising conceptual framework as these are inextricably linked to the complexities of the various situations. This study is a qualitative phenomenological case study aimed at seeking greater understanding of curriculum.

1. What are threshold concepts in the learning of agriculture that could lead to higher level of understandings in the subject, if any? (That is, by focussing on critical episodes/experiences, when it clicked for the students.)

To investigate quality, Davies (2006:82) argued, '... for threshold concepts to make a significant contribution to learning, teachers/curriculum developers must be able to *identify* these concepts in their subject'. Following Stake (2006:10), to be more case-study-like in the research question and hence 'prompt deeper reflection', this question could be re-emphasised as: what are threshold concepts in learning agriculture that could lead to identification of important concepts for proposing more quality and relevance in the future curriculum? In other words, this first research question was formulated to explore the widest possible range of important agricultural concepts from participants (teachers and students), when critical episodes or experiences clicked. It is specifically aimed to identify those concepts that are considered threshold in agricultural understanding since there has been no academic study related to agricultural threshold concept that has been done before. Simply put, it was formulated in order to discover the agricultural threshold concepts and its identification for proposing more quality and relevance in the prospective curriculum. This was made possible by examining understanding as an indicator of quality or learning success. Also, looking through the students' spectacles their worthwhile learning experiences perceived of value to them, the threshold concepts therefore can be identified. Thus, it would be interesting to find out if there ever exist threshold concepts in agriculture, given the optimism that in any discipline there exists 'the foundational principles of threshold concepts which help to grasp the subject to arrive at important new understandings' (Land, Meyer & Smith, 2008).

Notice also that this research question begins with *what* which indicates that it requires a 'descriptive answer and also is directed towards discovering and describing the characteristics of, and patterns in some social phenomenon' (Blaike, 2007:6). Answers to Research Question 1 would allow me to come to know the key concepts participants considered important, also to promote future quality and relevance of the curriculum and the enhancing of the teaching and learning processes of the subject. It also serves to map out all important concepts whose prominence helped me to carefully select purposive samples for subsequent in-depth interviews for this question as well for the next research questions.

2. Is there progression (or students' transformation in terms of development from simple to advance or complex knowledge and skills) in threshold concepts understanding?

This second research question is focussing on progression or development of participants' threshold conceptual understanding from simple to complex. 'Transformation is when students can understand and are able to make connections between ideas/concepts' (Cousin, 2006, 'Old wine in a new bottle' video presentation, http://video.strath.ac.uk/06/140-06-04.wvx). Similarly, Newton (2000:179) proclaimed that ‘understanding can be viewed in terms of its level of integration and coherence and also in terms of the capabilities it gives’. In essence, transformative is ‘the grasp of any subject’ (Meyer and Land argued, cited in Cousin, 2009:202) and is likely ‘to involve turning points that both deepen our understanding and bond us more closely to the subject which thus assimilates us to new understandings’ (Cousin, 2009:202). This research question was thus formulated to see integration between ideas/concepts and if students are successful in reaching their threshold level of understandings in the subject. In other words, it aimed to see if students within a certain timeframe, say after a one year period, have managed to get conceptually transformed in their thinking and have begun to think like an agriculturist or someone belonging to this disciplinary area. ‘Threshold concepts provide a way of describing the desirable overall learning outcome for students: they have learned to think and practice in the manner of scholars of a discipline, using a coherently structured body of ideas and procedures to analyse problems as they are defined by that discipline’ (Davies & Mangan, 2008:37).

3. How do students arrive at threshold concepts understanding and what are the implications for teaching and curriculum design?

The final research question is aimed to investigate and gain insight on how students get to their threshold concepts understandings over what has been learnt and also to see what meanings they hold to their world. Quite simply, this research question asks how threshold concepts understanding in agriculture learning is reached, because I want to understand how students understand the phenomenon. Answers to this research question will provide implications to the teaching and learning of agriculture. They will therefore provide useful information for utilisation into the future curriculum design and development which will include key point reminders for instructions and subject implementation. This research question is concerned with ‘how’, indicating that it is concerned with ‘bringing about change with intervention and practical outcomes’ (Blaike, 2007:7) towards future curriculum, in particular implications for classroom practice and teaching-learning methodology.

In light of the main issue, the above research questions are guided by the purpose of this study, and it was thought that there is no better way than to investigate from inside through the process of understanding the teachers’ and students’ experiences of agriculture education.

4.2 Overall Research Design

This section tries to describe the study's philosophical and methodological framework underpinning the research, in particular the rationale behind the research design and approaches used in addressing the research questions. Some justifications for the overall methodological approaches are also given alongside the chosen approaches. A research design is the plan for carrying out the research. Creswell (2009:5) defined the research design as the '*plan or proposal to conduct research*, and involves the intersection of philosophy, strategies of inquiry, and specific methods'. Hence, the overall research design or plan for this study is shown in Figure 4.1.

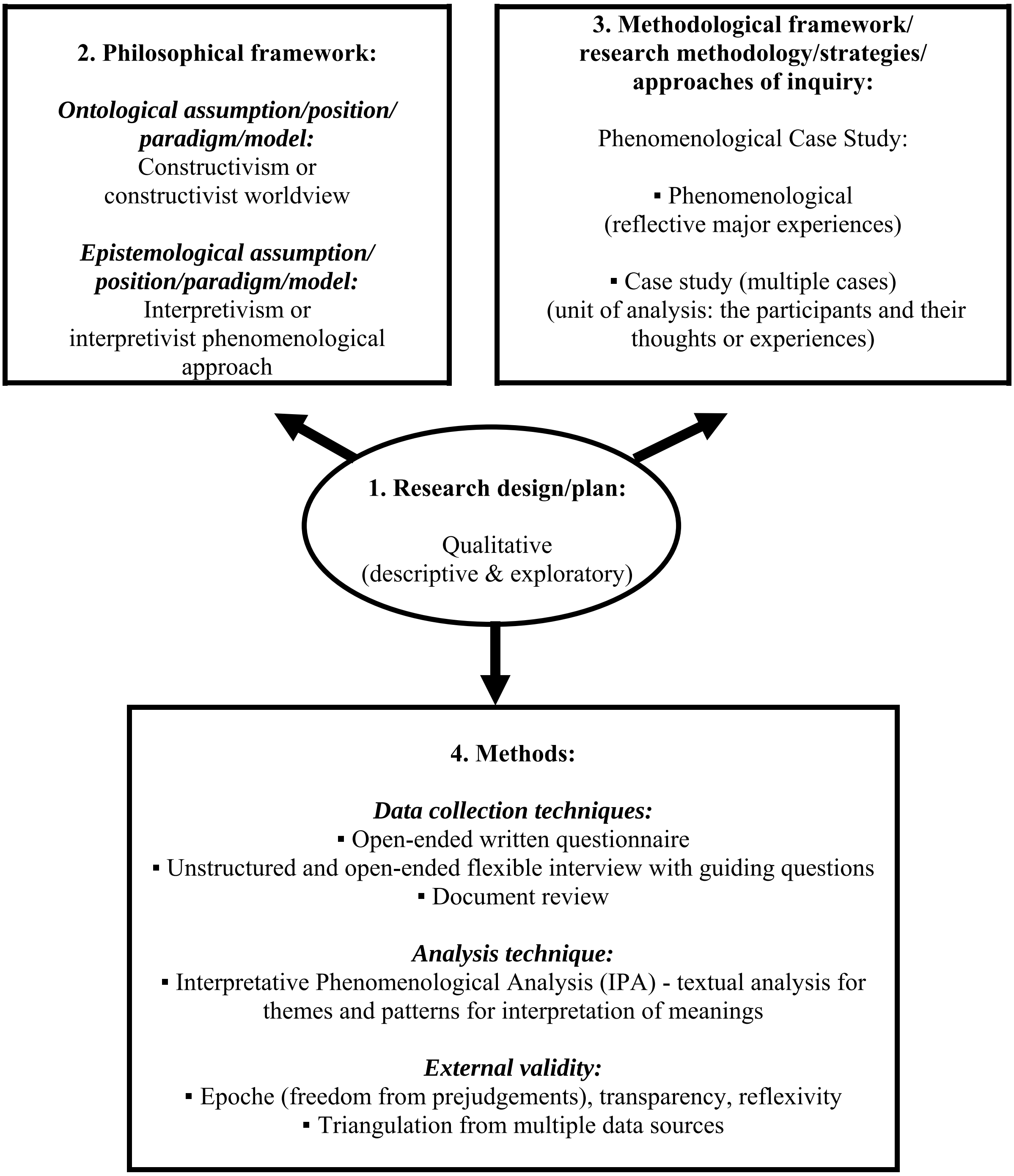

Figure 4.1 Overview of research design.

4.3 The Research Design

The research problems in this study subscribed to an understanding of human social phenomena and the producing of a holistic account from it. The main focus of inquiry is on experience and meanings 'as embodied or located in activity – broadly construed and includes perceiving, reasoning, and talking' (Cobb and Bowers, 1999:11) of actors' viewpoints in understanding the world of signification and meaning in which the actors act. Due to this requirement, the chosen research design or plan is the *qualitative descriptive exploratory approach*. This calls for exploratory understanding and deeper insights into the context of the study by having in-depth inquiry to elicit deeper into the threshold concepts phenomenon. The following rationales have guided my thinking in addressing the research questions in this study: 'the choice depends largely on the type of research question' and 'to use the method that is really advantageous' (Yin, 2009:2 &13) and also to 'maximise what we can learn' (Stake, 1995:4).

In addition, knowledge about qualitative research and its values is useful in convincing me that this is the research design to be adopted for this study. The qualitative research, as Smith, Flowers and Larkin (2009:45) pointed out, 'tends to focus on meaning, sense-making and communicative action. That is, it looks at how people *make sense* of what happens; what the meaning of that happening is'. Creswell (2007, cited in Creswell 2009) offered the following definition for qualitative research:

> Qualitative research is a means for exploring and understanding the meaning individuals or groups ascribe to a social or human problem. The process of research involves emerging questions and procedures, data typically collected in the participant's setting, data analysis inductively building from particulars to general themes, and the researcher making interpretations of the meaning of the data. The final written report has a flexible structure. Those who engage in this form of inquiry support a way of looking at research that honours an inductive style, a focus on individual meaning, and the importance of rendering the complexity of a situation (p. 4).

Moustakas (1994) on recognising the value of qualitative designs and methodologies advocated:

> ...studies of human experiences [that] are not approachable through quantitative approaches... focussing on the wholeness of experience rather than solely on its objects or parts ... searching for meanings and essences of experience rather than measurements and explanations ...through first-person accounts in informal and formal conversations and interviews ... as imperative in understanding human behaviour and as evidence for scientific investigations ... (p. 21).

Contrarily, I did not choose to employ a quantitative approach as this study does not seek to predict causal relationships or associations between variables that aim for generalisation as in the case of quantitative research. It is not the intention of this study to make generalisations. Punch (2005:146) stressed that the intention of the qualitative case study 'is not to generalise, but rather to understand the case in its complexity and its entirety, as well as in its context'.

Although the majority of this study is qualitative, there exists in some parts some conversion of qualitative information into quantitative data. Originally, this quantitative data was qualitative in its raw state but have been quantitatively converted for analysing the prevalence or frequency of the occurrence of certain concepts without aiming for generalisability. As Cryer (2005:79; emphasis added) argued in relation to choice of research paradigm, that 'since all such frameworks have limitations, this choice involves selecting the *one which fits the questions and objectives of the research best* while rejecting others even if they may have some salience'.

Another thing to note is the reason why this study did not subscribe to quantitative design. This is because the research questions asked were of the open-ended general types in order to allow exploration of the investigated phenomena. Therefore, this study has not tried to attempt to make generalisations to the wider population as in the quantitative method. A survey in a quantitative method usually employs close-ended questions and thus will not provide opportunity for in-depth investigation implying that it is unsuited for the interpretation of meaning aimed for in this study.

4.4 Philosophical Framework and Assumptions of the Research

The underlying philosophical framework or paradigm can affect and guide the research methodology. The research paradigm refers to the 'perspectives or assumptions related to the ways of looking at the world, as well as ideas on how it can be understood, i.e. the ontological and epistemological assumptions' (Blaike, 2007:3). In the words of Kiley and Wisker (2010:402), 'paradigm is the epistemological framing of one's approach to research'. It is thus crucial to know what is the positional ontology and epistemology under which the research has been framed so as to understand the logic behind the approaches to be taken. Grix (2002:184) wrote, 'an understanding of ontology and epistemology is important' as researchers 'need to understand the logic behind the approaches taken ... and they need to make their own approach very clear'.

But both terms, ontology and epistemology, are branches of philosophy whose meanings are not easy to understand 'given the variety of uses of the terms and terminology of social science research' and that therefore researchers 'have difficulty in differentiating between crucial terms' (Grix, 2002:175). However, Guba and Lincoln (1994:108) gave the following definitions: ontology is 'what is the form and nature of reality' and epistemology is 'what is the nature of the relationship between the knower and what can be known'.

These two terms are inter-related and it is this inter-relationship that affects the methodology (Grix, 2002; Morrison, 2007). Therefore, it is even more crucial to understand it. Morrison (2007:19) defined methodology as 'how the researcher gains knowledge in the research context and why'. The *how* (method) and *why* (rationale) of the methodological approach are shaped by the philosophical framework under which they sit, that is the ontological and epistemological assumptions of the research (illustrated below).

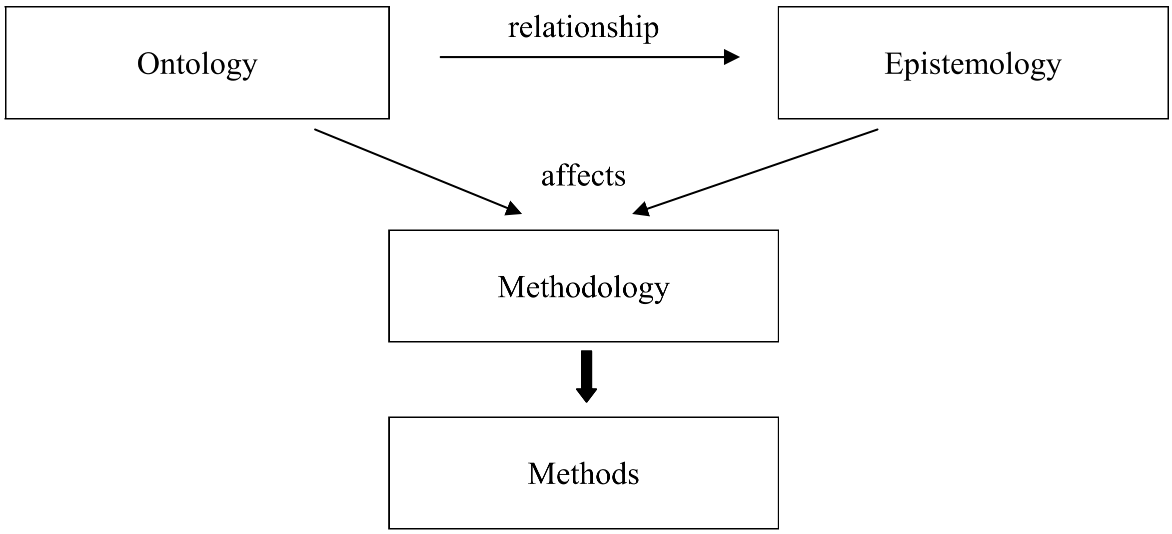

Figure 4.2 Relationship between ontology, epistemology and methodology.

The relational effects of ontology and epistemology on the methodology allow for methods and procedures to be logically chosen according to the research questions. This means that the methods which are to be employed should be able to answer the research questions based on these logical assumptions. However, Silverman (2006:402) provided a much easier definition to understand; 'methodology refers to the choices we make about appropriate models, cases to study, methods of data gathering, forms of data analysis etc. in planning and executing a research study'. These are essential key concepts in social research that one needs to know in order to understand the research process which makes up the whole of the research design.

4.4.1 What are the meanings of ontology and epistemology to the present author?

The definitions of ontology and epistemology were given by Guba and Lincoln (1994) above, yet these definitions are still very difficult to accept especially for a novice researcher at PhD (Doctor of Philosophy) level like myself. Because this study is a PhD research, it is thought essential that philosophy is an integral part of the research design in order to shape this current research thinking.

Winch (1958) argued that research in social research has to be supported with philosophy as compared to natural science research. His work is instrumental to the introduction of non-scientific approaches and led to the move interpretative epistemologies in humanities and social sciences. He said that human behaviour should be distinguished from behaviour of inanimate objects by the fact that it is meaningful – meaningful behaviour which the speaker/actor was a part. He (as cited in Pauw, 1993:107) stressed 'human science as philosophy' and claimed that 'human science should be philosophical by nature rather than scientific'. Philosophy according to Pauw (1993:107-109) was supposed to work with meanings of concepts and phenomena, and in support of Winch, he wrote that investigation should be supported by 'interpretation in terms of real-life meanings to gain an application to the world'.

These imply that there is a close connection between philosophy, interpretation, concept meanings and phenomena. By reflecting on various readings, I try to come up with my own definitions in order to come to terms with the two philosophical terminologies. To my understanding, ontology is the property of the things or subjects that I wanted to discover – the reality out there, the world or the participants' world (of the students' and teachers' as social actors). It is the social actors' constructions of their world of what is meaningful about agriculture learning – the things that they valued and had perceived quality to them – that ensures that the ontological assumption is based on a constructivism worldview. In other words, it is on how they constructed quality in agriculture and its learning.

Having said something on ontology, let's look at epistemology. It can be understood by asking: I know something occurs in the world but how can I know about it? This is my current key question. My understanding is that epistemology is the property of the researcher (or the knower, or simply, me as the current researcher for this study). It espouses the positional standing on how am I going to know what I wanted to know or how am I going to discover what I wanted to know regarding my participants, which has to be guided by my assumption and role as an interpretivist, based on the belief of an interpretivist phenomenological paradigm. My interpretivist position is to see how people, or the actors that made up the society, construct reality (or quality in this study) by interpreting the meanings held by social actors due to their 'social actions' (Bryman, 2001:12-13 cited in Grix, 2002:178). In other words, I am interpreting the cases' phenomenal feelings of what they considered or perceived important, useful, difficult, and so on, as they interact in their context to construct their world. I will then play the role of being an interpretivist on the participants' phenomenological experiences as voiced and constructed by them. Simply put, in my understanding, epistemology is my property (the knower's or researcher's property) that seeks reality of what exists in the real world and why. And it focuses on 'knowledge gathering processes' as put by Grix (2002:177).

In summary, the twosome of the philosophy – ontology and epistemology – allows me (as the researcher) to see the two sides of the coin and also see perspective from the other side and be able to put this research context in a bigger picture, from a broader perspective, and to situate this study in the bigger context of the country.

4.4.2 Ontological and epistemological assumptions of this study

So far, I have described my basic understandings of ontology and epistemology, but what are the actual assumptions based on these philosophical terms in this study? The ontological assumption is *constructivism* as the belief or paradigm that guides me as the researcher to view reality with a constructivist worldview.

As previously mentioned, social researchers believe the social world is seen as a social construction. Constructivism then holds the perspective that all knowledge is constructed by social actors (people in the society), including human perception and social experience which are contextually related. Winch wrote (1958:107 cited in Pauw, 1993:103), '... ideas cannot be torn out of their context..., the relation between idea and context is an internal one. The idea gets its sense from the role it plays in the system'. Meaning the system, which is made up of the social construction as opposed to individual construction, is where meanings can only be created from the culmination of an individual's constructions in order to know the whole truth of what exists in reality.

The epistemological assumption or 'conceptions of the nature of knowledge and of ways of coming to know' (Cousin, 2009:6) of this study is *interpretivism*. The researcher (or me) is carrying the role as the interpretivist in the phenomenological approach of looking for meanings in the participants' world. It is the worldview assumptions where researchers seek to establish meanings of a phenomenon from the views of participants (Creswell, 2009:16).

The ontological position on constructivism is often combined with interpretivism which means the participants are actively constructing meaning whilst the researcher's role is interpretive. The interpretive researcher views research participants as 'research subjects' and explores the 'meanings of events and phenomena from the subject perspectives' (Morrison, 2007:24). This qualitative approach assumes that 'individuals seek understanding of the world in which they live and work' (Creswell, 2009:8). The researcher then inductively tries to understand the phenomenon under investigation by interpretation of meanings through others' eyes. This interpretation could be 'shaped by the researcher's own experiences and background' (Crotty, 1998 cited in Creswell, 2009:8) and that there is the potential for reality to be construed differently. In this regard therefore, in order to minimise such bias the researcher will try not to distort a participant's account by reporting or maintaining neutrality and will find the objective truth based on discovered facts of the original information. The researcher will refrain from bias by focussing on understanding the meaning from the participants' view of a problem or issue, and not that of her own presupposition by bracketing her values.

Moreover, Miller (2006:108) argued that research in agriculture education is not primarily looking at discoveries and patents, unlike in general agriculture, where it is often looked down upon and is subjected to criticism. Thus to him, the main focus should be on understanding in order to reach consensus and meaning via interpretive and critical science which may be 'highly important in improving the quality of life of people' (p. 109).

4.4.3 Curriculum innovation is like creating a new product

The previous sub-section describes my ontological and epistemological positions in this study but what does this mean in terms of my role in carrying out this research? In this study, I assumed that I am dealing with the question of: how to come up with a new or improved quality product – a quality agriculture curriculum – that adds/creates value to the subject. To explain this in curriculum innovation, I am using the analogy of creating a new product or model to improve or add value to the learning of agriculture which could be adopted by stakeholders.

So, curriculum innovation is a not just about inventing a new product that could be foreseen as something that adds value to current existing curriculum. It is a process involving executing new ideas to create value, although it starts off similarly to creating something new (invention). Thus curriculum innovation is a process of creating a new curriculum product/model/idea/design for adoption. In doing so, I am grappling with the following questions. How do we know if a product is good and well-liked or vice-versa by its customers? How do we know if they love it? How do we know whether the curriculum product is well suited to its target audience? To know these answers, we need none other than their feedback as the utilisers of the curriculum. So, once we obtain their opinions, we can make improvements to match their needs. We need to find out what they considered worthwhile/valuable to have – what's suitable and what's not. In this case study, therefore, I need to interview students and teachers to examine and gain insights into their worlds of what they considered useful (and non-useful) to have, what is valuable and what is not. My approach is, therefore, to gather their opinions or constructions of their live experiences and to interpret these meaningful constructions of their world. Curriculum innovating and improving practices will likely help attract more interest, and retain students' interest, in agriculture which is crucial to the long term sustainability of the economy as required in government policy. The next section will link these assumptions to the chosen methodology of this study in what has been shaped by the epistemology, or 'how can the inquirer go about finding out whatever he or she believes can be known' (Guba and Lincoln, 1994:108).

4.5 The Methodological Approach of Inquiry – the Phenomenological Case Study

After having gone through some lengthy consideration between practical and logical, as well as the ontological and epistemological assumptions, and being guided by the problems and the research questions alongside some literature readings, I finally settled on the *phenomenological case study* as the approach of strategic inquiry for the study. As Flyvbjerg (2004:424) mentioned that 'a purely descriptive phenomenological case study without any attempt to generalise can certainly be of value [...] and has often helped cut a path towards scientific innovation'. What follows in the coming section is why this strategic inquiry, the amalgamation of both the phenomenological and case study approaches, was undertaken in this study.

4.5.1 Why was the case study approach chosen?

Firstly, the case study approach was employed in this research due to the context of the undertaken study. It is understood that, by and large, the case study is mostly suited for context-dependent knowledge that is specific to a certain place. Flyvbjerg (2004:422) mentioned that 'the case study is especially well suited to produce context-dependent knowledge'. Likewise, the boundary of the context of this study in which the Bruneian schools are embedded, is where agriculture is taught. In these schools, the implemented agriculture curricula are specifically prepared, thus are entirely unique and therefore the learning experiences are country-specific. The country's agricultural activity (which is managed by a separate government body) has indirect influence on the education of agriculture. This is manifested in that agriculture is always economically-oriented and contextually relevant in nature. Obviously this has an influencing effect on the learning of agriculture in schools (as has also been mentioned in the earlier chapter of this thesis) and the mindset or thinking of stakeholders. For these reasons, the case study approach is appropriate in order to seek understanding of these partially indirect contextual influencing factors that impinge upon the teaching and learning of agriculture in relation to the country's economy.

Indeed, the significance of the context as emphasised by Yin (1981), that 'a case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context, when the boundaries between phenomenon and context are not clearly evident, and in which multiple sources of evidence are used' (cited in Yin 2009:18; Yin 1984:23 cited in Punch, 2005:145). In addition, Stake (1988 cited in Stake, 2006:3) argued 'he or she may be unable to draw a line marking where the case ends and where its environment begins, but boundedness, contexts, and experience are useful concepts for specifying the case'. This is certainly the kind of scenario this study is immersed in and the several contexts are as mentioned in the earlier chapter. Readers will also see that in a later section, the data collection methods involved in this study are of various techniques (mixed methods) and from multiple sources in order to establish the triangulating process.

Secondly, the readers would appreciate that this is an in-depth study involving a small number of samples of multiple cases. This is due to the small existing number of students taking agriculture at higher levels in Brunei Darussalam. Though, unfortunately, none of the cases were from university level due to there being no offering of agriculture at this level. Otherwise, this would have been the perfect sample for this study. But the best cases available for this study can only be found at a lower level i.e. secondary education.

As can be seen later, the maximum case participant number per group does not exceed more than 15 or else it becomes unmanageable. Reid, Flowers and Larkin (2005:22) reported the number of participants in most studies on IPA has not usually been more than 15, whereas the largest of 42 used the semi-structured interview method. Readers will see in the later part of this section that the interviewee number involved in this study is well within this manageable limit.

Thirdly, it should be emphasised that the third research question begins with *how* is ‘a case-study-like type of inquiry’ and ‘a cue for certain degree of openness over which the researcher has little or no control’ according to Yin (2009:9 & 13). Besides, it is not a standalone inquiry research question due to its relational preceding research questions as is usually the norm in any case study research. In this third research question, the concern was not on events as they are occurring, but rather looking at the participants’ recollection of events or reciprocating the past which had already been encountered. Here, I will only turn to participants’ episodes only after it has happened. So it is an attempt to interpret the *existence* on a specific matter or on experiences (as shall also be seen later which explains why this research is employing the case study approach). The case study is suited to concerns regarding the existence and embedded nature of the cases in context rather than their incidence. It is an in-depth study of cases.

Moreover, Stake (1995) as cited in Creswell (2009:13) stated, ‘... cases are bounded by *time and activity*, and researchers collect detailed information using a variety of data collection procedures over a sustained period of time’. Sustained here means over a prolonged period of time and that the research activities are not done all at once, which is what happened in this research. This study is trying to identify the ‘existence’ of threshold concepts as the pinnacle of understanding as experienced by the learners and not for its ‘incidence or prevalence’ (Yin, 2009:9). Similarly, Yin (1989) also pointed out ‘a case study is intended to demonstrate *existence, not incidence*’ (cited in Smith et al., 2009:30, emphasis added).

Up to this point, the clear distinguishing fact for employing the case study approach for this particular research is due to this research being held in relation to issues in an educational aspect as well as partly the issues affecting the socio-economic factors of the country's agriculture, despite the fact they are somewhat minimally related. Placing the importance of economy in the learning of agriculture is an overarching issue which should not be neglected. This study is using the case study approach because the study is partly affected by socio-economic perspectives, even though the scope is not impossibly extended to involve other players in the agricultural communities such as farmers, agri-business entrepreneurs, government organisations and the like. Due to the study's limited time span, unfortunately, such scope is reserved for future study and placed on the shelf for the time being.

4.5.2 Advantages and weaknesses of the case study research

The previous section explains why the case study research approach is subscribed in relation to this study. Apart from that, there are also many other advantages of case study research that make it the most appropriate approach for this study. Amongst these advantages, according to Stake (1995:37-39), and reiterated here, are that:

(1) it 'endeavours to understand rather than explain'.

(2) it facilitates better 'understanding of human experience' rather than seeking 'cause and effect' as in quantitative research.

(3) it attends to the 'uniqueness of individual cases and contexts – particularisation is an important aim'.

But despite these, there are also some weaknesses of the case study research. Among some of these according to Stake (1995, emphasis added) are:

(1) 'Much of the *information* needed to round out the study of the case *is difficult to get and resources are limited*' (p. 24).

(2) 'In case study work there is abiding *tension* between the case and the issues. They each *demand more time* for study than is available. In both instrumental and intrinsic case study, they *compete for scarce resources*' (p. 25).

(3) 'Qualitative inquiry is *subjective*; *slow*; *results pay off little*; ethical risks are substantial, *cost* in time and money is *very high*' (p. 45).

(4) 'The phenomena studied by qualitative researchers often '*take long to happen*'... and often, *needing a long time to understand what is going on'*. 'The work is *labour-intensive'* (p. 45-46).

4.5.3 What is the case study?

Besides an in-depth study that is bounded by activity and time, the case study is actually '*an approach* or *methodology* whereby social construction of meaning in-situ is created'

(Stake, 1994:236). For a single case study, it is a detailed or close examination of an example or phenomenon which aims to describe 'things as they are', and not as they might or could be, with the main intention 'to thoroughly understand the case', and not merely to see what is the difference and the commonality (Stake 1995:9).

Stake (1995:xi) also wrote that 'the case study is expected to catch the complexity of the case' and 'we look for detail of interaction with its contexts'. He added that 'in the qualitative case study, we seek greater understanding of the case; we want to appreciate the uniqueness and complexity of the case, its embeddedness and interaction with its contexts' (p. 16). And in doing so, the researcher or observer must be objective i.e. neutral and not biased and need to bracket off his/her belief by entering the scene '... with a sincere interest in learning how they function in their ordinary pursuits and milieus and with a willingness to put aside many presumptions while we learn' (Stake, 1995:1).

In defining a single case study, Stake (1995:xi) wrote that besides 'it is expected to catch the complexity of a case', among its other characteristics are: it has unique complexities; it is of very special interest; and we look for the detail of interaction with its contexts. He defined a case study as 'the study of the particularity and complexity of a single case, coming to understand its activity within important circumstances'.

This implies that the case study has the characteristics of being unique or particular, complex, specific, contextual, and bounded in a system – which are similar attributes to this study. This study is considered unique and very particular to its Bruneian context and the boundedness of the case participants to the complex inter-relationship between several contexts: historical, social, political, economic and educational. It is dealing specifically with some aspects of learning in agriculture which is one of the subjects offered within a country's education system. The contextuality and embedded issues (as described in Chapter 2) are instrumental for directing the study towards achieving the desired quality-relevant curriculum design.

4.5.4 The multicase study research

The previous section mentioned the characteristics of a single case study. However, this study is employing the multicase study research whose approach and principles are similar but slightly different in the way data gathering, handling and analysing are done compared to in a single case research. The difference being the multicase study is dealing with the collection of several cases, unlike a particular single case as in the single case study. The multicase is intended to examine the generalisation of a particular collection of cases analytically and comparatively both within and across cases. The analytical generalisations or findings from the multicase however, will only provide evidence for this particular group, not for the whole population of students studying agriculture in Brunei Darussalam. Hence, in dealing with the reporting and analysis of the cases, each case is individually handled but attention is paid to what is revealed collectively as the main focus of research interests. Thus it is the generalisation of the whole group under study as oppose to particularisation of an individual case. That is, I am not interested in any particular case, but more interested in generalising to a particular collection of cases as presenting in the main findings.

4.5.5 Case definition, the cases and recollection of past experience as the unit of case

So what is a case? A case according to Stake (1995:2) is 'a specific, a complex, functioning thing'. He adopted Louis Smith's (an early education ethnographer) definition that the case is 'a bounded system', that is, 'an object' rather than 'a process'. Stake used the Greek symbol 'theta' to represent the case as something that 'has a boundary and working parts' and 'likely to be purposive, even having a self'. He purported that 'the case is an integrated system' implying as something that is embedded within a system.

But what is the case for this study? Following Stake's definition, the case for this study is the participants which mostly are students or in social science known as actors or 'the people studied' as in Stake's term (1995:4). The student participants are the functioning things and are bounded to several contexts, particularly the education system of the country. Studying them can lead to me having a greater understanding in addressing the need to improve the quality of the curriculum as the noble cause in this study.

The students were purposively selected at the outset, thereafter they were surveyed before being selected as the final cases. In making purposive selection of the cases, I (following Stake, 2006:23) was guided by my experience and intuition, as well as preliminary responses from the open-ended questionnaire at the beginning of the investigation. The cases were thought of as the most relevant to the quintain being studied which provided me with diversity across contexts as well as a good opportunity to learn about the complexity and the issues. As Stake (1995:13) emphasised, the case selection could be done based on three criteria: diversity, a case where we can learn most and optimise/maximise understanding.

What is the unit of case? As mentioned, the cases in this study are the participants (i.e. the agriculture students). The unit of case analysis on the other hand, is their thoughts or rather their 'conscious experiences' – the experience that has major encounters or phenomenological in the participants' real understanding (Moustakas, 1994:47) of learning agriculture. This conscious experience according to Moustakas includes their 'thoughts, feelings, examples, ideas, situations that portray what comprises an experience' (ibid.). Following that, indeed it is these experiential components as described by Moustakas that will be analysed in this study; in which way are participants getting into threshold concepts understanding of agricultural learning as the unit of cases.

Although the case study should deal with the current events or existence of happenings, in this study, the events had already happened and therefore were visited in retrospect by the process of memory recollection or precisely by a *reflective process* through interviewing them. Interviewing provides a way of observing things which we cannot see ourselves (Stake, 1995:133). Only through interviews can we find out their intuition and sense-making which is unobservable. As Husserl (1931:117 cited in Moustakas, 1994:92) stated that 'we are aware of things not only in perception, but also consciously in recollections, in representations similar to recollections, and also in the free play of fancy ... they float past us in different 'characterisations' as real, possible, fancied'. He further emphasised that 'only through acts of *experiencing as reflected on* do we know anything of the stream of experience and of its necessary relationship to the pure ego' (p. 93).

4.5.6 The case study design for the research

This study is employing the multicase study design where investigation is focussing on examining several cases linked together. Each case to be studied has its own problems and relationships. Each case has its own story to tell. However, it is the collective phenomenon exhibited from the collection of cases that is the official interest in this research. That is, I am determined to try to understand thoroughly the whole quintain rather than each individual case.

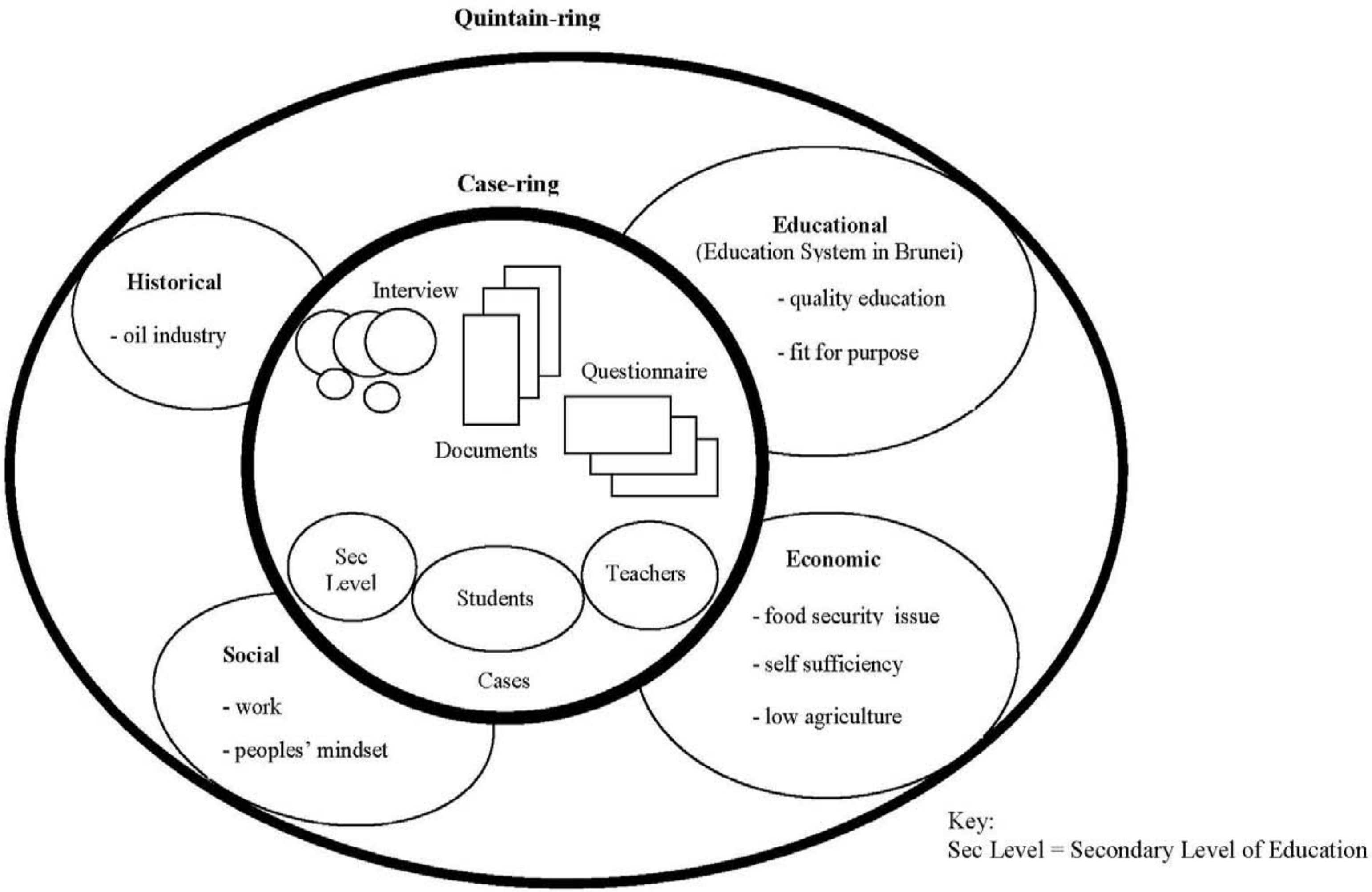

Figure 4.3 The case-quintain rings represent the schematic overview of the design of the case study.
(Adapted and modified from Stake 2006:5)

This research is a multicase study and is instrumental for promoting high quality education in Brunei Darussalam. It is *instrumental* since there This research is a multicase study and is instrumental for promoting high quality education in Brunei Darussalam. It is *instrumental* since there is more emphasis on the issues rather than the cases themselves. 'When the issue question is of more interest to the researcher than is the case, the case study is called an instrumental case study' (Stake, 1995:18), meaning, the researcher (or I) wishes to understand the issues in the quintain thoroughly by choosing to study it through its cases.

Moreover, Stake (2006:7) also argued that there exist epistemological and procedural dilemmas in any case study research in what he called 'the case-quintain dilemma'. Further, he emphasised that 'the multicase study is about the quintain'. The quintain is the 'whole', 'arena' or 'target collection' (Stake, 2006:6), or understandably from my point of view the cases with their issues. This study attempts to address the burning issue of needing to improve the quality and relevance of the curriculum. Thus, the quintain in this study consists of case actors (agriculture students and teachers) and their inter-related contextual issues in relation to history, social, economic and education. This study is to describe the work within individual cases as well as commonalities across cases in order to describe the quintain collectively.

Figure 4.3 represents the design of this case study research. It tries to illustrate the quintain-ring and its case-ring subset, which helps to clarify the ambiguity of the case-quintain relationship dilemma. As seen in this figure, the quintain is the cases and their boundedness to contextual issues as have been described before. As mentioned and reiterated many times throughout this thesis, the issues of quality and fit for purpose are relational to curriculum, and therefore will not be explained again under this section. Also, there will not be a specific written chapter for each of these individual issues but the description appears interspersed throughout this thesis as the boundary of the boundedness is quite diverse and has not become clearly evident over time to me. Readers may also wish to refer back to the context of this study as described in Chapter 2 in order to get the complete picture.

4.5.7 Why a phenomenological approach?

Besides the case study approach, this study is also employing the *phenomenological* approach of inquiry as it is considered to be the most appropriate. Phenomenology is the *study of experience* or of what people perceive in the world. It seeks for meaning and understanding of phenomenological experiences. It is a 'discipline which is concerned with understanding the thing as it shows itself as it is brought to light' (Heidegger, 1962/1927 cited in Smith et al., 2009:24).

It is also both a 'philosophy and method' where the researcher tries to identify 'human experiences about a phenomenon as described by participants' (Creswell, 2009:13). Moustakas (1994, also cited in Creswell, 2009:13) described phenomenology as involving 'studying a small subject through extensive and prolonged engagement to develop patterns and relationships of meaning'. The emphasis is on 'how people in educational settings build understandings of their world by continually trying to interpret the sense of data' (Morrison, 2007:24).

Its origin of discipline comes from health psychology and is picked up by many other disciplines including the social sciences. Smith et al. (2009:4-5) mentioned that it involves the researcher in investigating how people make sense, reflect, think and feel what major or significant important experiences have happened in the everyday life of the participants through interview. Here he said, when people are reflecting they are phenomenological. Specifically, it is what Smith described as the way 'to understand other people's relationship to the world are necessarily *interpretative,* and will focus upon their attempts to make *meanings* out of their activities and to things happening to them' (Smith et al., 2009:21).

The aim, wrote Moustakas (1994:13), 'is to determine what an experience means for the persons who have had the experience and are able to provide a comprehensive description of it. From the individual descriptions, general or universal meanings are derived. In other words, the essences or structures of the experiences'. Its functions, as described by Farber (1943, cited in Moustakas, 1994:49), among others are: 'it is not concerned with matters of fact but seeks to determine meanings. It offers direct insight into the essence of things, growing out of the self-givenness of objects and reflective description'. Specifically, Moustakas (1994) summarises phenomenology as:

> A scientific study of the appearance of things, of phenomena just as we see them and as they appear to us in consciousness. Any phenomenon presents a suitable starting point for phenomenological reflection. The very appearance of something makes it a phenomenon. The challenge is to explicate the phenomenon in terms of its constituents and possible meanings, thus discerning the features of consciousness and arriving at an understanding of the essences of the experience (p.49).

Hence forth, due to these aforementioned arguments, the phenomenological approach is subscribed. The stance is based on the interpretation of the way humans give meanings or value to their lives which needs a value and an epistemological approach, as in this study. Hence, evidence from interviewees' responses gave insights to their phenomenological experiences as I (the researcher) interacted with research participants or cases. I then tried to understand the cases' world through interpretation of meaning construction, of what counts as value or quality to them. It is thus possible in addressing the research questions, to construct meaning of their experiences through interpretation on their phenomenological experiences as constructed by each case from a subjective perspective.

4.6 The Research Methods

A mixed method of data collection techniques was employed in this study in order to address the research questions guided by the previously mentioned assumptions on the methodological, epistemological and approaches standpoints. An overview of the methods used is presented in Figure 4.4 below.

Main research questions:	Methods:	Subjects:
1. What are threshold concepts in the learning of agriculture that could lead to higher levels of understanding in the subject, if any?	▪ **Written open-ended questions for teachers** ▪ **Written open-ended questions for students** ▪ **Follow-up interview** (posing similar questions as in the open-ended questionnaire to some selected participants)	▪ **Teachers** (all agriculture teachers with five years and above in teaching experience) ▪ **Students** - Secondary students
2. Is there progression (or learner's transformation) in threshold concepts understanding?	▪ **Open-ended selected one-to-one interview** (interviewing carried out twice on two separate occasions within two consecutive years)	▪ **Students** - Year 2 (t=1 → 2) [Key: t = 1 is time at year one]
3. How do students arrive at threshold concepts understanding and what are the implications for teaching/curriculum design?	▪ **Open-ended selected one-to-one interview** (gleaned from the interview data) ▪ **Documentary review:** - Curriculum programme guide or syllabus for agriculture curriculum - Government's official documents	▪ **Students** - Secondary students

Figure 4.4 A schematic overview of the research methods for the study.

The methods were open-ended written questions, an unstructured open-ended flexible interview with case participants, and a documentary review on curricular and policy materials. These varieties helped facilitate triangulation from multiple data sources. Flyvbjerg (2004:424) expressed that 'the choice of method should clearly depend on the problem under study and its circumstances'.

For answering Research Question 1, two sets of questionnaires with open-ended written questions were separately prepared for teachers and students. Details of these questionnaires will be presented in the later sections of this chapter and are also found in the Appendix. All agriculture teachers with five or more years teaching experience were involved in answering these questions. For the student participants, these questions were administered to secondary level students. Dependent upon their responses, follow-up interviews were planned on some selected participants and carried out at various stages to further expand their responses.

To answer Research Question 2 regarding progression on threshold concepts understanding, the unstructured open-ended one to one interviews were carried out twice at separate occasions, each at different times within their two year study period. Their responses were then analysed and distinguished to check for any progression. These interviews were only conducted with some selected students based on their previous written questionnaire responses.

In answering Research Question 3, responses from students' interview data were gleaned to provide information on how they arrived at threshold concepts understanding. To see some implications on teaching, several documents were also inspected and analysed such as their prescribed curriculum document currently used by the school, and several government policy documents.

The next section will now turn to explain the reasons why these methods are chosen in addressing these research questions.

4.7 Methods of Data Collection

The three methods of data collection employed in this research were: (1) the open-ended written questions; (2) the interview; and (3) documentary review. This next section will describe and explain the rationale why and how these methods were employed in this research study.

4.7.1 Open-ended written questions

As mentioned earlier, this study did not employ quantitative approaches such as the survey. Close-ended 'questionnaires are of little use if meaning and understanding are primary concerns...' (Gillham, 2000:79). Furthermore, the use of a survey may not help uncover the phenomenological experiences that emphasised meaning in order to answer this study's research questions. Instead, broad and open-ended questions are useful. Such questioning structures allowed for wide ranging responses to be collected from participants. This also enabled response-mapping which was fully utilised in selectively choosing participants for a follow-up in-depth interview. Besides that, this survey's open-ended questionnaire also provided a framework for me to formulate guided interview questions to be used for the in-depth interview. The details of these questionnaires will be explained further under the sections that describe the instruments.

4.7.2 Interview

The majority of information collected for addressing the research questions in this study was done by interviewing. Interview is a valuable research tool that allows for a quick and rich source of data collection. In-depth information can be obtained from a complex social situation and their interconnections to the reality of the world. As Punch (2005:168) puts it 'it is a very good way of accessing people's perceptions, meanings, definitions of situations, and constructions of reality. It is also one of the most powerful ways we have of understanding others'. Interviewing is also done due to the little time the researcher has to observe what the interviewee has come to observe or experience. As Stake (1995:69) argued, 'interview questions would get the interviewee to describe scenes that the interviewer could not witness him or herself'.

In this study, the threshold concept understanding is at the onset where students begin to make sense as they understand and see connections of what has been learnt, as such it enables the learner to apply the knowledge to any related situation. This would not be observable to the researcher unless through participant interviewing and retrospection. Only through interviewing the learners can the researcher view how the learners see connections of various concepts that promote their understanding and thus the time spent in retrospections during the interview helps individuals in thinking and viewing the world more meaningfully. Hence, the intended interview aimed to seek phenomenological threshold concept understandings and the integration of ideas/concepts as reflected through the voices of the participants. The interview method is a powerful tool to find out the unknown and the unseen. As Patton (1990, cited in Hughes, 2002:209) mentioned, 'the purpose of interviewing is to find out what is in and on someone else's mind. We interview people to find out from them those things we cannot directly observe'.

Since the purpose of this research topic and the information collected was on individual personal experiences, the interviews involved in this study used informal, interactive, one-to-one open-ended questions. The advantages of one-to-one interviews are they 'easily managed; allow rapport to be developed; allow participants to think, speak and be heard; and are well suited to in-depth and personal discussion' (Reid, Flowers & Larkin, 2005:22) – all of which facilitate more opportunities for probing into deeper meanings into the participant's lived experiences.

On the contrary, the focus group interview method which can draw upon multiple voices (as opposed to individuality) is not subscribed for this study as it is the rich data of individual life experiences that is required here. The focus group method is not a sensible choice because it cannot seek responses from the individual subjective understanding perspective. Smith et al. (2009:57) argued that 'one-to-one interviews are easily managed giving participants the space to think, speak and be heard'.

The need for guiding questions in the interview

However, getting a good interview is not always easy because it is not easy to ask the right questions and it is often difficult to control or steer the flow of the interview (Stake, 1995:64). Thus, besides the prepared open-ended interview questions, there was also some guiding questions prepared to help with the interviewing. This was done because 'unstructured and open-ended interview questions are not pre-planned and standardised, but instead there are general questions to get the interview going and to keep it moving' (Punch, 2005:170). These questions were prepared to achieve what Creswell (2009:8) mentioned: 'the more open-ended the questioning the better, as the researcher listens carefully to what people say or do in their life settings'. Moreover, the more standardised the questions the more the inability to obtain important and salient data from the interviewees – this was avoided so as not to limit the information gathered from participants.

Thus, an outline of generally prepared questions, serving as guiding questions, was prepared with an interview schedule alongside some instructions (see later section and also the Appendix). These questions not only served as guidance but also for deeper probing in case of further clarification. These guiding questions were developed as a means of reducing the tendency of 'unstructured interviews' that having 'the potential of limiting the analysis' (Smith et al., 2009:70). The advantage of having guiding questions was that the interviewer was able to focus on what being said by the participants, and at the same time avoiding having to come up with the next questions rather than less attentive on what being said. But generally, the participants were given as much chance as possible to talk about what has been phenomenal and valuable in their understanding of agriculture and the meaning it provides.

Hence, of course, the interview schedule was prepared with the flexibility of allowing the interviewer to take stake participants expressing his/her concerns and claims seriously. Generally this made the interviewer 'more engaged and an attentive listener, and a more flexible and responsive interviewer' (Smith et al., 2009:59).

However, Moustakas (1994:114) emphasised that although a series of questions developed in advance 'aimed at evoking a comprehensive account of the person's experience of the phenomenon, these are varied, altered, or not used at all' when the participants shared his/her full experience. Similarly in this study, the prepared guiding questions may or may not have been used once the interview was progressing smoothly so as not to interrupt the flow of the participants' description of their experiences.

Structure of the guiding interview questions

The mechanism for developing the guiding questions' structure for the interview was inspired by the work of several people such as Moustakas (1994), Meyer and Land (2003 & 2006), and Davies and Mangan (2005). Although not all questions were exactly taken from their research, some adaptation and modifications have been done to suit this study's research problem and purposes. But as a rule, basically these questions were structured from general to specific. The general questions were first asked in order to initiate the interview, the next questions were followed by the specific questions related to the first responses. The interview was conducted in both English and Malay languages.

For example, just to mention a few, the opening sentence at the beginning of an interview was as open-ended as possible by proposing such a statement as: 'try to remember the last time you have understood about agriculture and tell me anything about the situation, how you felt, did or said?' (modified from Stevick, 1971 cited in Moustakas, 1994:115).

For probing, Moustakas (1994:47) mentioned, whilst carrying out their reflection on conscious experiences during interview, participants' text description can include 'thoughts, feelings, examples, ideas, situations that portray what comprises an experience'. Therefore in order to capture these experiential components during the interview sessions, I have formulated the following guiding questions: what are your thoughts about it? What are your feelings when ...? Can you give any examples of ...? What are your ideas when ...? Can you provide any situations where you think you could understand agriculture fully? These questions were used during the interview in order to help me to illicit what Moustakas (1994:59) described as any 'passionate involvement with whatever is being experienced'.

Interview process and interview technique

Consent from participants was obtained prior to the beginning of the interviews. They were given an explanation of the purpose of recording the interview and were assured that the recording will not be disclosed to any other people – it was solely for the purpose of me remembering what had been said during the session. At the beginning of the interview, easy and spontaneous questions were asked in order to encourage participants to talk at some length. This was to make them feel at ease and relaxed in a trusting environment.

Following that, the interviewer set the scene by asking topics which had been studied. Progressively, the interview questions asked participant to focus on their memory of their experience about the moments that has vivid impact on them in getting to understand certain parts of the agriculture topic. Throughout the session, the responsibility of the interviewer would be to make the participant feel as comfortable and speak as honestly as possible besides bracketing her own experiences and priori preconception in order to get the full description from the participant.

To ensure a good flow of questioning technique, although this may not be possible at all times, Smith et al. (2009) gave the following advice:

> The general flow, or rhythm, of an interview tends to shape the tone of a transcript from the broad and general (in the beginning) to the specific micro-details of events (towards the middle of the interview), to some kind of synthesis or 'wrapping up' at the end of the interview (p. 83).

Smith et al. (2009:59) suggested that the sequences should move gradually from 'primarily narrative and descriptive to more analytic or evaluative' but this may not follow the same order as in the prepared schedule. In addition, he said that, 'it is good idea to aim for the interview to start with a question which allows the participant to recount a fairly descriptive episode or experience. This way the participant quickly becomes comfortable talking. Invitations to be more analytical can be introduced as the participant begins to ease into the interview' (p. 60). Moustakas (1994:116) suggested, in relation to this analytical part at the end of the interview session, is by posing the following questions: 'how did the experience affect you?', 'What feelings were generated by the experience?', 'What thoughts stood out for you?', 'How do you share what is significant with others?'

During the course of the interview session, in order to encourage participants to speak elaborately of their accounts, prompts on hard-to-understand questions are probed from time to time (see the Appendix for the schedule). Engaging in the epoche (setting aside prejudgements) is necessary during the interview so that the interviewer will not direct or lead the interviewee's responses. This epoche will be dealt with in detail later under the validity section.

Limitations to interview method

On the other hand, unguided open-ended interview questions are raising the issue of the difficulty to replicate, amounting to a difficulty in managing the responses. Another limitation of the interview method is that the interviewee may give dishonest responses. There is no way we can know whether the interviewees are telling the truth or they are just saying something to please the interviewer. 'One of the weaknesses of interviews is reflexivity – where interviewees give whatever an interviewer wants to hear' (Yin, 2009:102). Reflexivity is how a person's values, beliefs and interests influence her research in an attempt to know what to know (epistemological). So, it is very important to keep in mind where the interviewer/researcher positions herself in the research. On this note, Punch (2005) argued:

> On a technical level, this is an issue about the validity of interview responses, aspects of which include the possibility of interviewer bias and effects, the accuracy of respondents' memories, people's response tendencies, dishonesty, self-deception and social desirability ... The more difficult problem concerns the correspondence between verbal responses and behaviour, the relationship between what people say, what they do and what they say they do, and the assumption that language is a good indicator of thought and action (p. 176).

It may also happen that the interviewee may get influenced by the interviewer's body language. Therefore, it is important for the interviewer to portray neutral behaviour during the interview session and be very careful not to influence the interviewee by providing leading responses in order to get as genuine responses as possible from the participants.

4.7.3 Documentary review

Another method of data collection technique employed in this study is the document review. Documentary data was collected in conjunction with interviews. This was done in order to obtain some implications of findings towards the prospective curriculum. The documents for reviewing include the curricula for the courses, and several other official documents to check on government policy. The aim is to see if the current curriculum reflects enough emphasis on the essential conceptual understandings that is considered threshold and whether this is pitched at below, above or just appropriately to learners. The main aims of the current implemented curriculum could also be noted. In addition, reviewing the policy document will inform me whether it reflects or connects to the implementation of the agriculture subject in schools. This research activity of document review, or analysis, also served as a triangulation purpose, as a way of ensuring external validity by collecting data from multiple sources of evidence.

4.8 Data Handling and Methods of Analysis Technique

This section tries to describe the handling of collected data, and briefly, the methods for which the analysis is to be carried out. Table 4.1 below gives a quick glance of the analysis.

Table 4.1
Intended Analysis of Data

Data	Data handling	Analysis technique
Questionnaire responses	- Compile and tabulate all translated responses	- Look for key words - Group into common themes and categories
Interview responses	- Audio-tape recording - Transcribe verbatim	Using IPA: - textual analysis and emergent coding - sort into patterns and themes for meaning interpretation

4.8.1 Questionnaire responses

All responses from the questionnaires were compiled and tabulated in their original form. Translation of the non-English responses was also carried out. This tabulation allowed for easy retrieval of data and could be used for comparison when looking for certain key words for the subsequent analysis. These key words were then grouped together under some common themes and categories. The total scores would provide an indication of the importance of certain threshold concepts as perceived by the participants.

4.8.2 Interview responses

All interviews were audio-tape recorded and transcribed verbatim (word for word) for relevant and important information. It was decided to transcribe into WORD and use manual coding to minimise mistakes. The transcription then was manually analysed using the IPA method (see next section) which involved textual analysis and coding in looking for patterns. The recurring patterns of ideas, thoughts, feelings, situations, etc. conveyed meanings of participants and these were then to be developed into themes for meaning interpretation. The IPA method of analysis technique will be further explained in detail in the next section.

4.8.3 So what is IPA?

The Interpretative Phenomenological Analysis (IPA) was developed in psychology by Smith (1996) based on Husserl's idea of phenomenology who famously argued 'go back to the things themselves'. What Husserl (1858 - 1938, cited in Fouche, 1993:114-115) meant here was 'an invitation to the things as they presented themselves to consciousness, that is, as a return to the phenomena as they immediately appear before they are overlaid by theory'.

Smith et al. (2009:1) defined IPA as 'a qualitative research approach committed to the examination of how people make sense of their major life experiences. IPA is phenomenological in that it is concerned with exploring experience in its own terms'. IPA is also where 'the analyst attempts to make sense of the participants' attempts to make sense of their own experiences. The IPA aimed to understand what a given experience was like (phenomenology) and how someone made sense of it (interpretation)' (ibid.). In the IPA analysis, the analyst reflects upon his/her own preconceptions about the data, and attempts to suspend these in order to focus on grasping the experiential world of the research participant. Reid, Flower and Larkin (2005) offered the following explanation for IPA:

> Taking 'the insider's perspective' is thus only one part of the analytic process, because the analyst also offers an interpretative account of what it means for these participants to have these concerns in this particular context. This means that there is a balance of 'emic' and 'etic' positions in IPA. In the former (phenomenological, insider) position, the researcher begins by hearing people's stories, and prioritises the participants' world view at the core of the account. In the latter (interpretative, outside) position, the researcher attempts to make sense of the participants' experiences and concerns, and to illuminate them in a way that answers a particular research question (p. 22).

4.8.4 Characteristics of IPA

The IPA has three distinctive characteristics underpinning its theoretical perspective: interpretative, hermeneutics, and idiographic (Smith et al., 2009). The analyst will try to be interpretative of the participants' account in order to elicit meaning. Hermeneutics is where interpretation on live experiences of one particular case is carried out and then connects this interpretation to other cases for common meanings. That is, to see connection between the small parts to the whole parts in order to get a bigger picture. This is carried out by annotating verbatim transcription of a particular case to produce themes which then will form higher order or a super-ordinate theme in order to come up with the whole interpretation. Idiographic is where the whole interpretation will be presented in descriptive narration with supportive verbatim extracts from participants in order to support the claim.

4.8.5 Why is IPA the chosen method of analysis?

Because meaning or relevance of experiences is the focus of the study and not on causal relations, IPA would be best for examining the experiential relevance. IPA is useful where the 'bedrock of the research priority is to understand or make sense in detail the participants' experiences' (Chapman & Smith, 2002:127). This study is seeking the quality of education through phenomenological interpretation of experiences. The aim in IPA is, therefore, to capture those phenomenological experiences the students had whilst learning agriculture. The values they hold about certain phenomena in agriculture will provide an indication of the quality and relevance of knowing certain information. Analysing these instances on their accounts could lead to the discovering of threshold concepts understanding for mastering the subject. Hence, the choice of opting for IPA in this study is apt since analytical findings on their perceptions of valuable experiences would be an essential precursor to the understanding of agriculture.

4.8.6 How is the analysis carried out?

In doing the analysis, as the researcher and acting as an interpretivist, I interpreted meanings from participants' construction about their world after having interacted with them through the interview. Here, whilst analysing the verbatim text, I can use my own conceptions (guided by the study's research questions), unlike when data collecting (interviewing) where I have to bracket-off and act naively to elicit deeper meaning.

Verbatim text analysis is where 'words are analysed in segments for meanings to compare, contrast and are sorted into themes and patterns' (Miles & Huberman, 1994:7, cited in Morrison, 2007:28). Each verbatim transcript will be analysed individually case by case, where important texts are highlighted and commented on based on the account given by the participant. Emergent themes for each highlighted text were assigned and coded which later proved useful for developing an emergent theme for the group (hermeneutic circle).

A hermeneutic circle is where 'the part is interpreted in relation to the whole; the whole is interpreted in relation to the part' (Smith et al., 2009:92). This means that, each case transcription will be analysed for a systematic search of themes, where theme connections are made before moving on to the next case. Variations and commonalities among the group of participants would also be compared and analysed to provide a whole description but not to make a claim for all or for generalisation. Finally, the write up for the cases, which will be descriptive or narrative, is supported by verbatim extracts from the participant (i.e. idiographic focus). For clear and well detailed steps on the analysis, refer to Chapman and Smith (2002:127); Shinebourne and Smith (2009:155) and Smith et al. (2009:73). This section has described, in general, how the analysis was carried out, and the steps I have taken will be described in detail in the following sections.

4.8.7 Transcription of interview data and steps in the IPA analysis

The transcription of the interview data was done case by case. Each audio recorded interview was transcribed verbatim into tables and columns into Word programmes where paragraph and line numbers were assigned. This was for easy referencing and helped in identifying specific excerpts from the long transcripts. The given paragraph number helped me focus on the interviewee's responses with regards to each time when a new part of question was posed.

All mixed languages (Malay and English) were freely used during the interview sessions both by the interviewer and interviewees, and therefore would also similarly appear as in the audio recording. I decided that all the Malay language idioms were simultaneously translated into English wordings during subsequent transcribing to avoid double work. The validity of this translation was cross-checked during transcribing to ensure that the transcribed verbatim was closely matched with what the participants said during the interview by repeatedly listening to the voice recordings over the transcription. Each line of transcription was then numbered (as shown in Table 4.2) for reference and therefore allowed easy retrieval when extracted later.

Table 4.2
Format of Table Layout for Transcribing Interview Data for Each Case Participant

Original transcript:	Line number:	Researcher's comments:	Emergent themes:
Paragraph number:			
(1)			
Verbatim text...	1		
	2		
	3		
	4		
Researcher's interpretations:			
Implications to instructions and curriculum design:			

Table 4.2 shows the layout format for the columns used at verbatim transcribing. The columns at the right hand margin were allocated for me to give comments on the original transcript and to note on the verbatim text where key words and later themes or pattern (super-ordinate themes or major themes) could be written in the last column. For an example of transcription please refer to the Appendix.

Each interview verbatim text from each interview was then analysed case by case according to this study's research questions, the conceptual framework and the contextual issues in the quintain that guided the analysis. The four steps in the analyses are now described in turn.

Step 1: Highlighting and annotating researcher's comments

The first step in analysing each case begins with highlighting and commenting on important texts based on the interview account given by the participant. This included key words, phrases and explanations given by respondents. As mentioned before, in analysing verbatim texts, Smith et al. (2009:4) in his phenomenological approach advised looking for cues on how students make sense, reflect, think and feel regarding significant experiences in the everyday life of the participants through interview. Thus, in analysing the interview data, I was constantly looking for phenomenal major experiences or critical episodes such as feelings, thinking, examples, attitudes, situations or the absence of these, which are related to concepts or conception that are transformational and integrative (and how they were mediated), but may also or may not be troublesome, which will be automatically irreversible and bounded to the agriculture-specific disciplinary and contextually. For each highlighted text in the original transcript, initial comments on its importance are then given and this is annotated under the researcher's comments column.

Before the next step of assigning the emergent themes was done, impressions/interpretation of the data were also made and recorded. This was noted underneath each table of verbatim text for each case interview participant. When it comes to doing this, Smith et al. (2009:91) advises 'free associating from the participant's text, write down whatever comes into your mind when reading certain sentences and words'. This is where meanings of the participant's world as interpreted by the researcher are created; and what can be learnt from their experiences was then produced. This is also cross-checked with any note written after the interview session. For accuracy of this interpretation, it needs to be ensured, and so doubly checked, that this impression was reflected from the exact words used by the interviewee participant as in the original interview voice recording data, and also the need to be ethical and precisely coherent.

Step 2: Assigning emergent themes

The second step consisted of assigning any emergent theme based on the researcher's comments. Emergent themes for each highlighted text were assigned in the column margin next to the researcher's comment. In doing this step, the focus was on the initial researcher's comments rather than the transcript itself. According to Smith et al. (2009:91) the focus is 'what can be learnt from the initial comments' and this was done by 'attempting to produce a concise and pithy statement of what was important in the various comments' to capture the essence of the narratives and to what is crucial at this point. As a guide, he advised that 'themes reflect not only the participant's original words and thoughts but also the analyst's interpretation and it feels like they've captured and reflect an understanding' (p. 92).

In assigning themes for each case, it was important to bracket off (maintaining epoche) my previous assignment of themes when moving on from one case to another, so as not to get influenced by the previous case with the new case being analysed. This was very important so that fresh and new themes could be assigned as they emerged in addition to the already frequently appearing themes. Finally, each emergent theme was then coded according to this study's research questions (i.e. RQ1, RQ2 and RQ3); but no coding for the conceptual framework and contextual issues was required as these just relied on the themes assigned. Examples are historical issue, social issue and economic issue. These tasks were useful later for developing a super-ordinate theme for this particular group (hermeneutic circle) as the emergent themes come together in a new whole.

Step 3: Extracting key words and searching for connections across themes (abstraction) within each case

This step is still about analysing each case individually. For this step, a table (see Table 4.3) was prepared to help with the analysis. Here, abstraction and extraction were both done simultaneously. In extraction, key words or phrases corresponding to the highlighted emergent themes were extracted. This step was done manually by copying, dragging and pasting the appropriate verbatim texts close to this table so that it was easier to see the whole statement and hence extract the key words. This statement was then deleted when the extracting process was over and repeated with other new statements. This whole step was manually done case by case before moving on to the next one.

Table 4.3
Extracting Key Words for Themes and Abstraction of Sub-ordinate Theme into Super-ordinate Theme within Each Case

Super-ordinate theme - sub-ordinate theme	Para:Line	Key words	Line
Most difficult concept	1: 13		
- plant science		- hard, cannot understand	
-		-	
Most useful concepts			
-			
-			

The prepared table also helped in seeing connections or patterns between themes within each case. It allowed ease in identifying which of the sub-ordinate themes could form a connection and be grouped together under the same theme (in order to form super-ordinate themes) as the researcher constantly skimmed through the emergent themes. This step of forming super-ordinate themes is called abstraction in IPA. Basically, abstraction is sorting themes into clusters. Specifically, 'abstraction is a basic form of identifying patterns between emergent themes and developing a sense of what can be called a 'super-ordinate' theme. It involves putting like with like and developing a new name for the cluster' (Smith et al., 2009:96).

The above steps, extracting key words and abstracting themes are therefore a precondition for allowing the next step of analysing patterns across cases for forming similar themes to represent analyses for the whole multicase group.

Step 4: Looking for patterns across cases in the multicase group

The fourth step consisted of looking for patterns across cases. Because this study is a multicase study research, it was important in the analysis to look for patterns across cases to represent findings for the multicase group. This was done by sorting the themes in a table format so as to group and see the relationship of interconnectivity or patterns to form a super-ordinate theme. The coding (RQ1, RQ2, RQ3 and so on) from the former step (Step 2) also assisted the sorting into various patterns.

In a multicase study such as in this research, these steps helped in order to 'see connections/patterns across cases, how does a theme in one case help illuminate a different case, and which themes are the most potent' (Smith et al., 2009:101). An example of a table to help with this kind of analysis was prepared, such as shown in Table 4.4 below.

Table 4.4

Layout Table for Looking for Patterns across Cases

A. **Most difficult concept**	
- *Plant science*	
Student 2M: I found osmosis difficult.	Line 22
- *Enterprise + business*	
Student 2D: I know I am not good at it.	Line 36
- *Animals*	
Student 2N:	Line 25
Student 2F:	Line 31
B. Most useful concept	
Soil	
Student 2C:	Line 36

Since there were two rounds of interviewing done (i.e. Interview 1 and 2), two tables (like Table 4.4) were prepared separately representing each round. These tables were later combined in order to see the collective patterns for the group. The reason for having the tables separate in the first place allowed me to compare the development of progression of the cases between the first and second interviewing. The final outcome of the analysis resulted in emergent themes for the whole group of the student participants' data which allowed me to see patterns and similarities from both interviews simultaneously. The purpose was to see how themes from cross cases (from first and second interview) fit together. The way to do this is to print out the resultant themes from cross cases in each interview, cut them into a separate piece of paper and rearrange them to see connections of themes for the whole group, which of course, are guided by this study's research questions. In doing this analysis some of the themes were discarded, and some were given more importance depending on the given responses and their significance as seen from the amount of interview prevalence shown during the transcriptions of key words extracted in Step 3 above. It is obviously the ones with the most response from case participants that were given the most importance. Those that did not get as much mention from participants, tended to be discarded. For more information of this technique, refer to Stake's (2009:96) advice.

From the described steps above, it was then possible to provide the meaning and to make sense of the participants' world by interpretation of their phenomenological experiences. A collective interpretation from all participants was then produced to seek greater understanding of the cases and their interaction within their contexts of learning agriculture. These results and findings are presented in Chapter 5 (dealing with the results of analyses and findings).

4.8.8 Guiding the inductive data analysis

The analysis of this research inductively looked at each case in order to holistically view a whole picture. This is because I was specifically looking to analyse each individual case and then to view holistically the whole group, searching for answers and meaning of understanding in relation to wider contextual issues of the whole multicase study. That is, by moving from particular to more holistic, or from parts to whole – hermeneutically in the exact word of IPA. But how I did this in the analysis will be further explained in detail in the next section.

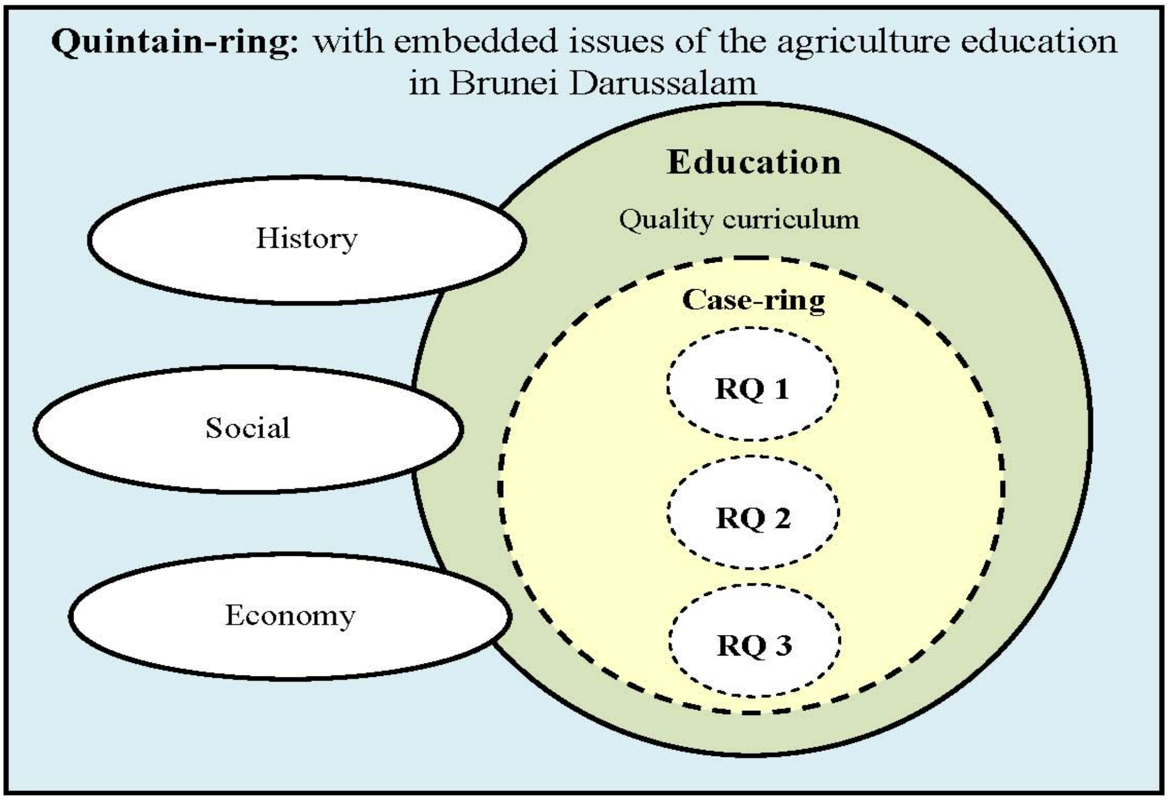

Figure 4.5 Relationship of research questions in the case-ring under educational issue, the conceptual framework (agricultural education and economic balance) and other issues in the quintain to guide the analysis.

What guides the analysis? Before analysing the data, it was important to determine what guided me in the analysis. In analysing the data and what to look for, the advice advocated by Briggs (2007:375) was taken: 'guiding your analysis, therefore, will be both the research questions and the conceptual framework of your research'. In addition to this however, I felt that the issues in the quintain also needed to be taken into account. This was because, as this study is a case study, the analysis is not just guided by the research questions and the conceptual framework, but also by the issues (historical, social, and economic) in the quintain in which the research context is embedded. Figure 4.5 tries to illustrate this relationship. It can be seen in the figure that the research questions are mainly rooted in the case-ring – the ones that guided the analysis of the empirical data of the cases. But there are also findings from the data that are related to the conceptual framework and the issues in the quintain-ring that affected this case study research.

Also, considering that this study is an instrumental case study, as mentioned in an earlier part of this chapter, it is vitally important to take account of the issues within the study context. On another note, the analysis guide was also based on the epistemological stance of this research which is relying both on the phenomenological and case study research approach.

This conjecture has thus guided my activities on the analyses and the subsequent reporting of each and every individual case. Specifically, the beginning analysis is based on the IPA analysis (case by case basis), and eventually encroaches to the whole of the multicases (across the cases) and the related contextual issues in the whole quintain characterisation of a case study research. Thus, the procedures for analysing the data are in part extended from relying on the IPA method at the beginning, to subsequently subsume that of the case study research at the end. The IPA is strongly rooted in the psychology research and phenomenal feelings of the cases, whereas the case study research is very much influenced by the contextual issues within which the quintain is situated. The mixture of both is thus considered. This amalgamation also somehow follows the advice taken from Creswell (2009) that:

> A case study involves a detailed description of the setting or *individuals*, *followed by analysis of the data for themes or issues*. Phenomenological research uses the *analysis of significant statements*, the *generation of meaning* units, and the development of what Moustakas (1994) calls an *essence description* [p. 184, emphasis added].

4.8.9 Guiding the analysis to the research questions

The above section has tried to explain the rationale behind the guiding thoughts for the analysis. In this section, I will explain these guiding thoughts in relation to the actual data analysis carried out precisely with regards to the three main research questions. The details shown in Table 4.5 helped me to focus on what was guiding my analysis. In analysing the data inductively, I analysed the data case by case, checking for data that could lead me to some answers relevant for addressing each of the main research questions.

In addressing Research Question 1 and looking for quality of understanding, I constantly checked for evidence of threshold concept understanding in each case participant. These analyses are embedded in the cases' thoughts, feelings, experiences, opinions, reflections, explanations and examples that surfaced during the discussions in the interview as well as some of their written responses from the questionnaire. The three threshold concept characteristics such as integrative (evidence of ability to connect/link concepts), transformative (the most meaningful concept) and troublesome (the most difficult concepts) were being scrutinised in the data to check if threshold concepts understanding had taken place in the agriculture domain. If these had been successfully taking place, students would have achieved deeper understanding which is an indicator of quality in learning as they are able to make connections between ideas or concepts. This resultant deeper understanding could be derived from many aspects of learning – it could be seen by students as some knowledge that is important, valuable, meaningful, relevant, helpful or even useful. And it could also be hard, difficult or troublesome, which could become normal eventually and may help towards better understanding. These are the qualities presumably characterised in learning which educationalists would expect to observe in students' learning that provided higher impact.

However, as this research is searching for quality from the learners' perspectives, the criteria for learning as perceived worthwhile, was also scrutinised in the data – responses such as those learning experiences which were meaningful, relevant and phenomenal to them. These are the determinant of quality that excites students' learning. That is, the expected learning criteria which could be perceived as quality and most valued by learners in this study. In trying to understand the experiences an individual had in learning agriculture in this study, students' phenomenal experiences helped to pinpoint relevance and therefore indicate meaningful learning which was assumed and interpreted as quality, as I believe this in part, could reflect some form of individual's transformation in learning. I have explained the focus for analysing the data for answering Research Question 1. Next is the second research question.

For Research Question 2, assessment of indications that learners have made progressions and transformation in learning agriculture were also analysed. In analysing the data, I constantly assessed participants' development in thinking – whether they had tried to link ideas as in the 'think and practice' of a discipline (Davies & Mangan, 2008) or perhaps like agriculturists, more or less, in view of transformed understanding in the discipline threshold concepts. While doing this, I concurrently checked the learners' progression on evidence of their thought structures and if it could be categorised according to SOLO's five hierarchical level of learning cycle: pre-structural, uni-structural, multi-structural, relational, extended abstract. In analysing progression across these levels, the cue words 'connect', 'relate', 'continue' or 'inter-relationship' were analysed in the data. The rationale for using SOLO alongside the threshold concept framework in the analysis will be explained in the next section.

Table 4.5

What Guides the Analysis: Research Questions, the Conceptual Framework, and Issues in the Quintain

1. Research questions in the case-ring:

RQ1: What are the ***threshold concepts (key concepts)*** *in Agriculture that leads to higher/quality/deeper levels of understanding? (i.e. focussing on critical/phenomenal episodes/experiences when it clicked)*

● *Checking for threshold concepts characteristics in the data:*
- integrative (connecting/linking concept)
- transformative (most meaningful concept)
- troublesome (most difficult concept)

● *Quality – indication of quality:*
deeper understanding: able to connect between ideas (see ** below)

** Understanding:
- important/valuable knowledge learnt
- meaningful, relevant
- helpful, useful
- difficult, troublesome, hard
- easy

● *Quality to students also means:*
- meaningful
- relevant
- phenomenal

} Criteria that excite student's learning

RQ2: Is there progression (student's transformation in terms of thinking development from simple to advance or complex ***knowledge and skills****) in* ***threshold concepts understanding****?*
[Understanding → progression → transformation from novice to expert (thinking development)

● Checking for **progression** in thinking development (in terms of SOLO taxonomy) and 'think like agriculturist' (in threshold concepts framework) and able to visualise problems like agriculturists in **knowledge and skills**:
- think and visualise problem like agriculturists (in secondary level students)
- development in thinking from simple to complex in terms of SOLO taxonomy

● Evidence of transformation: value of agriculture manifested in a **transformation** in an individual's **attitudes** and **perspectives**

RQ3: How do students arrive at threshold concept understanding and what are the implications for teaching and curriculum design? ***[i.e. how threshold concept understanding in agriculture is reached]***

● Pinpoint by the most phenomenal learning experiences the students ever had

2. Conceptual framework:

● Correct balance between agricultural **education** and **economy** to address quality and relevance in the curriculum through threshold concept framework

3. Issues in the quintain-ring:

● Overarching issues

History:	- oil
Social:	- work/employment/job
	- people's mindsets
Economic*:	- food security issue
	- self-sufficiency
	- low agriculture production

● Main issue
- Education*
(already covered in the case-ring in number 1 above)

NB: * Also appear in the conceptual framework at number 2 above

Analysing the data for findings to Research Question 3 related to how students arrived at threshold understanding and was quite straight forward but crucial. Answers to this question determined what counted as phenomenal and pinpointed indications to what created qualitative understanding in learning. Once the most phenomenal experiences in the cases had been identified in the data, it was much easier to see what made such experiences phenomenal based on the corresponding interview responses. This guidance on the analyses has framed my thinking when looking for aspects of qualitative understanding related to threshold concepts. Whilst analysing the data, I was also constantly aware of the influencing factors inherent in the conceptual framework of this study – the purpose behind agricultural education in the context of Brunei Darussalam and the two E's parity (agricultural education and economy) for addressing curriculum quality and relevance. The E's abiding forces are also part of the issues in the quintain-ring, aside the main issues related to education, which are already covered in the case-ring. The related over-arching issues of the quintain – history, social and economic – was also constantly kept in view during the analyses in order to gain insight into these pressing issues as perceived by case participants. This section has explained what guided my analysis of the whole data. Results of the analysis and the findings in the light of these analytical thoughts will be presented in the next chapter.

4.8.10 Rationale for using SOLO

Most threshold concepts have been researched at undergraduate level (student ages 19 years and above) for determining the overall outcomes of a discipline or course. Whereas the concrete-symbolic modes of thinking stage in Piaget's cognitive development theory is predominant at secondary schooling (from the age of 16 years, where complete transformation in discipline is not yet fully developed). Since this study is not done at a higher level of education (or university), SOLO taxonomy is therefore utilised to measure the progression transcended from a secondary level of education before threshold concept understanding can be detected at a higher level.

Previously, Ashwin (2008) had also used the SOLO taxonomy in assessing the quality of learning outcomes in threshold concepts studies for the GCSE (General Certificate of Secondary Education) economics subject for 14 to 19 year olds. He reflected that although he anticipated SOLO would accurately reflect the quality of the learning outcomes with regards to understanding and assessing threshold concept acquisition (p. 173), it only gives illumination into (or points towards) the problem, rather than provides the solution (p. 181). However on a positive note, he commented that his results derived from a SOLO assessment do illustrate very clear distinctions between the qualities of responses (p. 182).

Table 4.6

Guiding Data Analysis in Looking for Progression using SOLO Taxonomy for Secondary Level of Education

Levels of SOLO taxonomy	Explanation of level of understanding	Sample verbs indicating levels of understanding	Examples of students' responses given in the SOLO video to the question posed: What is a cow?	
SOLO Level 5: **extended abstract** - higher order thinking (**transformative** in threshold concepts theory)	A student has the capacity to generalise the structure 'beyond' the information given, and even produce new hypotheses and theories, which may then be scrutinised.	- to generalise - to hypothesise - to theorise - to generate - to create - to formulate - to reflect	*'Cattle, or kye, are domesticated ungulates – a member of the sub-family bovinae. And, it seems to me that humans must have been for the root cause for the diversification of cattle, because they were selected for different genetic characteristics like draft, meat, milk, size, colour, and behaviour to name a few'.* [NB: Given responses is much longer plus ability of hypothesising/theorising].	Deep understanding (higher order cognitive processes)
SOLO Level 4: **relational** (**integrative** in threshold concept theory or at formal stage in Piaget)	A student can now link and integrate several parts into a coherent whole. Details are linked to conclusion and its meaning is understood. He has the ability to relate, compare, analyse, and so on.	- to relate/apply - to compare/ contrast - to analyse - to explain causes - to argue - to criticise - to justify	*'The essential difference between a Jersey cow and a Hereford-angus cow is that a Jersey cow produces a lot more milk, but is substantially smaller'.* [NB: Relating/comparing between two types of cow species].	Deep understanding Thinking and practice in discipline (Davies & Mangan, 2006a). 'Working understanding of the discipline of physics' (in Biggs & Collis, 1991:66, Table 5.2).
SOLO Level 3: **multi-structural** - if there are connection, they are very simple	A student at Level 3 three can focus on several relevant aspects, but they are considered independently. He is able to classify, to combine, to enumerate, and so on.	- to classify - to combine - to enumerate	*'Cows give us milk, and when slaughtered they give us oil, meat, fat, bone...and leather'.* [NB: More responses given but of the same thing or simple related].	Surface understanding
SOLO Level 2: **uni-structural** - students memorise and can only carry out a simple procedure	Where a student will focus on one relevant aspect only. Here the student has the competence to identify, to do a procedure, and/or to recite.	- to identify/ name - to do procedure (follow simple procedure) - to recite	*'A cow is when you are milking'.* [NB: Fewer sentences only in the given response].	Surface understanding

SOLO Level 1: **pre-structural level** - lower order thinking	The student has no understanding, uses irrelevant information, and/or misses the point altogether, and is incompetence.	- no understanding - irrelevant info - misses point	*'Ahm...'* [NB: No answer given].	

Source: 1). Biggs's BlogSpot (2011), http://www.johnbiggs.com.au/solo_graph.html; 2). Brabrand & Andersen (2006), SOLO Taxonomy video entitled 'Teaching teaching & understanding understanding' (with English subtitles), http://www.daimi.au.dk/~brabrand/short-film/

SOLO was also chosen in this study since it is non-discipline specific and can classify learning outcomes in terms of its quality (Biggs, 2011, www.johnbiggs.com.au). Hence due to these reasons, SOLO and threshold concepts were thus used for guiding my analysis on progression for Research Question 2. Table 4.6 outlines the details of the SOLO taxonomy for assessing progression in the case participants' learning. Please note that this table was produced from the information I obtained from Biggs's BlogSpot (2011) and the video on SOLO taxonomy (Brabrand & Andersen, 2006) which was endorsed by him.

Besides analysing progression using SOLO, evidence such as whether they are able to think and visualise problems, or reflected experiences like agriculturists in the data were also noted, whilst at the same time checking to see if they are able to make/see connections in ideas or concepts in their learning and reflection. There was also some judgement made so as to distinguish and identify whether case participants had made progression in the time between their first and second interview periods. These thinking progressions might be in terms of knowledge, skills and perception; and may as well have been in terms of transformed attitudes and perspectives, since it is not impossible that there may also have been some progression in these aspects.

4.9 Internal and External Validity

This study is not on causal situations (i.e. quantitative associations between variables) so internal validity or consistency is not relevant for the method. However, internal validity in qualitative research refers to 'the internal logic and consistency of the research in relation to its purpose and design' (Punch, 2005:254). Punch mentioned that, 'the research has internal consistency if all the parts of the research fit together, and where the findings themselves have internal consistency and coherence, and the propositions developed and confirmed by cross-validation of findings with other parts of the data' (ibid., p. 254).

It is the external validity (question of generalisability) that was of concern to this study because this study was about descriptive and explorative case study where inferences are involved. As Yin (2009:43) puts it ‘basically, a case study involves an inference any time an event cannot be directly observed. An investigation will infer that a particular event resulted from some earlier occurrence, based on interview and documentary evidence collected as part of the case study’. The case study is not intended to generalise to a larger universe but relies on analytical generalisation where the investigator is striving to generalise a particular set of results to some broader theory. To overcome the potential issue of validity, I have tried to maintain transparency, epoche, and triangulation, which will be explained further in the following sections.

4.9.1 Transparency

Whilst using the above qualitative approach, it was also important for me to be mindful that my personal opinion was not to interfere with that of the participants’ opinion. The interpretation should be based on what the participants said and should not distort what they thought in order to maintain the subjectivity of the data.

4.9.2 Epoche in phenomenological research

Epoche or Husserl’s (1931) ‘freedom from suppositions’ means ‘setting aside biases or prejudgement or presuppositions’ is so inextricably linked with phenomenological research to assure the validity of the research. According to him, in his action it is necessary for the researcher ‘to stay away from or abstain’ from his own ‘previous knowledge and commitments’ (Moustakas, 1994:85). There is the need for the researcher to discover new knowledge or the phenomenon under investigation, as if it is encountered for the first time in a freshly and naively consciousness manner in order to get the best potential of the truth. He stressed, the approach is to see with openness – to look and see things freshly and naively as if for the first time and not to let our prejudgement or priori enter the research things. All previous knowledge and experiences should be bracketed and voices of the past should not hamper the findings or data, he added.

Further, Moustakas also emphasised on being a transparent researcher, ‘the challenge of the Epoche is to be transparent to ourselves, to allow whatever is before us in consciousness to disclose itself so that we may see with new eyes in a naive and completely open manner. Thus in the process of being transparent in the viewing of things, we also become transparent to ourselves’ (p. 86). Despite ‘epoche is rarely perfectly achieved', he further iterated:

> Approached with dedication and determination, the process can make a difference in what and how we see, hear, and/or view things. Practised wisely, realistically, and with determination to let go of our prejudices, I believe that the actual nature and essence of things will be disclosed more fully, will reveal themselves to us and enable us to find a clearing and light to knowledge and truth (p. 90).

In experiencing the epoche, for me, it was very difficult to contain myself during the course of the interview sessions; not to persist from sharing my own experiences and thoughts, and for my own reflexivity to hamper the process. However, this was overcome by trying to act as naively as possible, as if hearing for the first time the participants' dialogue in order to get the exact meaning of their experiences. I had to maintain this stance throughout the whole course of the interview sessions until completion, whilst also being careful not to provide any gestures that could give lead to their responses.

Also, as has been mentioned earlier, I had to bracket-off during the data collection (interview) and also during the analysis part of the verbatim text, particularly when assigning themes for each case participant. Thus, epoche was practised during data collection as well as during each of individual case's analysis where it was important to maintain the validity of each case participant stance in order for me to understand the meaning of their world.

4.9.3 Triangulation

To overcome the issue of external validity, triangulation of data, in which to 'facilitate' (Hammersley, 1995 cited in Morrison, 2007) and validate the findings to give a true picture and better understanding of the research problem, was practised. By collecting information from various sources or research subjects (students, teachers, and documents), I was able to arrive at findings for the same research questions. The findings would be inexplicit if only one type of data collection method was used. 'Triangulation is a way of establishing the best view from our data' (Stake, 1995:108). It 'involves comparing different kinds of data (e.g. quantitative and qualitative) and/or different methods (e.g. observation and interviews) to see whether they corroborate one another' (Silverman, 2006:404).

4.10 Ethical Issues

Interviewing the less powerful, such as students in this study, requires some ethical considerations. It is important to be considerate to the people who are being interviewed and not to leave any trail or clue for identification. Their consent and permission was therefore obtained at the outset, and as in voice-recording, prior to conducting the interview.

At the start of the interviewing, I asked permission from the participant for the session to be recorded. If this was declined, then as an interviewer, I would have needed to rely on note-taking. I would have had to be very fast in doing this during fieldwork. Fortunately, no one denied permision for the data to be collected. Additionally, it was also necessary to seek the interviewee's permission when recording is to be used for public presentation or in any other manner of usage prior to dissemination to ensure anonymity and confidentiality. Video-recording can be very useful for recording responses as well as the body language of the interviewee, but this needed to be destroyed at the end of the study for the same reason. However, in this study, only audio-recording was decisively carried out since it is the meaning and understanding of experiences that were the focus of the investigation.

It was also extremely important at the outset for me to inform interviewees regarding the purpose of the interview and how the information was to be used. I had expressed and emphasised in lengthy explanation that the reporting would be anonymous and unidentifiable to convince the participants. They were also informed of the right to participate and to withdraw anytime if they wished and to decide between signing a form of consent or refusal.

Furthermore, ethically, each case in this study was assigned a unique code that only I and my two supervisors would know. The coding of the cases was done so that their true identity could not be traced against the information they had given by other people. Codes such as Student 2N, Teacher A, and so on, are for the sole purpose of indentifying them in my interview data. Whereas codes using numbers such as Student 1, 2 and so on were assigned to participants for the information data gathered from their questionnaire.

4.11 Originality of the Methodology

The fact that no work had been done in the agricultural learning of threshold concepts attested to the originality of this research methodology as this was previously an unexplored area in disciplines. I was stimulated to learn more of this area so I was viewing the problems from a disciplinary perspective based on my previous experiences. This case study was also conducted in a locality and organisation which had not been previously studied. Although the IPA and the case study approach are well-documented methodologies, synchronised useage in this study was unique. However, the approach and instruments I developed were evolved from, and helped by, reading various literatures, guided by the purpose and objectives (research questions) of the research, as well as the philosophical framework of the study. As Cryer (2005) mentioned:

> If these are fairly standard in the field of study, but the student uses them in new untested ways, this would justify a claim of originality. Or if the student develops new procedures, tools and techniques for a specific purpose, this, too would justify a claim of originality (p. 191).

4.12 Procedures for Gaining Entry and Securing Permission before Data Collection

This study was conducted on Bruneian students and teachers in agriculture. Although the institutions are under the affiliation of various departments, access and cooperation was not difficult as long as there was a proper procedure in place for obtaining official permission from the relevant authority. Permission letters were sent to each school's principal and the respective departments that they belonged to under the Ministry of Education. When letters granting permission were received, the research activities were commenced.

Having done that, my next step was to visit each individual school to extend courtesy calls to the school principal to verbally inform and provide detail descriptions of the research activities to be conducted. This included discussions on who was to be involved, and when and where the interviews and questionnaires would be carried out. Upon successful liaison with principal, the next step was to meet the class teachers personally, get their permission and to negotiate which class period students would be surveyed and interviewed. The time and venue for fieldwork taking place would then be mutually agreed between me and the case participants.

4.13 Case Participants

The main student and teacher participants in this study were small in number. They were purposively and carefully selected within certain situated contexts in order to get the best information possible. The teacher participants were all chosen on the basis of their experience of teaching agriculture for not less than five years. However, due to some non-respondents, only 14 out of 17 agriculture teachers participated in answering the questionnaire. The non-respondents had been emailed, and courteously reminded by telephone about returning the questionnaire, but still did not take action. Two teachers were subsequently selected to participate in the follow up in-depth interview consequent of their questionnaire responses. The age range of these teachers was from 26 to 47 years old. Table 4.7 shows the participants that were involved in this study along with their breakdown.

Table 4.7
Participants of the Study

Participants	Open-ended written questionnaire	Male-female ratio	Selected interview
Teachers	14 (initially 17, 3 non-respondents)	(5:9)	2
Secondary students	19	(11:8)	7

Since there are no agriculture studies at university level, I had to make use of the cohort of students from a secondary school, coded School Z. These 19 students were studying agriculture during the year 2009 to 2010. All had participated in answering the questionnaire, and seven of them were interviewed twice on two separate occasions for eliciting their threshold concepts understandings and progressions. Their variation in age range falls between 16 and 21 years old. The interviewees (both teachers and students) were selected based on how well and vividly they described their responses to all the items in their previous survey questionnaires.

4.14 The Instruments

The following sections will describe the instruments and items used in this study as well as the rationale for using them. The full layouts of the instruments are also found in the Appendix.

4.14.1 Open-ended questionnaire for teachers

This questionnaire was formulated in order to address Research Question 1. The idea to formulate some parts of this questionnaire was adapted from Davies and Mangan (2005:12). The purpose is to identify which agricultural threshold concepts do teachers think important for students to grasp. The items for the questionnaire are as follow:

1a). There are many concepts of agriculture that students need to understand in order to master the subject. List down all the key agricultural concepts that you think are very important in order to provide a very good understanding of agriculture to students' learning.

1b). Which **five** of these do you think as the most important? And explain why?

1c). Rank these five in their order of importance, with 1 – the most important and 5 – the least important.

2. Explain the reasons behind your ranking order.

Item 1 above helped me to identify key concepts by asking teachers to nominate or list down those key concepts in agriculture that they perceived as important. Narrowing down their responses by just selecting five out of those helped me to focus on the most important concepts. Their ranking and reasoning informed me how important a certain concept is to an individual teacher and to compare it with the rest of the collective responses for its prominence.

Besides the above items, the questionnaire also aimed to collect demographic data which requires teachers to give details on their particular background such as gender, qualification (year and where obtained), year of starting teaching, years teaching at the same school, teaching timetable, levels taught, number of students handled, etc. These are necessary to provide background information to situate the context of the collected data and the analysis parts which came later. Comparison of their responses allowed for some selected teachers to be involved in the follow up interview in order to probe them deeper on their thoughts.

4.14.2 Open-ended questionnaire for students

This questionnaire was administered to secondary students under the close supervision of their class teacher in the researcher presence. Students were also asked to fill in some particular details such as name, gender, class, and their school for referencing, not for identification purposes, in case I needed to get back to them for selected interviewing. Students were convinced that their responses would be treated as highly confidential and will not be revealed without their consent. The purpose of this questionnaire was to identify threshold concepts which could hold the key to their agricultural understanding. It also sought to identify any phenomenal experiences the students may have and whether they have applied and utilised their knowledge to good use. Responses to the questionnaire allowed me to select participants for subsequent interviewing. The items in this questionnaire consisted of the following:

1. Describe which of the topics you find helpful to your study (in understanding agriculture)?
2. Could you explain what factors or experiences have influenced this?

3a. Do you think that you have used what you have learnt? Yes / No.

3b. Could you explain it in terms that someone else would understand?

4. Do you think what you have learnt is beneficial to you? Yes / No. Explain in what way?

4.14.3 Interview questions to see students' threshold conceptual understandings

Students' responses to open-ended questionnaire above, allowed me to proceed students' selection for interviewing in order to check their further understanding of agricultural concepts, connectivity and integration. The first and second items in the interview served to find out if there is a positive feeling or interest that is perceived as valuable to students which may point to quality learning. Students were also asked whether they have encountered any conceptual difficulty or troublesomeness in understanding certain concepts. These findings would be useful for the future designing of curriculum, where teachers should spend more time and effort teaching the difficult parts. The question on troublesomeness was posed, if provided, there was evidence of where a student had faced difficulty in learning. The following are the items which served as guiding questions in the interview:

1. What topics have you learnt this semester/term?
2. Which did you find the most helpful in improving your understanding of agriculture and why?
3. Which did you find the most difficult (troublesome) and why?

The above are the main questions asked during the first interview, although there are other questions to guide and keep the interview going. The complete procedure, guiding questions, prompts and probing to encourage and keep the interview flowing can be found in detail in the interview schedule shown in the Appendix.

4.14.4 Interview questions to see progressions

The guiding questions on progressions were formulated and posed during the first and second round interview. These three sets of questions were a bit different from the first interview in that the items were purposely set to see individuals' progression in understanding of agricultural concepts as they progress their studies from first year to second year. As a precaution, the word ‘connect’ or ‘integrate’ was totally avoided (following Davies & Mangan, 2006b:7) during the interview sessions as these are the words being looked at for as indicative of a threshold concept. In other words, a more indirect interview question was posed. The items that were guiding the interview questions are as follow:

Set 1. (First year of study)
- What do you understand about agriculture having studied it for one year?
- Can you remember what you have learnt in your first year?
  [e.g. student response might be hydroponics, etc.]
- What do you understand about hydroponics?
- Does that help you to understand {connect / relate*} anything else?
* avoid mention

Set 2. (Second year of study)
- How different is it your study from your first year?
- Anything new or is it just the same thing?
- How do you feel your understanding of agriculture has progressed compared to first year?
- Can you explain by giving an example?
- Does that help you to understand {connect / relate*} anything else?
* avoid mention

Set 3. (Second year of study – extension questions on application of knowledge)
- What is the most important you have studied this year?
- How will this help you with your future plan?
- Have you thought of applying this knowledge after finishing the course?
- Can you explain by giving an example?
- Does that help you to understand {connect / relate*} anything else?
* avoid mention

4.15 Reliability of the Instruments

The reliability of the instruments was established in that there were consistent responses from the respondents. This was assured by explaining to teachers prior to taking the questionnaire the meaning of the word *concepts* or any items unclear or any other aspects that they didn’t understand. Any queries regarding the questionnaire were handled swiftly due to my presence during administering the questionnaires. Teachers were also given the option, if they wished to respond in the Malay language, should they feel that they express better in their own language. This way, there is no dispute regarding the points they wanted to raise in their responses.

Similarly, the student's questionnaires were also set bilingually to minimise misunderstanding. Each statement had its corresponding Malay translation underneath it so students can understand each item clearly. If they did not understand, they were able to seek clarification from me or their class teacher throughout the session. Likewise, students could also respond in Malay if they felt less confident with their English. Mixed responses were also acceptable, if this way they felt more comfortable in expressing clearly and understandably.

This also applied to interview questions. Students and teachers could respond in both languages, whichever was the most convenient to them. In most interviews, the participants responded well, without problems and demonstrated ease in communicating in both languages because it is not the words they used that were important but rather the meaning behind them. To improve my interview techniques and reliability of my guided questions, I also pilot-tested my instruments and the interview techniques, to six students from another cohort.

4.16 Time Frame of the Fieldwork

In order to clearly demonstrate to readers the undertaken fieldwork I have carried out in this research, the following list sets out the arrangements made in fieldwork activities undertaken in Brunei Darussalam.

Fieldwork 1: July and August 2009

- Pilot testing questionnaire and interview
- Questionnaire – agriculture teachers with over five years of teaching experience and selected secondary students
- Interview – selected agriculture teachers and secondary students

Fieldwork 2: August 2010

- In-depth interview – selected students
- Document review

4.17 Critique of Research Approach and Methodology

In retrospect, I am delighted that my research approach and choices of methodology has informed my research questions. This suggests that the various elements (purposes, research questions, approaches, data gathering and analysis techniques) do fit together in my research design; and that I have successfully achieved my pursued objectives. Specifically, I was greatly helped by: (1) my conceptual framework (see 'a threshold concept in doctorateness' by Trafford 2008:274); (2) the choice of overall research design – through careful consideration of the research paradigm (ontological-epistemological philosophical framework), choice of methodological approach of inquiry, the adopted IPA technique and clear guiding thought for carrying out the analyses (described earlier); and (3) subsequent synthesis of points of view and findings by assimilating within my own practical experience, and of others, to arrive at new understandings.

My new understandings would turn out to be vague if this period of careful thought and consideration was not properly conceived in the right manner, and this has taken far more time for an inexperienced PhD researcher like me given no previous literature to follow. Understanding the research paradigm, ontological-epistemological philosophical framework, theory and theorisation (see Kiley, 2009:298), and 'when theory is not' (Sutton & Staw, 1995), are some forms of threshold concepts new for me in this doctorate study. Likewise, understanding the meaning of methodology (the framework under which the inquiry sits) is also crucial, as well choosing the case study and confusion over phenomenology (essence of experience) and phenomenography (the categorisation of the different learning experiences/styles, Marton 1981), to methods and subsequent data collection techniques in order to produce a big book thesis.

A case study is always affected by its real context and certain multi-dimensionality. This research saw many facets attached to its milieu such as social, societal, economic, political, human capital and employment which mould the subject's co-existence in Brunei Darussalam. This highly adhered situational context seems to fit the prescribed instrumental case study I have chosen in this research.

Qualitative interpretivist research and the subsequent interpretation of data, as I have experienced in this study, have consumed a tremendous amount of time (far more than I expected), despite providing greater understanding of meanings. Given this short period of PhD study and with so much new things to learn, this had limited my opportunity to share the findings at a wider audience and public conferences. Perhaps, this is the next best step for me to do in the not too distant future as the findings finally become convincing and clear.

The threshold concept framework in this study acts both as an analytical and theoretical lens to help interpret best agricultural learning experience based on what is phenomenal and meaningful. Analytically, it helps identify transformative and integrative characters of concepts, and theoretically of ways of viewing quality.

4.18 Limitations of the Study

This study provided an in-depth analysis of a localised phenomenon of agricultural threshold concepts in Brunei Darussalam. However, the followings are the limitations of the study.

1. Unfortunately, the data and findings cannot be replicated and is therefore non-generalisable to the whole population due to the small sample. It is not the nature and intention of this study to derive such generalisation since it is about deeper understanding of a localised phenomenon. A multicase study is never about generalisation but *particularisation* of a generalised group. Currently in Brunei, there are no agriculture courses at higher learning institutions to be used to provide case participants. The sample in this study is believed to be the best available for this study based on my past experiences.

2. A further limitation of this research, apart from the small sample, is that due to the limited time scale, this study may need improvement if further research is needed to make the results explicit. But for the purpose of this study and the IPA methodology employed, this small sample is thought appropriate in terms of PhD research and manageability within the limited time frame. Smith et al. (2009) advises keeping the sample small for a novice researcher.

3. The findings from this study is limited to, and applicable only to, the curriculum being taught at the time of the data collections and may not be valid to the whole year curriculum of the study samples. The threshold concept findings here cannot be considered exhaustive but rather suggestive. The threshold concepts discovery in this study is, therefore, specific only to this particular cohort, programme, course and the level or stages of education for this case study's student learning period and thus non-

transferable.

In short, the findings and outcomes from this study will not be used to generalise the assertions for the whole population of students in this discipline or other related agriculture disciplinary areas, though this may pave the way for future research. The specific particularisation of the findings will only be true to the time and situation when it was carried out and cannot be considered as applicable or repeatable to any other time period apart from the time frame of this undertaken study.

4.19 Critique of the Method

The survey method although useful for giving some general outlook of students' learning of important concepts, did not provide me deeper understanding of students' phenomenal experiences. In an almost similar fate, the teachers' survey had only informed me of the general trend of their responses. But fortunately, their shortlisted and first rating ranking activities helped, and together with the supported validation of findings (triangulation) from selected teachers' interviews, led me to the actual overall findings. So, a combination of mixed methods is therefore useful in order in deriving the full findings.

Contrary to the survey, the interview method for the students has proved to be far more useful. Their interview data had explicated the complexity of agriculture learning and demonstrated a distinct picture of key areas of potential thresholds and troublesome knowledge. However, during the process of interview not all the interviewed students were 'equally articulate and perceptive' (Creswell, 2009:179). This is one of the limitations of the interview method as experienced in this study in that it is very subjective. There was some possibility during the interview that students might not be able to express and articulate their ideas, therefore having the risk for me of being unable to probe and get the most meaning from them. This could also be attributed to the fact that I have to ask indirect questions most times in trying to pin down integrative threshold concepts. However, an advantage of posing such indirect questions has allowed me to stake the widest possible identification of the existing threshold concepts within agriculture including those that are potentially troublesome. Given that this study is about understanding a phenomenon, the interview method has proved to be the best way of getting deep understanding and meaning of the phenomenon and the research questions.

During fieldwork, it was not appropriate to check the validity of the interview transcripts verbatim with the participants since it is not necessary to check the *internal* validity of the data, given that purpose of the research is to capture the complexity of a phenomenon where internal consistency is not required. The potential issue of external validity of the findings was overcome by practising transparency (discussed earlier) in order to maintain the authenticity of data. Also it was achieved 'by the sound research design' (Prescott, 2011:32); 'in how carefully participants were selected (homogenous); how the interview schedule was constructed and the interview conducted; and what steps were used in analysis' (Smith, et al., 2009:182); and the triangulation of data from various sources. Some form of validation (mainly to confirm) was carried out where interview findings were casually read and verbally checked with participants during the second interview session. Punch (2005:255), however wrote, 'member-checking or checking with the people who are being studied and who gave the data, is not appropriate in all situations, and its use and limitations need to be assessed'. Validation on my interpretation of the data was therefore purposively not carried out due to its sensitivity to the participants and also its form not being understandable to laymen.

Lastly, it is a bit difficult to ascertain which area to explore given no previous agricultural discipline threshold concept literature is available to guide me. The strength of the interview method is thus proven in this sense. The importance of giving a voice to our children in order to take account of their opinions is thus a good methodology and listening to their voices is a good starting point for including their perspectives. Our failure to see through learners' eyes and hear their voices as to what learning means and what is worthwhile, is of the utmost regret in curriculum innovation. The forthcoming findings resulted from this study, however, could open up an opportunity for future research initiatives linking school-based to university level education. This chapter has described the research design, the philosophical framework and the methodological aspects of this research. In the next chapter, I will present the results of the analysis and findings emanating from implementing these research considerations.

Chapter 5

RESULTS OF ANALYSIS AND FINDINGS: CASE BY CASE

This chapter aims to present the case by case data gathered from students studying agriculture during the field work in the year 2009 and 2010. The analysis of the results (based on the guiding thoughts and procedures described in the previous chapter) and my subsequent interpretations, and the contextual issues that surrounded their phenomenological learning experiences are described here. In the IPA methodology, when a researcher carries out his/her interpretation, this act corresponds to analysing the data and eventually derives their findings.

5.1 Layout of Reporting

In reporting these analyses and findings, I will provide individual descriptions of the cases in *narratives* as a way of informing readers of the cases involved in this study. Yin (2009:170) suggested the multiple-case report to contain multiple narratives to cover each single case. Additionally, Stake (2006:90) stressed that 'in the obligation to be useful to society and to the individual reader (whether this is a policy maker, another researcher, or a practitioner), the research should talk briefly or at length about individual cases'. This then forms the basis for analysing at group or multicase level (presented in the next chapter) which consequently represents the whole findings since a multicase study is about understanding the whole quintain.

5.2 The Case Participants

The case participants had been enrolled in taking the agriculture course during 2009 to 2010. The first data collection was in August 2009 when they had completed their first year and were about to go on to their second year. The age range of the cases was between 16 and 23 years old.

Upon administering the open-ended questionnaire to all the students (N=19) in the cohort, seven students (n=7) were subsequently interviewed face-to-face the same year. Their responses to the questionnaire helped me to select the subsequent participants for interview. The second round interview took place the following year in August 2010. All the interview sessions had taken place in a quiet room located within the institution.

Results of the analysis from 14 interview transcripts following Steps 1, 2 and 3 of the IPA (as described in Chapter 4) are presented in the next section.

5.3 Results of Analysis and Findings

Creswell (2009:184) following Stake (1995) and Wolcott (1994) wrote that 'a case study involves a detailed description of the settings or *individuals* followed by analysis of the data for themes or issues' [emphasis added]. The layout for this section follows: descriptions of each individual case first, then the results of the analysis and findings.

In the following sections, descriptions of each case are given to inform readers of its uniqueness and in order to thoroughly understand each one of them. Tables showing the results of the IPA analysis from the interview transcripts are shown in the Appendix since they take up space here, and only the researcher's interpretations are presented in this chapter. Note that, due to the long length of the original transcripts, they will not be shown in this thesis. However, readers would be able to see an example of a case transcription (Student 2C) shown in Appendix 5.1.

The descriptions for the selected seven cases, codified as: Student 2C, Student 2L, Student 2N, Student 2D, Student 2A, Student 2F and Student 2M, are given in the following sections. The majority of the information in these descriptions was obtained from the discussions and interactions with these students during the *first* interview sessions. They are therefore written and presented descriptively as closely as possible to the true information as given by them. Some of the information was also taken from the responses they gave in their written questionnaire. Please note that some data in the narratives however, was censored so as to not lead to any easy identification of the cases in order to protect their true identities due to research ethical considerations.

5.3.1 Student 2C

(i) Case description

Student 2C has never studied agriculture before. She decided to take agriculture courses after being encouraged by her sister since her father is also involved in farming activities. Her father's involvement in the agriculture sector even made her more interested to get involved in agriculture. Although she admitted that it is a bit late for her to be on the programme, she has no regret for their decision in nudging her to enrol into the course.

She found that both the annual and perennial horticulture has helped her understand about agricultural knowledge. The topic she found interesting while on the course was perennial horticulture which is about fruits. However, the topics she found easier to understand (although she argued nothing is too easy for her on the course) is annual horticulture, particularly regarding vegetable planting, spacing, pruning, thinning, etc. She also found that the experiences on making vegetable beds and paddy planting were the best ones that have influenced her thinking regarding the importance of agriculture for present and future times. She believes that agriculture knowledge possesses much benefit and thought that anything she had learnt is really useful for her future so she could help her family's farm. Not surprisingly, the most enjoyable experience she had so far in learning agriculture is doing her individual projects and getting income from the produce. She even planted some vegetables in her own time at home just so she could get extra practice on top of what has been given in school while also providing opportunity for her family's own consumption.

To her, the planting concept is important and necessary to teach students at the beginning of the course so students could grasp agriculture faster. These are the basics in planting and included the reasons or purposes behind doing certain agricultural practices such as: all planting techniques and procedures on step by step planting starting with bed preparation and basal fertilizer application, introduction to various different types of seeds and the use of various tools in agriculture. And these, she said, must be explained first and foremost during lectures before students even embark on practices in the farm. For this to be effectively understood, she was of the opinion that teachers should demonstrate step-by-step procedures and at the same time explain why each step is carried out prior to practical activity.

For teaching poultry rearing, she pointed that it should be taught from the start of rearing, not just on the theory part and when time for slaughtering. She stressed that ideally, it should start from day old chicks through to slaughter in order to get a complete understanding of the chicken rearing cycle.

When asked what impact agriculture had on her since studying it in the school, she mentioned that it has created in her a difference in thinking and perspective compared to before the course or when she was without it. She now realised that 'agriculture is for life'. She emphasised that 'agriculture is connected to everyday life, for example, rice and poultry and all the food that we eat – are all connected to agriculture. Even beef is ruminants from agriculture farming; the vegetables that we eat; basically all are connected to real life'. In short, she could see the connection of plants to animals and right to the food we eat and how they provided for our life and where these food supplies come from, which all have encapsulated in activities derived from the agriculture sectors.

For her future plan, she is interested to work as a technician, but may also be likely to further her studies. She is also interested in teaching agriculture. To be a good agriculture teacher, she stressed, a teacher should guide and demonstrate students by providing more hands-on activities besides giving encouragement and motivation while at the same time making them aware of agriculture's future importance. She would also promote agriculture and assure prospective students to study agriculture since the course is very interesting. Reflecting on her feelings about His Majesty's recent visit to the paddy harvesting event which she also attended, she said she felt very proud of his concern on agriculture in the country, especially in the rice production area. And this made her even more motivated to venture into the agriculture sector in future.

(ii) Results of first interview analysis

Appendix 5.2 presents results of (IPA) analysis from Student 2C's first interview. It shows results of the analysis from Step 3 (extraction and abstraction) where key words corresponding to (emergent) themes were extracted; and sub-ordinate themes were clustered into super-ordinate themes within this particular case.

Researcher's interpretation:

It is very interesting to note how Student 2C can connect her agricultural knowledge to everyday and real life experiences; no wonder she was able to relate her experiences well throughout the interview session. An interesting point she raised during the interview was when she said 'agriculture is important for life' – it is such a strong sentiment – and is evidence that she really saw the importance and relevance of her learning. It is also interesting how at first she disliked agriculture due to heat and the manual labour work one has to put up with, but this soon was overturned after realising the benefits of agriculture once she experienced/saw it.

Her realisation of agricultural importance and its usefulness and its connection to everyday and real life experiences was even more evidenced when she planted her own vegetables at home, just for an extra learning experience. It is really inspiring how she previously disliked agriculture but has become someone interested and enthusiastic about it. This is a sign of a positive and remarkable development in her attitudes.

These findings from Student 2C's interview data revealed that knowing or realising the importance of agriculture towards life makes one appreciates life even more – 'agriculture knowledge helps one connect to what life is all about – food and the system of needs, production and producing', she stressed.

Implications for teaching/curriculum design:

- To include individual research projects as something a student would most enjoy doing. The tasks of doing some work together in group, such as in paddy planting and vegetable bed preparation, and also suggested that agriculture curriculum should include some collaborative or cooperative learning styles in future syllabus.
- The findings also revealed that for practical activities, the start requires detail and ample explanation which should be provided prior to *before* the start of activities in order to clearly brief students on tasks ahead of them. The teacher must, beforehand, explain clearly the purpose behind doing each of the to-be-undertaken tasks to enhance the connection between theories learnt in the classroom and practice, and at the same time remove trepidation for some students who have no prior agricultural experience or background.

(iii) Results of second interview analysis

Appendix 5.2 presents results of the (IPA) analysis from Student 2C's second interview. It shows results of Step 3 processes (extraction and abstraction) within this particular case.

Researcher's interpretation:

Clearly, from this second interview analysis, Student 2C has narrated on many occasions that she has been transformed – her conviction of being confident with the agricultural knowledge gained from the course, her thinking styles and progression towards more of an agriculturist thinking. She can relate her knowledge to everyday and real applications of agriculture, and even tried out her knowledge gained from school for self-practice at home.

The data also revealed that the individual research project has been phenomenal for her as one that has given her the most understanding of agriculture. Evidently, it was revealed throughout the interview that she is fascinated with anything related with planting. Her enthusiasm for planting was clear when she even came to school on Friday when the school day was off (Line 45). She said, ‘it’s all about planting, the techniques, procedures, profits from planting’. She also thought that management of plants was important as without good knowledge of this, plants’ growth is affected and that yield will be obviously low. To Student 2C, the individual research project was difficult and challenging due to the hard work at the beginning working on soils but not the later part on harvesting and getting the yields out of the crops, which were the more exciting parts to her. This difficulty or hard work thus get overturned by the excitement on seeing plants’ growth development and fruit bearing, and benefits reaped from yields and profits from the sale. All these seemed to have created confidence in her to try out even more planting despite the challenge and hardship.

Thus, it seems that seeing high yield is an indicator of success in doing project work, which gave a lot of satisfaction to Student 2C. The data also revealed that, in the case of Student 2C, it all revolved around crop production such as the difficulty or the challenge of hard work experience, and seeing the end results such as yields from harvesting and the relative profit returns. All this evidence seems to be a measure of success or meaningful achievement the student felt – both phenomenal and exciting learning to them. This was expressed by Student 2C saying, ‘I have confidence now (Line 109), I cannot believe myself with what I’ve achieved (Line 96), I am addicted to plant more (Line 100)’.

However, despite all her excitement, she also spoke of the most difficult concepts in agricultural research methods which were characterised by lots of calculations and the time needed to do them. She also found farm management, including accounting, as confusing which had caused her to re-sit her test.

Implications for teaching/curriculum design:

- Individual research projects (all about planting, techniques, procedures, profit from planting) are useful for deeper understanding of agriculture – a difficult but enjoyable experience for students. This means a lot of time should be set aside for this component in the course to allow meaningful experiential development, so students can focus and relate more their theoretical knowledge to practical applications. Excitingly, not only do students get to enjoy 70 per cent from selling their produce (Student 2C:I2:L38) but are also personally involved in marketing their own products, which is a real life experience for many to reflect on.

- It is very important that students can see the usefulness of their learning to everyday applications of their life, so teachers must stress this during lessons and be clearly stated in the curriculum guidance to create such facilitation for students.
- Also in the curriculum, a high percentage mark allocation to a specific part of the curriculum signals the high importance for students to put in extra effort; one that they foresee must be passed in order to progress the course.

5.3.2 Student 2L

(i) Case description

Student 2L had never studied agriculture before but his grandma owns some paddy plots. When asked why he joined the school, he said he wanted to try something new, not due to initial interest. Before entering the course, he admitted he didn't know much about agriculture. After some time, he learnt so many things in the school which he found to be valuable and brought great experience to him. For these reasons, he expressed no regret over his opportunistic decision, seeing what he gained so far despite having no interest at first. Among the agricultural topics he liked and found interesting were topics on plants and animals, both theoretically and practically.

He has the opinion that in order to understand agriculture better, students would need to understand both the internal and external processes in plants and animals – where most of these topics are specifically covered in plant science and animal science. For him, by knowing the internal processes 'we can improve how to make plants grow well and healthily; whereas for animals, we should know what to do if the animal is pregnant and how to diagnose the symptoms if they are healthy or not'. So to him, it is critical to know animals and plants not only externally but most importantly internally. He emphasised that by knowing the internal processes we could understand the problems better and know what to do as and when they happen. He believed that not knowing these processes could cause many problems. For example, when applying fertilizer to plants, one should not apply too near to the roots or else it will cause plant dehydration and damage the whole plant internally, he mentioned. From this, only then could we understand and know how to apply fertilizers properly, he claimed. He emphasised that through certain practices in agriculture we can make one understand about agriculture, but only after having fully comprehending what happens *inside* the plants. Therefore the absence of this understanding will prevent one from being a better farmer, he argued. He underscored that knowing sciences relates to the internal process, even though he only studied combined science in his previous education. This is a fascinating insight that Student 2L displayed in the interview.

To him, the best agricultural experience he had so far was paddy planting. He said it was the most enjoyable experience. And since then, he could withstand heat from the sun where previously he couldn't, even to the point of disliking it. The paddy growing experience made him think about where our rice comes from. In particular, the handling of paddy plants planting and the process involving converting husked paddy to consumable rice grains. According to him, the yields obtained and especially the experience had a real impact on his agricultural awareness dealing with human food needs, which he saw as not easy at all.

On asking which of the agriculture concepts should be taught the earliest in an agricultural course, he suggested that it should be first about soils, such as the soil types and its pH. He mentioned that knowing this is essentially important before embarking on growing anything because one needs to know which soil is good for certain types of crops. Secondly, he said, it should be about plants, such as how to plant (planting techniques), fertilizing, management, procedures and the materials and resources needed. And thirdly, it should be about animals. All these topics need to be incorporated in balance so students will have a complete knowledge, he stressed.

For improvement of agriculture in the country, he suggested that more qualified agriculture teachers are needed to teach programmes in schools. He is also of the opinion that pupils at primary schooling should be exposed to agriculture by integrating planting activity in their curriculum so that they will know where plants come from at the earliest stage. This way, he continued, will give them the basic knowledge of plants where they can further learn about it at secondary education.

His future plan is to further his study in the area of agriculture before finally becoming an agriculture teacher. He would advise prospective students planning to take agriculture to try and experience the interesting parts, such as plants and animals, although he said that most people are put off due to the sunburn effect of the heat from engaging in agricultural activities under the sun.

(ii) Results of the first interview analysis

Appendix 5.3 presents results of (IPA) analysis from Student 2L's first interview. It shows results of the analysis from Step 3 (extraction and abstraction) where key words corresponding to (emergent) themes were extracted, and sub-ordinate themes were clustered into super-ordinate themes within this particular case.

Researcher's interpretation:

It is interesting how Student 2L stressed on knowing the internal and external processes in plants and animals as providing deeper understanding of agriculture. Student 2L emphasised that not knowing these internal processes will not hamper one from becoming an agriculturist but these scientific parts of plants are necessary to help better understanding agriculture. He believed through plant science, learners can visualise the internal processes in plants, and can help solve plants' problems. Therefore, he said that knowing both internal and external processes helps learners make plants grow well (by providing good care and environment) and treat the animals correctly and also know what to do when problems arise. It seemed that he was transformed in his agriculture learning since he can relate his lessons on theoretical processes to practical activities. Taylor (2006) mentioned that students unable to visualise internal processes in biology is one of the reasons for encountering troublesomeness. This issue was seemingly overcome by Student 2L given that he was able to integrate internal and external concepts with processes, whose consequences affect real application (Lines 14-21). He also emphasised practical activities as having the ability to reinforce theory lessons in order to understand deeper: 'If we just learn without practice, just learn like that ...may be one will understand, but that person will *never understand deeper why that happens*' (Lines 22-24).

The three courses that provided him with the best understanding of agriculture in the programme were: Plant Science, Annual and Perennial Horticulture, and Animal Science. The science parts seemed to help him a lot in understanding the knowledge application to practice – annual and perennial horticultural practices. Also, among the topics he suggested that must be taught earliest are soils, plants and planting, and animals.

The most phenomenological experience for Student 2L was paddy planting, despite at first admitting to disliking the heat from the sun. But his disliking eventually was overturned by the more interesting parts of agriculture and those related to performing some activities – the feeling of getting the challenge, understanding the hardship and the difficulties of planting, producing, and processing rice. This led him to appreciate food and farmers' effort in producing rice as our staple food. He observed that the most difficulty that drives people away from agriculture is the heat experienced under the sun. But, soon this gets overshadowed by the benefits of obtaining yields from agriculture, which made him more than eager to do it again. He even pledged to gain more and more knowledge of agriculture in future. Far from deterring him, he became increasingly getting more motivated.

Student 2L has the ambition of becoming an agriculture teacher in future. Realising the values of agriculture, it is interesting how he remarked that agriculture should be introduced as early as primary education. He argued agriculture should be introduced to primary school children so they will love growing and know some basic agriculture, especially in a form of planting activity, not as a whole subject but as part of after school curricular activity. Could this feeling be evolved from the fact that now he knows the joy of agriculture, and how he wished to have experienced it much earlier? Unfortunately, the interview session did not delve deeper into this.

Implications for teaching/curriculum design:

- Paddy planting activities must be included in the agriculture curriculum as the experience could make students appreciate staple food production and know how rice plants are planted, including all the involved rice processes.
- Soils, plants and planting, and animals should be among the earliest topics to be taught to facilitate understanding.
- Plant science and animal science topics should be included in the agriculture curriculum to allow deeper understanding of what happens inside plants and animals, as well as encourage connections to unseen tangible features.
- Theory should be reinforced with practical activities, so students can relate theory lessons to practical applications, and internal and external processes/concepts.
- Planting activities should be introduced in primary education's curriculum so children will love growing and know some basic knowledge in agriculture, to create exposure and early interest in agriculture.

(iii) Results of second interview analysis

Appendix 5.3 presents results of (IPA) analysis from Student 2L's second interview. It shows results of the Step 3 processes (extraction and abstraction) within this particular case.

Researcher's interpretation:

From the interaction with Student 2L, I could feel the importance of Brunei's agriculture to him. Throughout the interview session, there was plenty of evidence that he had been thinking along the lines of an agriculturist. Having studied for two years and with exposure to local and overseas learning experiences, my encounter with him during the interview revealed him as being actively conversant and had evidence of agriculturist-like thinking. Most of his reflections and overviews demonstrated constant engagement with agricultural minds – constructing understanding, interpreting and visualising/viewing problems from agricultural perspectives. Besides busily planning for future pursuits, he also anticipated how problems could be sorted for improvements, and rationalised what good there is for practice and what's not.

He sees himself as future player and having a bigger role in Brunei's agriculture, despite only learning agriculture for two years. He posited that the nation would need more experts in the research area (Lines 57 & 95), which is significant. He noted the nation's milieu of less interest of agriculture (Line 74) and stressed that more people should join this sector (Line 79) for the sake of Brunei's future.

He has also been actively connecting his agriculture knowledge with science. One of the most interesting findings from Student 2L's second interview is that he pointed out apart from production or farming which many people have misunderstood (Line 53), 'people didn't realise that most agriculture is related to science – applied science is important in agriculture' (Line 51).

All in all, the knowledge, skills and attitudes that he gained and developed from the course, including the experiences and the learning process have broadened his horizon and opened doors to many other opportunities. He has many plans and insightful interests in agriculture, including a desire to pursue further study in this area. It is just a matter of choice for him to pick which one that he really intends to do upon completion of his course – a hard decision for him to make, he said.

Implications for teaching/curriculum design:

- From what can be learnt from this participant's interview, it seems that the curriculum and the school must ensure that teachers' knowledge in agriculture, including farm management, must be especially relevant to the learning. The teachers must be agriculturally qualified to teach in this area. There is evidence that students were not happy with the way instruction was being conducted.

- Attachments or work placements should be included as part of curriculum as these are useful for giving students exposure and broadening their horizon so they can get in-tune with the real environment of working in the agriculture sector in the future.

5.3.3 Student 2N

(i) Case description

Student 2N's deep interest in horticulture drives her to read a lot of books about plants. During her lower secondary schooling, she studied agriculture and found it interesting and enjoyable. Although she would have loved to study it again as she progressed to upper level, she could not study it anymore since it was not offered at her school. Instead, she was given pure science subjects (biology, chemistry and physics) due to her good results. She then went to sixth form and completed with one A-Level pass.

After a few years leaving it behind, she decided to return to study agriculture again. On several occasions, she narrated various mixed feelings: frustration of unable to study it in her previous education, the disappointment that the course was not offered then and only being able to start much later than anticipated, but at the same time felt glad (regardless of the depression of wasting a few more years in waiting) that finally the opportunity had come. She said, 'the wait is worth waiting for'. She felt fortunate being successfully accepted into the course, though she acknowledged foreseeing certain deficiencies in facilities and resources as expected. These, however, will not dampen her spirit, she said, to finally get to study agriculture which has intrigued her so much in the past. She also thought that given her past experience and the basic knowledge during her lower secondary agricultural learning, she believed that the foundation had given her a competitive advantage over her current classmates. That helped her a lot towards the current course she has undertaken, although she realised that this time she needed to study more in-depth knowledge. For example, the previous lessons and experiences in rearing poultry gave her familiarity of some terms used in poultry husbandry. Likewise, her previous experience in planting long beans also informed her how to carry out the basic required steps in land ploughing, types of fertilizer to use, methods of basal dressing application, and also to carry out certain cultural practices on plants such as trellising.

In the current course, among the useful topics that she found helpful for agriculture understandings were annual and perennial horticulture, whereby practical activities are given on site such as how to manage plants and how to apply fertilizer, with more in-depth application of knowledge, according to her. She stressed that she prefers theory side-by-side with practical activities whilst learning agriculture, so that by infusing the two together students could have a better picture (of how, what and why) in front of them. She was also of the opinion that, this way, what is covered in theory can be visualised in practice, and thus promotes better learning and understanding. She believed that the practical parts help better in understanding and will give an overall picture of other subjects as well. Hence, she thought, the topics that must be taught to students, if students are to learn agriculture better and get the overall picture, are: field crops (how to plant and the basics of raising plants, such as vegetables), and animal science (basic ideas on how to handle chickens, cattle, etc.).

The most difficult topics she found and had trouble understanding were plant science and soil management. She explained that in soil management lessons involved a wide range of topics to be learnt, including the different types of soil, within a short given time. She recalled that she could not understand the explanation given by the teacher as that the notes or the syllabus (curriculum) contained too much information, she speculated. Aside from that, the practical activities were also quite confusing she reported, as she didn't get to understand the aim of the activities and the final conclusions or applications to real practice. For example, the experiments on collecting the different types of soil from different sites where students needed to measure the size of soil crumbs, and measure the pH, made her 'hang' (or in a liminal state as in Meyer and Land's term), she complained. She described most of the time they (students) didn't know what they were supposed to do and what to achieve at the end of the experiment. As a result of being unable to relate to this particular experiment, she admitted she had problems relating to what practical application this experiment had in real agricultural practice.

When asked what should be the key towards understanding agriculture that needed to be incorporated into the learning, Student 2N said that generally 'in any subjects no matter related or unrelated to agriculture, all the learning should emphasise on how to incorporate in real life' (that is, the application of the learnt knowledge in real life). This, she believes, would allow students 'to think outside the box', that is, 'to visualise or picture out what being learnt in the real life situation'. Especially in agriculture, more opportunity of this kind of thinking should be given to students, she pointed. She advocated that agriculture be a practical subject, unlike in mathematics where the resources are numbers which is much different to agriculture, so students need to know the usefulness and application of the knowledge in real farming, she said. Additionally, she argued that unlike in maths, agriculture learning can connect one with the real world, such as plants and the environment. That is why she felt as if she knows much better than the rest of her family members, and often she get asked by them despite the fact she isn't yet an expert in agriculture, she disclosed. But in responding to their queries, she assured that she would explain it to the best of her ability based on what she knows. Thus, this has affected a little bit of her personality, she claimed. For example, on issues like open burning which she is not in favour of and is her number one dislike, she would advise instead to decompose the materials. So, her mind is thinking more like an environmentalist, she claimed. Likewise, for pesticides application it should be organic chemicals that must be used, she expressed. To her, agriculture can provide a good choice of alternatives in life for one to make a sensible and rational decision for the environment.

One of the issues pointed out by Student 2N is that most people tend to think that agriculture is all about going under the sun, which is not necessarily true according to her, as we can have machines to do the work. 'Technology is always rising so we can take advantage of that in helping agriculture', she emphasised. She observed that the agriculture industry in Brunei is still low. In the future she would like to improve and help the country progress in this area. She felt sad for her country for not being able to produce its own food sources; she sighed that there is 'so much food going into the country, but not so much going out of the country'. When asked what she would like to convey to someone who is not interested in agriculture, she replied that we should start with what one wants to be. 'Is it the job or for the money?' she asked. But to her, money is everything to start with. She assumed that when people think about money, automatically people will do the job.

Nevertheless, some of the concepts of biology that she learnt during secondary school helped her understand agriculture, such as food and photosynthesis, and water movement in plants; as there are some similarities with agriculture, she said. However, if given the choice between studying pure science subjects and agriculture, she said she would definitely choose agriculture. Her intention in the future is to become specialised in horticulture (both amenity and commercial), and to venture into this industry if given the opportunity.

(ii) Results of the first interview analysis

Appendix 5.4 presents results of the (IPA) analysis from Student 2N's first interview. It shows results of the analysis from Step 3 (extraction and abstraction) where key words corresponding to (emergent) themes were extracted; and sub-ordinate themes were clustered into super-ordinate themes within this particular case.

Researcher's interpretation:

The absence of practical activities in theory lessons encouraged memorising, according to Student 2N, as students could not visualise the learning in front of them. While doing practical work provides deeper understanding, she emphasised that it is even better when adjoining the practical with theory. There seems evidence in Student 2N's data that practical activities could help overcome troublesomeness and prevent students from adopting rote learning, as doing activities makes students remember more.

In doing practicals activities, such as soil experiments, students need to know the purpose behind each one undertaken tasks through the teacher's guidance, and therefore teachers need to clearly inform students of the connection between what they are doing with real world application. The reason behind carrying out each task during experiments must be made very clear especially towards inferring the results so that students can relate the knowledge to a real farming context. And there is a strong point Student 2N raised that learning should be connected to context by emphasising how to incorporate it into real life (Line 68).

Although Student 2N appreciated her lower secondary vegetable growing experiences and used this past experience to strengthen her understanding and knowledge in the current course, the learning experiences on vegetable growing and broiler rearing seemed to have a greater impact on her, in particular vegetable growing which she admitted contributed to her overall understanding of agriculture. Hence the basics of field crops and animals are essential to provide an overall picture and understanding of agriculture, just like what she opinionated about her lower secondary agriculture experiences.

Having learnt biology at the Upper Secondary level also helped her in understanding the difficult concepts such as water movement inside plants and the photosynthesis – (well spotted on by this student), both of which are concepts that are particularly troublesome and frequently mentioned in some research literatures.

Learning agriculture has transformed her perception towards the environment which has somehow changed a little bit of her personality (see Lines 86 & 90). As a result, her family members take her advice on environment related issues, despite her conviction that she only knows a little. Through learning agriculture, it seemed one tends to have an ability to make informed choices on how to treat the environment responsibly, such as prohibiting open burning and excessive pesticides usage, given what has been experienced by Student 2N. She also defended the low public perception associated with manual labour in agriculture. This negative perception, she opinionated, can be negated through invention and use of machinery in agricultural work and practices.

Implications for teaching/curriculum design:

- Practical activities on vegetable planting provide in-depth understanding of agriculture; excellent for application of theory into practice.
- Vegetable growing seems to be a threshold concept as Student 2N said, '... vegetable growing, it does give an overall picture for other agriculture topics or subjects' (Lines 16-17). This means the growing of plants could be used as a point of reference to relate to other parts of agriculture concepts/courses. It has an integrative effect.
- In learning agriculture, teachers need to encourage more hands-on activities through infusing theory and practical activities together so that students can visualise or see the picture in front of them. Failure to visualise the learning could lead to memorising in students (see Line 46). Difficult concepts therefore must be followed with practice so that students can visualise them in context and see the relationship in real practice.
- Teachers need to explain the rationale behind doing each task undertaken in an experiment for effective learning to take place.
- Plant science and soil management are difficult, so these need more explanation with examples or through using experiments so students can picture what happens inside plants or soils. This method of learning is useful for understanding abstract concepts, such as photosynthesis and water movement in plants.
- Teachers need to stress to students that agriculture does not necessarily involve solely manual labour. And to remove the misconception that agriculture is labour intensive, machinery should be encouraged for use in farming or practical activities.
- It is important that the application of what has been learnt should be stressed on how to incorporate it into real life. This is so students can know the purpose and rationale, and its usefulness in a real context, particularly for agriculture, in order to understand it completely. As Student 2N mentioned:

> I think we as a student we need to know how you incorporate it into real life – I think that is the main point, like, I feel as a student you just learn and learn, but then you don't think outside the box, you tend 'not' to think outside the box, like asking why should I do this for? What is it for? Like this subject, what is it for? What are the importance when you do practical and all that stuffs? So I think the students need to be briefed about that. Like, they need to be shown [demonstrated] so that they can picture what they are learning and its needs to be used in real life or real situation (Lines 67-81). So I think the students need to know what is the usefulness in real life when you are going to do your farming, this is, what your subject is for (Line 79).

- Generally, the findings from Student 2N's interview seem to suggest that for agriculture to be well understood, students need visual and concrete examples in front of them. This further implied that agriculture should not only be taught by way of theory but most importantly practically through hands-on and practical demonstration. Student 2N's interview also revealed that most learners would not fully understand if learning is only based on books or inanimate presentation, it has to be real and in-context to be visualised and fully understood. This also suggests for consideration that agriculture learning be approached via concrete and visually receptive methods in order to be effective.

(iii) Results of the second interview analysis

Appendix 5.4 presents results of (IPA) analysis from Student 2N's second interview. It shows results of Step 3 processes (extraction and abstraction) within this particular case.

Researcher's interpretation:

Similarly to her first interview finding, her second interview also showed that there is a need to alleviate the poor image and perception of agriculture during learning. Poor perception of traditional farming involving heavy manual labour work needs to be overcome with a modern perspective by introducing machinery and agro-technology. There is also the tendency for the agriculture industry to be regarded as of secondary importance. As Student 2N expressed, 'in Brunei we have oil that's why we think paddy is like our second industry. May be we can promote this paddy farming, but then I think we need to use more modern technology. Like nowadays, who would want to get dirty and do manual work, I don't think people nowadays would want to do that, especially the youngsters. When you give them technologies, they are very excited because modern technology. You don't have to get down into the mud and get dirty' (Lines 130-135).

The most difficult subject for Student 2N in this second year was agriculture research methods. Calculations such as the Latin Square, standard deviation and using various formulae as statistical tools are difficult for students to understand. The concept of standard deviation is particularly troublesome for students wherein they cannot conceptualise deviation around the mean. Among the reasons as mentioned by Student 2N are: (1) hard to process/understand, (2) confusing, (3) don't really understand the teaching, (4) there is too much calculations, (5) too complicated, and (6) too advanced for her level. There is also evidence in the case of Student 2N of not knowing why and when to apply the calculations. It seems that the purpose of undertaking the calculation was not made clear during instructions. The difficulty could stem from the inability to connect the concept according to the purpose the formula is designed for.

Student 2N also found the individual research project difficult as it has to be done on an individual basis and over a specified limited time period. But this seems not as much troublesome to her compared to agriculture research methods, as she managed to complete the project till to the report writing stage. Though she admitted the research in her project had to be repeated twice or even perhaps trice to get good results, she was not able to do this due to limited project time. This could be that the crop she chose for the research was not suitable in that it is not fast-growing enough and therefore do not produce the desired results within the allocated six months project period.

In agriculture, knowing about soil is one of the key components for knowing the basics of how plants grow in relation to crop production, aside from external factors influencing the plant environment including pests and diseases. Student 2N had understood this relationship very well, expressing: 'it's a very complicated world the plants are living in' (Line 61). Here, she seems to have connected various aspects of agriculture together and had provided a clear explanation for her thought.

Another evidence of the ability to connect in Student 2N is that she was able to explain how food could connect agriculture to business (Line 62): 'firstly, agriculture is where food is produced, and secondly, food is to do with business for the simple reason that people buy food. Buying food will involve the act of business, whereas producing food is the role of agriculturists, so this explains the connection between food and business in agriculture', she said. This relationship relates to agricultural production and management to that of business and is central for success which is determined by demands in the agricultural industry. Producing food which is not in demand would not increase business, as there is no use in producing a certain commodity if there is no buyer for it at the end of the day. She argued, '...you have to see the business opportunity, like in Brunei, what is in demand? We cannot just, oh just because I like this fruit I want to plant this fruit. And then say [regrettably], but nobody is going to buy it. So that's why, that is where it is connected' (Lines 77-79).

Implications for teaching/curriculum design:

- The difficulty encountered in the research method area particularly in understanding the standard deviation implies that teachers need to explain the logic behind the use of each formula. The concept of standard deviation must be made clear by using simple data first as examples so as to ready students for handling bigger data in their project.
- In order for the individual research project to be successfully implemented within the allocated six month period, the kind of crops chosen for the project should allow for optimal growth to take place and thereby produce observable results within the stipulated period. Suitable plants with rapid growth should be used unlike in the case of student 2N who used plant specimens that took a longer time to grow.
- Both the overseas study trip and attachment which the students experienced have an eye-opening effect in broadening their horizons and for relating the acquired knowledge gained from their courses into the real world. Provision for study visits, be it locally or abroad, similarly attachment or work placement within industry or the government sector, is therefore essential experiences for a real understanding of agriculture and its application.
- There seems to be an obligation to include modern and technology-based farming in future curriculum to dispel students' negative perception of agriculture. This would also give a modern twist or perspective on top of traditional farming so youngsters are more attracted to agriculture. This, however, is dependent on whether such equipment is procurable as this could be very expensive for schools to budget.

5.3.4 Student 2D

(i) Case description

Student 2D had completed his A-level studies and passed with one A-level, but these were non-agriculture based subjects. He then decided to take an agriculture course at this school. He knew that studying at the present school was his final choice, as concurrently he had applied to other institutions, but was rejected. Therefore, he accepted the offer to study at this school.

His interest in agriculture began when he studied agriculture while in lower secondary. He attributed his interest to the vegetable gardening project he experienced during that previous time and admitted this helped him in understanding the current course he is taking.

During the first interview, after learning agriculture for a year, among the topics he found difficult but provided a better understanding was annual horticulture, including vegetable planting such as legumes and the brassicas. However, his interest is more on animal husbandry than plants due to it being much easier to grasp and understand, according to him. He thought that all topics in animal husbandry are useful. The reason he found animals easier to understand is because he said it is related to simple biology and also due to ease in management, such as feeding and health care. He has expressed confidence over learning new things, and the experience gained from rearing broiler chickens through this course.

Comparing his experience between growing plants and animal rearing, he found that the former makes one very tired easily since it is mostly done outdoors in the sun (perhaps one of the reasons why he found it difficult). Whereas the former (animals) are mostly kept inside buildings and are less exposed to heat. The chicken rearing topics that he is most interested in are prevention and treatment of diseases. He declared he loves everything that involves poultry rearing from start till the end of slaughter. His preference for animals seems to support hand-in-hand with his future desire of becoming a vet once he completes this course. On another thought, he was also hoping, if the opportunity avails, to further study or may open up a farm enterprise. He is also interested in a teaching career. He realised the vast potential of future human resource needs in this area (agriculture) for the country.

Although he is in favour of animals, when asked which concepts between plants and animals could help in better understanding agriculture, he answered both areas should be mastered, as none of them could be left out. ‘Agriculture consists of both’, he said. Speaking on troublesome concepts, he found enterprise planning really difficult as the context is more related to business. Another one he found difficult is plant science. Although he admitted it is an important subject, he didn’t really understand what was taught, even though he read more information from text books and the internet. Due to the wide knowledge available from these sources, he found it hard to distinguish which of the information are truly relevant to Brunei agriculture.

(ii) Results of the first interview analysis

Appendix 5.5 presents results of (IPA) analysis from Student 2D's first interview. It shows results of the analysis from Step 3 (extraction and abstraction) where key words corresponding to (emergent) themes were extracted; and sub-ordinate themes were clustered into super-ordinate themes within this particular case.

Researcher's interpretation:

For Student 2D, learning about vegetable growing in his first year was difficult, although it provided for a good understanding of agriculture. Likewise, he also found plants science difficult. This difficulty, he expressed, was due to the complex biology parts in plants and is far more difficult (as there are specific scientific names of cells and plants to remember) than in animals. He also explained that in animals, one only needs to know about the care, health and management of the animals being looked after. It seems that the difficulty of Student 2D studying plants is related to biological aspects which are more to do with cells' micro structures in plants. It is also prominent that the associated exhaustion and heat emanated from the sun's exposure seems to put him off, and this effect is less in animal rearing as animals are mostly kept indoors protected from heat.

The fact that this student had previous vegetable growing experiences in the lower secondary school encouraged him to study more agriculture at a higher level and this has improved his understanding of agriculture at a much earlier stage. The data also indicated that business and enterprising seem to be the agricultural concepts that most students have found troublesome, including him.

Implications for teaching/curriculum design:

- Earlier exposure to agriculture during lower secondary level motivates students to study agriculture even further at a higher level.
- Teachers need to explain more theoretical concepts in plant science, especially the biological aspects related to plants' cell micro structures, so that students can understand the link these ideas have in real plants and practices.
- Business needs to be taught in context to give students better understanding and experiences.

(iii) Results of the second interview analysis

Appendix 5.5 presents the results of (IPA) analysis from Student 2D's second interview. It shows results of Step 3 processes (extraction and abstraction) within this particular case.

Researcher's interpretation:

The most difficult concepts in the second year for Student 2D is farm management, which involves accounting and marketing. The difficulty surfaced from language and terminology used as being 'big words, difficult terms' (Line 11), according to him. As a result students had difficulty explaining, expressing or describing the idea behind the concept. This leads to students resorting to memorising as a strategy to overcome such difficulty. Another possible reason for this difficulty is due to learning based on theory only without practical reinforcement. Agriculture research method is another difficult concept for him this year – confusion over when to use various calculations for specific purposes in the experimental design.

However, the most challenging, interesting and satisfying aspect for him was the individual research project which created strong interest, a lasting impression and passion for agriculture. When probed why the individual research project was interesting and satisfying, Student 2D mentioned that, 'it's because I've done the project successfully... I've got the yield and I managed to sell it, too. There was no problem and so on, so it's a total success!' (Lines 32-34). The findings seem to suggest that this is the success factor: the yield and sales as an indicator of achievement. Student 2D felt satisfied seeing the yield and the results of his project as he was able to meet his research objectives. This indicates that doing the individual research project well means success and drives students to have a passion and strong interest in agriculture. This student claimed that doing the project has been the most challenging, interesting, enjoyable and satisfying activity he had done (Lines 52-54) during his second year.

The findings also suggest that doing work manually in paddy fields is challenging (Line 63). There is a lot of evidence throughout the interview that he had been transformed in his agricultural knowledge (see Lines 80-82) when he mentioned there is a link and continuation, as he could relate well and spoke eloquently of his experience, convincingly and with confidence.

His experience from work attachment (both locally and outside country) where he played the role of a junior researcher exposed him to invaluable real work experience. The feeling of being employed helps relate his learning to the work world and create readiness to enter the workforce (Lines 88-111); this is important for shaping students' eye for the future and beyond.

Implications for teaching/curriculum design:

- In farm management, teachers need time to explain ideas and concepts behind each terminology. And frequently, they need to check for students' understanding from time to time. The requirement in the curriculum is to provide students the opportunity to practise closely to reality so that they could get the whole idea logically and contextually in real practice.
- For the agriculture research method, teachers need to explain more clearly with examples, and let students gain confidence in using the statistical formulae through simple exercise questions first before using complex data taken from real experimental research.
- The individual research project on plants is best for providing a lasting impression in students to understand with confidence and autonomy, and to connect the learnt agriculture knowledge with practice.
- Attachments and work placement are an integral part of any agriculture programme to provide exposure and broaden students' perspectives with regards to the agriculture work world.

5.3.5 Student 2A

(i) Case description

Before taking the current course Student 2A studied at sixth form. She had never studied agriculture before. During the time of the interview, she had completed one year of study in the current programme.

The topics she considered important to provide deeper understanding of agriculture are soils, animals and animal science, plant science and annual horticulture, such as the vegetables (although she found this more difficult).

She has the opinion that agriculture is related to science such as biology, especially those related to plants (in plant science e.g. growth hormones) and also some aspects about animals (such as on reproduction and enzymes). The concepts that could help her understanding faster in plants include photosynthesis, transpiration, and respiration;

although she admitted she doesn't quite know how to explain them. She mentioned that during planting activities in agriculture, these concepts can come to mind and can be visualised to take place in plants.

However, unlike many other students who thought they could understand better during practical activities, she is one who thought that she could understand much better instead during theory lessons, as more explanations are given compared to during practice.

When probed on her questionnaire responses regarding persistence and hard work that influenced her understanding of agriculture, she clarified that these could motivate one to get better yield and more profit. Not surprisingly, the most memorable agricultural experience for her was on wet paddy planting specifically playing in the mud, she stated. She said learning agriculture is fun. Compared with vegetables, paddy is much easier to look after, she revealed. In future, she aims to venture into a paddy planting enterprise with her family.

Besides animals, the best topic she liked was soil. According to her, it is important to know the types of soil we have and what to mix to improve it. She also said that it is important to know what treatment is needed for diseased animals. Although she compared both as having the same level of importance, she preferred learning about animals since she found it easiest.

(ii) Results of the first interview analysis

Appendix 5.6 presents results of analysis from Student 2A's first interview. It shows results of the analysis from Step 3 (extraction and abstraction) where key words corresponding to (emergent) themes were extracted; and sub-ordinate themes were clustered into super-ordinate themes within this particular case.

Researcher's interpretation:

Throughout the interview session Student 2A could not explain in depth but rather just responded in some short sentences. As a result, the interview cannot probe deeper as she could only relate to some parts of her experiences.

She seemed to have difficulty connecting her theory into practice. She felt that there was insufficient explanation given during activities compared to the classroom when she learnt about theory (Line 5). Although she admitted that some of these theories will appear to help during practical activities, she had trouble explaining the relationship (Line 33). She realised that there is a connection to science, and it appears to have helped her understanding agriculture. From the discussion during the interview, it seems that she is more of a science person but not so much a practical person. This creates an imbalance as agriculture relies a lot on the application of knowledge. This is somewhat the opposite compared to the other participants who prefer learning by hands-on activities to reinforce their understanding.

It would seem to me that she hasn't been able to transform in her agriculture learning, although she may enjoy having the dirt and all the experiences in paddy planting. She found annual horticulture (which is to do with farming in vegetables) challenging and difficult. Due to hardship considerations, she has a preference for animal rearing and paddy planting, since these agriculture areas require less hard work, according to her. Although she understood that one has to work very hard in order to get more yield and profit. Her positive feelings towards agriculture, however, aspire her to venture into paddy planting (her most favourite activity) in the future, despite being unable to transform in understanding apart from her positive attitude towards agriculture.

Implications for teaching/curriculum design:

- Teachers need to explain explicitly the rationale behind each practical activity rather than just giving plain instructions on what to do.
- The curriculum must include paddy planting and harvesting as for some students this is a phenomenal experience.
- Vegetable planting could be troublesome for students who are unable to connect their practical activities to theory and therefore are unable to get transformed in their understanding yet. This could be used to benchmark progression evaluation and for detecting transformation in learning agriculture.

(iii) Results of the second interview analysis

Appendix 5.6 presents the results of (IPA) analysis from Student 2A's second interview. It shows results of Step 3 processes (extraction and abstraction) within this particular case.

Researcher's interpretation:

From this second interview, the evidence that Student 2A hasn't been able to transform as I analysed from her transcriptions are: (1) she could not think agriculturally as she wasn't able to explain the application of knowledge in an agriculture way; (2) she was not been able to connect between concepts; (3) she was not able to utilise the knowledge for her future benefit. She even admitted that she hasn't been able to increase her knowledge (not making much progress), despite being in the second year (Line 24).

One of the comments she made was the time to do practical activities was limited due to insufficient resources, or lack of them in the school farm, including inadequate animal livestock (Line 29). Her understanding of agriculture was not increasing due to the lack of practical activities taking place. This could mean that less practicality contributes to a lack of understanding.

But on the flip side, it appears that she also seemed to have difficulty in understanding certain activities, and therefore prefers theory lessons over practical activities. She also didn't seem to connect between her theory knowledge and practice, so she would prefer to have specific topics taught in compartments, one by one, rather than encompassing/connected to each other (Line 6). It seemed that she has a problem of organising the learnt knowledge in a logical mental schema.

Like most students in her group, she also found agriculture research method difficult due to the calculations and formulae involved. Identifying the different types of soil was also difficult to her despite her liking to learn about soils as identified from her first interview.

Also, similar to her first interview finding, the paddy planting experience was most meaningful to her and had given positive feelings as she enjoyed and valued her experience from the attachment and the overseas study trip. In her words she claimed these paddy experiences: 'it sticks to my head' (Line 11).

During this second year, she enjoyed doing the individual research project due to the obtained yields from her project. But overall, she hasn't been able to make much progress in the two years course. Despite having difficulty in the annual horticulture, she admitted that it is in fact the planting techniques and cultural practices in this course that is the most effective for her understanding, which she found to be troublesome.

Implications for teaching/curriculum design:

- Planting techniques and cultural practices in annual horticulture (vegetable growing) provide for effective understanding of agriculture. This is even admitted by a not-so transformed student, such as Student 2A. Thus, these must be stressed well in the curriculum so as to facilitate students' understanding of agriculture and to allow more transformation to take place by provision of practical activities connected to theory.
- The curriculum must include paddy crop production – the husbandry and practical activities are fun and meaningful to most students.

5.3.6 Student 2F

(i) Case description

Student 2F never studied agriculture previously and was not interested in it. However, due to her parents' wishes, she decided to choose agriculture over her other choice since she also applied for another course at another institution at the same time. She then thought that since agriculture is newly offered, she should choose it. At her home backyard, there were some vegetable plots planted, such as chillies. She regretted not being interested before. To her, agriculture is so important now that His Majesty lauds agriculture as being important towards reaching self-sufficiency. She stressed that there is a lot to be done to improve the agriculture sector for Brunei.

In the current course, she was of the opinion that the most relevant topics for getting a good understanding were annual horticulture, perennial, soil and water management, all of which mostly come under the plant science topic, she said. However, she added that the topics which must be taught to students at the start of agriculture are soils, water management and plant science for the vegetables, and later animal science. But first, students need to be taught about soil including its pH and its types, then only on planting, particularly those types of plants suitable for Brunei's climate – these are the most important topics at the commencement of learning agriculture, she stressed. And she suggested teachers must demonstrate first any task or experiment before letting students try a sample or experiment when in practical lessons.

The most interesting and enjoyable topics for her so far during this first year were: soil, water, animals and annual horticulture and planting vegetables both the fruit and leafy types. However, the most difficult concepts for her was on plant science – plant processes and cell structures such as chlorophyll, organelles, various hormones in plants, and the photosynthesis process for C3-C4 types of plants. These are useful topics but hard, she said.

She also learnt about animals such as goats' management and feeding, casting and spaying. But she didn't like the idea of slaughtering animals as she felt that it is a bit inhumane to kill animals, especially the ones she reared. So she preferred to focus on plants instead. And similarly due to animal cruelty reasons, in the future she would want to further study a degree course in anything to do with plants (as opposed to animals) and she may work with the government particularly in the research area.

(ii) Results of the first interview analysis

Appendix 5.7 presents results of the (IPA) analysis from Student 2F's first interview. It shows results of the analysis from Step 3 (extraction and abstraction) where key words corresponding to (emergent) themes were extracted; and sub-ordinate themes were clustered into super-ordinate themes within this particular case.

Researcher's interpretation:

Student 2F emphasised that topics on plant science and anything related to plants are relevant towards grasping and understanding agriculture, especially on vegetable growing. Although she found the theory parts from plant science useful, she also found plant cell structures and the processes (photosynthesis) most troublesome and therefore hard to memorise for the exam.

Throughout the first interview, Student 2F kept highlighting her experiences on the vegetable growing project. It is evident that she seemed to enjoy most of her vegetable growing practise compared to the theory part, especially when she talked about yields (Lines 19 & 25) from her vegetable project.

It is also evident that she did not enjoy her practical activity on animals due to the fact that she could not endure seeing animals being slaughtered or agonised in pain when treated. Her compassionate feelings towards the animals she reared also led her to avoid eating their meat totally and hence her personal preference of plants over animals.

When probed on how she mastered the various knowledge she learnt in the course, she seemed to treat some knowledge in isolated chunks or discretely and she didn't seem to link between ideas very well. Instead, she mentioned learning strategies such as asking teachers and discussing with friends (Lines 68-71). Although there was a brief mention in the interview of a connection between agriculture and business in order to be successful, I thought this was insufficient to indicate that she thinks like an agriculturist.

Implications for teaching/curriculum design:

- Teachers need to set aside more time to explain explicitly and provide demonstration and opportunities for students to explore components of plant science and relate the ideas in plant growth.

(iii) Results of the second interview analysis

Appendix 5.7 presents the results of (IPA) analysis from Student 2F's second interview. It shows results of Step 3 processes (extraction and abstraction) within this particular case.

Researcher's interpretation:

Student 2F's difficulty in agriculture research method is due to the many formulae to use, and the hard and long steps in the calculations. This caused confusion as to when to use and apply the formula in the research (Lines 2-12), but she admitted that the agriculture research method is important and required when doing research in agriculture.

Although she admitted animal husbandry is difficult for her, upon probing I found that it is not at all troublesome for her (Line 25). The difficulty encountered when remembering the names, scientific terms, and symptoms of diseases with respect to various animal treatments and medicines, forced her to memorise for exams. Hence, it was only a little troublesome as she could understand the topic except in some minor parts.

When asked about the best part of her learning during the course, she mentioned the time during the practical work as she could understand better, especially on plants. She admitted that she is 'a plant person' (Line 19) and 'loves plants' (Lines 21 & 33). This evidence reveals that Student 2F clearly valued the practical aspects of her learning as something providing the best agricultural understanding. Activities during vegetable growing, paddy planting and tree crops planting (Line 33) had been phenomenal for her, especially when there was yield. Yield is phenomenal as she gets a lot of satisfaction getting it from her hard work. This made her fall in love with agriculture, as she described it:

> Oh this is really fun ...planting! Especially when I get the yield... I said to myself... ah this is from my effort. The feeling is hard to describe, it's even much more satisfying than cooking. So, now I fall in love with agriculture... very much so. Especially, if it is about plants (Lines 37-40).

This suggests that practical activities in plant growing husbandry could be an area where threshold concepts persist. The feeling of satisfaction surfaced from getting yield through hard work can be considered phenomenal as this causes her to fall in love with agriculture and made her understanding better, exceeding her cooking passion already fostered three years ago, she disclosed. Another finding also showed that the exposure and experience gained during attachment and study trips have groomed students into having a real agriculture perspective, besides informing and guiding students to future direction and ambition.

Implications for teaching/curriculum design:

- Teachers need to explain why the formulae in the agriculture research calculations are designed. In addition, they must also ensure students understand when to apply and use these formulae, and to check their relevant understanding to avoid frequent confusion.
- Practical activities are central for learning agriculture to ensure better understanding of knowledge, especially on plant growing. This seems to suggest an agricultural threshold concept for this particular student.

5.3.7 Student 2M

(i) Case description

Student 2M at first has no interest in agriculture, and neither did he study the course before. His father owns an orchard growing various kinds of fruit trees such as banana and durian. According to him, the reason for taking this course was due to his intention to help his father's orchard since none of his siblings have had any interest in it.

Student 2M found that the annual horticulture topics are useful for providing better understanding of agriculture since they are the easiest for him. He said this topic provided him the planting experience and plants' bed-making, knowledge on using machinery and the opportunity to learn something new which he didn't know before. These helped him gain knowledge on how to improve his plants and how to manage them properly to get a good yield. They include the management of plants such as weeding, transplanting and pruning, which he found the easiest. He suggested that for grasping agriculture at the start of the course, concepts on tools and their proper use, and factors needed for planting such as soil fertility, rainfall, climate and temperature, should be taught first as introductory to basic agricultural knowledge.

The most difficult but very important concept to him was on business because he said he didn't really understand about it. He clarified that this difficulty is due to the various terminologies existed in the subject. He viewed that business planning and management are important to know on how to manage and gain profit, as without this knowledge a big loss may occur if one is not careful.

The paddy planting experience was to him the most meaningful one. The hard work from the paddy planting experience helped transform him to appreciate agriculture more, he declared. He wrote, 'the experience which I get during the paddy planting gave me the opportunity to appreciate the hardship of being a farmer, that is, for their hard work in managing the paddy to help produce more yield' (quoted from his written questionnaire response). This causes a transformed attitude as to the way he values food – to someone who would no longer waste his food on his plate (Lines 35-37). The hardship has also made him appreciate more of his father's effort and how hard it is to provide food for the family, he said. This meaningful impact has also been strengthened by His Majesty's visit which he saw as a focus on the importance of agriculture in the country and further motivated him to learn more. The agriculture areas that he is interested in to learn in-depth in the future are thus on paddy and fruit planting.

(ii) Results of the first interview analysis

Appendix 5.8 presents results of (IPA) analysis from Student 2M's first interview. It shows results of the analysis from Step 3 (extraction and abstraction) where key words corresponding to (emergent) themes were extracted; and sub-ordinate themes were clustered into super-ordinate themes within this particular case.

Researcher's interpretation:

From this first interview it is evident that Student 2M found annual horticulture topics on vegetable growing provided better understanding of agriculture since they are the easiest for him, whereas the paddy planting experience was the most meaningful and phenomenal for him.

The findings in the interview showed that his phenomenal paddy planting experience had been very valuable to him, changing him as a person as well as how he perceives agriculture as a whole. His conscious awareness of hard work from the paddy planting experience has transformed him to appreciate agriculture even more. His transformed attitude characterised by the way he appreciates food as someone who would no longer waste food on his plate is moving and inspiring. This realisation seemed to appear ever since he experienced the hard work in agriculture. The hard work from agricultural experience has engaged his mind into thinking what agriculture is all about. In his words, when 'you do hard work you get food'. Fundamentally, it made him aware about the life of a farmer. From there he began to become appreciative how hard farmers have to work, including his own father (who works in the orchard) whom had earned his deep respect for providing food and support to his whole family.

I found it truly amazing how this transformation was brought about in this student just by involvement in paddy planting activities in his school. In effect, his paddy experience has impacted him so much that it transformed him to view life from a new perspective – to become prudent and hardworking towards the future – and even aspires him to contribute to the agricultural sector's future in rice production. This determination shows that a phenomenal experience has a personal transformational effect by affecting inner feelings and attitudes, driven by the desire to help his father and the awareness on the importance of the country's self-sufficiency in rice production (Line 11). He could be in a process of becoming an agriculturist because his personal desire to venture into future paddy production formed by the experience, whilst also trying to help his father, has triggered more catalysts behind the successful understanding of his course.

The fact that Student 2M found business troublesome is not a good sign for him and for his future endeavour. This is unfortunate as sound knowledge in business, particularly agribusiness, is important for the success of agricultural entrepreneurship. Business is thus something that Student 2M needs to master if he hopes to be a key player in agriculture in the future.

Implications for teaching/curriculum design:

- There is a need for more emphasis on the business component of the course to complement the agriculture business. Time and teaching should ensure that more explanation be given with regard to terminologies and technical terms that are hard to understand. Business in practice should also be highly considered in the curriculum.
- Topics on tools and their functions, and the factors needed for planting and growth including soil pH, temperature and climate like rainfall – must be taught earliest.

- Paddy planting must be included and be made compulsory in the curriculum to create a phenomenal experience in many students, and may also improve their attitudes – useful to make students think hard what agriculture is all about.

(iii) Results of second interview analysis

Appendix 5.8 presents results of (IPA) analysis from Student 2M's second interview. It shows results of Step 3 processes (extraction and abstraction) within this particular case.

Researcher's interpretation:

There is evidence that Student 2M has been actively connecting between his agricultural concepts. It seems that he has become more inquisitive and hypothesised between various concepts and ideas. He questioned the inter-relationships and dependability between concepts in the crop production area in optimising a balanced requirement between what is already pre-available for crops in the soil, with additional fertilizer application requirements and a crop needs.

Although he admitted some confusion in connecting these various relationships (between crops types and balanced crop-fertilizer requirements, and soil types and nutrient contents) there is not much prominence in the difficulty being encountered by 2M in this second year term as he had almost overcome these integrations (Line 14) and conceptual connections. From this second interview, there was evidence that he had been transformed in his agricultural knowledge, much more than in the first year wherein previously he just had improvement in his attitudes towards agriculture.

Here, he was more advanced in his thinking progression and demonstrated much more confidence in his responses. He proclaimed the importance of the relationship between the concepts of soil (types of and its nutrient contents with respect to soil physical structures and chemical properties) – fertilizer (its types, application and suitability to various soils types and crops) – and crops (types of and suitability to various soils types) as concepts that are most important to be understood. Clearly, this is a high level thinking process in action taking place in his minds – an active construction of meaning towards real practice engagement which requires studies at a research degree level.

One of the most important findings from Student 2M's interview data is his conviction about his paddy planting experience. There is no doubt that it has been the most phenomenal learning experience for him (Line 53) as congruent throughout his two year study. He kept highlighting the experience, contemplating and stressing its relevance in the country's economy and the pursuit for achieving rice self-sufficiency. This was supported by his motivation to pursue further study on rice production. He was of the opinion that paddy planting experience from the beginning of soil preparation through to planting till harvesting, processing, packaging and marketing as providing a complete package for starting to learn to understand agriculture. 'So, paddy is a package for someone to understand agriculture better', Student 2M mentioned convincingly.

He also emphasised the role of practical hands-on activities (learning by doing) in enhancing understanding and making it easier to remember agriculture learning. Hands-on activity gets one to experience what it is like and hence makes one understand better. He quoted 'teach me I will learn, show me I will understand' to stress this point.

When probed over his previous troublesomeness on business terminologies, he admitted he had improved since last year. He now theoretically understood to some extent how to plan a business, how to start a business, and how to manage a business. Except from one particular aspect where he hasn't yet got confidence, being to run an actual business, since the experience given in school is still largely based on theoretical ground and not so much actual implementation and experience in real business practice, which the curriculum needs to address.

Implications for teaching/curriculum design:

- An agricultural threshold concept that is integrative or connective could be between the dynamic relationships of soil-fertilizer-crop needs in the production area. How to determine this inter-relationship may need to be taught at a higher level of agriculture, since this includes more aspects of scientific experimental research. But an inclusion at lower level curriculum must be encouraged to establish early understanding and could prevent further confusion in later years of learning agriculture.
- Paddy planting must be included in the curriculum – an excellent package for transforming someone to start to understand agriculture.
- Need to emphasise and provide hands-on practical activities because by experiencing students can remember more and understand better.
- Need to highlight to students the real practice of doing business, in order to understand and experience how a business should run skilfully and practically.

Chapter 6

RESULTS OF ANALYSIS AND FINDINGS: ACROSS CASES

The previous chapter presented results from case by case analysis as a way of informing readers of the cases within this study's multicase. This chapter aims to present the consequent results of the multicase through cross-case analyses and the findings from examining all the cases together. It also tries to highlight and discuss important key issues and emergent findings corresponding to this study's problems, research questions and the conceptual framework.

6.1 Layout of Reporting

Based on the individual case analysis as described in the previous chapter, further analysis across cases (using Step 4) was carried out and the findings are presented in this chapter to help me understand the whole quintain. The cross-case analysis is also a way of ensuring no misleading interpretations of the data would take place because it represents the multicase collectively as opposed to a single case. Moreover, this allows for the triangulation process is in practice since data were gathered from the multiple cases via the mixed methods as discussed in Chapter 4.

The layout of the reporting of the data follows this sequence: results of analysis, interpretations, findings and discussions. On discussing the analysis, Thomas (2009:227) advised that for a study employing an interpretative approach like this present study, the *analysis* (or/and interpretations as in IPA), *finding*s and *discussions* should be together 'since all the time you will be testing out your emerging findings against your thoughts. All the time you will be validating or rejecting your findings against the body of knowledge that you already possess by virtue of your own experience and your reading'. He added that this seems 'messy' and 'involving a knotty intertwining of ideas', but interpretative researchers in education and social sciences cannot adopt a linear approach by separating them for the reason he argued above.

In some sections in this chapter, there is also a presentation of quantitative data analysis stemming from the qualitative data – this is necessary for cross cases analysis to support recurrences of findings as a way of establishing data, in practising triangulation from various vantage points. It is also decided that the supportive verbatim extracts from participants will not be accompanying the findings to support the claim but these idiographic characteristics of the IPA will appear in the next chapter when addressing each individual research question.

6.2 Cross-Case Analyses and Findings

Although the results of analysis and findings from specific selected individual cases composed in the multicase group were already presented to readers in the previous chapter to inform about each case, that doesn't give the true representative findings for the whole group which we are more interested in. Hence, this is the purpose of the present chapter. 'A multicase study is not design for comparing cases neither for determining prevalence of incidence as in quantitative research. The cases studied are a selected group of instances chosen for better understanding of the quintain' (Stake, 2006:83). To reiterate what I mentioned in the previous chapter, the present instrumental multicase study is interested in a *collection of several cases* in order to examine generalisations of particular collection of cases. This is to analyse cases to see connections or patterns, illuminations of each other and which are *potent* across cases (Smith et al., 2009:101).

The results of the cross-case analyses and findings for this multicase or group level will now follow. Please note that these results are derived after carrying out Step 4 (extraction and abstraction) in the IPA analysis as described in the methodology chapter. However, the actual outcomes of the process will not be shown in this thesis, but a summary table result of the analysis is presented (Table 6.1). While inter-relating the themes (abstraction into super-ordinate themes) and meaning making, the validity of the accuracy of the information was being constantly checked as I went back and forth checking the analysed data with the interview transcriptions. This systemic process of cross checking and analysing textual data in the IPA has also provided a way of establishing data through the triangulation process via this cross cases analyses.

The IPA analysis of interview data from the cross-cases yielded 63 themes. These themes were clustered into 11 super-ordinate themes, as shown in Table 6.1. When the themes have been clustered accordingly, the corresponding evidence as seen in each case's key word extract described under Step 4 of the analysis were checked against each theme according to the evidence. Two types of tick were used to differentiate the data where shaded ticks present those evidence derived from the second interview data.

Table 6.1

Themes from Cross-cases Analysis

Super-ordinate themes:	2C	2L	2N	2D	2A	2F	2M
1. Basic concepts help grasp the idea of agriculture faster – 'agriculture starters'							
1. Annual horticulture: planting field crops, seeds, plants' maintenance (weeding, watering, fertilizer application)	✓	✓	✓		✓	✓	
2. Soils: pH, types	✓	✓				✓	
3. Animals		✓	✓				
4. Types of tools and uses	✓						✓
5. Factors needed for planting including climate, temperature							✓
6. Water management						✓	
2. Concepts give good/deeper understanding of agriculture (integrative/connective/ transformative/phenomenal)							
1. Planting and planting techniques – all about plants	✓				✓	✓	
2. Plant science – study of plants		✓	✓			✓	
3. Soil			✓				
3. Most difficult concepts (troublesome) but useful (connective) for understanding							
▪ *First Year:*							
1. Plant science			✓	✓		✓	
2. Business		✓		✓			✓
3. Soil			✓		✓		
▪ *Second Year:*							
4. Agriculture research method	✓	✓	✓	✓	✓	✓	
5. Farm management	✓	✓		✓			
6. Ruminants husbandry						✓	
4. Vegetable growing							
- Useful, helpful, meaningful, in-depth understanding	✓		✓		✓	✓	✓
- Enjoyable, exciting, interesting and fun	✓			✓		✓	
- Easy	✓						✓
- Difficult					✓		
- Lower secondary experience on vegetable growing helps the current course			✓	✓			
5. Individual research project (on plants)							
- most interesting/enjoyable/exciting	✓			✓	✓	✓	
- most challenging, hard work, sweat, big project	✓		✓	✓			
- best liking/experience (meaningful)	✓			✓			
- useful/provides connection/link (integrative)	✓			✓			
- satisfaction, success, confidence	✓			✓			
- high yield	✓			✓	✓	✓	
- profit, sales, benefits	✓						
6. Practical reinforces theory							
- general (overall picture, visualise connection, can understand better)		✓	✓			✓	
- vegetable growing		✓	✓			✓	
- soil			✓				✓
- poultry (animal)		✓					✓
- paddy planting							✓
- water management							✓
7. Paddy planting (planting 1st year; attachment + visit 2nd year)							
- meaningful experience/phenomenal					✓		✓
- most memorable		✓					
- best knowledge/experience, most interesting/exciting of all		✓					✓
- exposure (attachment + study visit) to real agriculture		✓	✓	✓	✓		
- challenging work manually				✓			✓
- realise the importance for country's self sufficiency in rice production							✓
8. Values and importance of agriculture							
- seeing/realising values/importance of agriculture to our country	✓	✓	✓			✓	✓
- agriculture benefits surpass disliking of heat	✓	✓					

9. Progression (seeing connections)							
- agriculture + business						✓	
- agriculture + life (food for life)	✓						
- agriculture + food + business + management			**✓**				
- agriculture + science		**✓**					
- agriculture + research		**✓**					
- humans + plants		**✓**					
- crop + soil + fertilizers + environment, pests, diseases			**✓**				
- soil + crop + fertilizers needs, weather condition, temperature							**✓**
10. Transformation in attitudes							
- appreciate hardship					✓		✓
- care for environment			✓				
- against open burning			✓				
- against chemical spraying			✓				
- appreciate food (avoid wastage)							✓
- respect family more							✓
11. Contextual issues							
▪ *Education*							
- disliking heat/sun	✓	✓		✓			
- no agriculture subject at primary level of education		✓					
▪ *Social*							
- heat turns people away from agriculture (dislikes)		✓	✓				
- people's mindset poor perception on manual labour		**✓**	✓				
- not many people interested in agriculture		**✓**					
▪ *Economic*							
- insufficient in rice production	**✓**						
- low agriculture production, keep importing			✓				
▪ *Historical*							
- oil industry comes first, agriculture second			**✓**				

Key: ✓ 1st interview **✓** (shaded) 2nd interview

Themes 1, 2, and 3 correspond to concepts or knowledge that are perceived of having importance for the understanding of agriculture. These are the concepts characterised as agriculture starter (basic concepts), give good or deeper understanding, and most difficult (troublesome) respectively. The next four super-ordinate themes, namely, Themes 4, 5, 6 and 7, are themes that surround their learning experiences. These are vegetable growing, individual research project, practical reinforces theory and paddy planting, respectively. The rest of the themes centralise on the values and importance of agriculture (Theme 8); progressions and seeing connections (Theme 9); transformation in attitudes (Theme 10); and the perceived contextual issues (Theme 11). Each of the themes and the sub-ordinate themes clustered under each theme is described below.

Theme 1: Basic concepts – agriculture starters

The basic concepts which help grasp the idea of agriculture faster, which I labelled as 'agriculture starters' are, in the order of the most potent first: (1) annual horticulture – which is to do with planting field crops especially short-termed crops such as vegetables, knowing the different types of seeds whether for planting directly or indirectly, plant maintenance including weeding, watering and fertilizer applications.

Five of the seven cases announced that this topic is important as providing them with a good grasp of agriculture. Cross-checking of the analysed data obtained from the written questionnaires also showed that more than half (12 out of 19 students – 63 per cent) the students in the whole group responded that annual horticulture was perceived as useful for understanding. This shows that it is worthy of prominence. In the second place under this theme is soils with half of the interviewed cases mentioning it as helpful, these being concepts on pH, types of soils, and how to improve soils. Other agriculture starters garnered from the interview analysis which also seems to provide basic grounding at the start of agriculture course seem to be: (3) animals – including animal science; (4) types of tools and uses; (5) factors affecting planting including climate and temperature; and (6) water management; but these are less potent.

Theme 2: Integrative or connective concepts

Concepts that give good or deeper understanding of agriculture which are perceived as phenomenal and providing connections are: (1) planting and planting techniques – all to do with plants, (2) plant science which is the study of plants; and (3) soils. These first and second concepts are from the area of plant production and seem to be equally important in terms of bearing as half of the interviewed cases mentioned them. However, the first concept seemed to be more prominent during their second year, whilst plant science was more prominent in their first year of study. On combining both concepts which fall under the plants category, five out of the total of seven cases perceived the importance of plants' concepts; the third (soils) being less so.

Theme 3: Troublesome concepts

The most difficult (troublesome) concepts but also useful (connective) for understanding during the first year are: (1) plant science; (2) business; and (3) soils. For the second year: (1) agriculture research method; (2) farm management; and (3) ruminant husbandry. This result shows that plant science, which also previously came under Theme 2 as helping deep understanding, has also clustered under this troublesome theme here. Analysis results showed that the plant science concept is co-possessing integrative (connective) and troublesome characteristics, particularly in the first year. During the first year, both plant science and business seem to be most troublesome, each carries equal bearing with half of the cases mentioning them as difficult. Again as seen in Theme 2 above, the most difficult in the first year seems to come from the plant area, that is, plant science. But this does not mean that plant science is the most difficult of all, as business has also showed equally perceived difficulty in their first year of study. However, upon comparing these six troublesome areas, agriculture research methods have emerged as the most troublesome where six out of seven cases think so in their second year. The second most troublesome concept in the second year is farm management. It has similar counts to plant science and business in the first year, where half of the cases voiced difficulty. These findings provide prospective areas for improvement in future, as the troublesomeness in the concepts could slow learners' transformation to think like agriculturists.

Theme 4: Vegetable growing

Vegetable growing was mostly mentioned by the cases during first interview. This super-ordinate theme emerged from the analysis when the cases responded to the question of the most exciting experience and helpful for understanding. The majority of the cases (six out of seven) believed that vegetable growing provided meaningful experiences, including as useful, helpful, enjoyable, exciting, interesting and fun, except for Student 2A who also found it difficult. Two cases (Student 2N and 2D) thought that their previous lower secondary experiences on the vegetable growing project helped them with the current course they are studying. In fact, Student 2N thought that her previous experience provided her a competitive advantage over the rest of her classmates since she had learnt them much earlier. Similarly, learning it before and with sound prior knowledge increased his interest in the current course, expressed Student 2D (as seen from his written questionnaire response).

Theme 5: Individual research project (on plants)

In the second year, doing a project seems to be the most meaningful experience for students. The majority of cases (five out of seven) said their experiences during individual project work on plants were interesting, enjoyable and exciting. They also mentioned their experience as the most challenging, hard work and were a big task, and that they most liked the experience (meaningful). Two cases (Student 2C and 2D) were of the opinion that the experiences were most useful for providing connections. None the least, some have found satisfaction, success and confidence, especially if they had obtained high yields from their projects. In fact, four out of seven cases (Students 2C, 2D, 2A and 2F) mentioned high yields as bringing excitement and satisfaction to them. One of the amazing findings from some cases, for example in Students 2C and 2F, is that students had almost disbelief that they can actually grow plants – creating high confidence about their agricultural abilities.

Theme 6: Practical reinforces theory

Four of the cases mentioned that doing practical activities in learning agriculture reinforced their theoretical understandings. Hence, they valued the practicality aspects in supporting their lessons. One of the cases (Student 2N) mentioned that having practical examples in front of her helped her visualise an overall picture and thus prevented memorisation. She had the opinion that agriculture is a practical subject which should be felt and practiced without which one will not be able to understand better. Coincidently, the emergent findings also showed that vegetable growing cohabits with practicality; and together can be regarded as reinforcing theory lessons. The other two sub-ordinate themes under this category which also benefit students via reinforcement related integrated practical activities are soils and poultry rearing.

Theme 7: Paddy planting

The paddy planting experience was also honoured by students and received meritorious mentions. Out of the seven cases interviewed, three students thought that it was phenomenal. Students 2A and 2M said that it was the most meaningful. While Student 2L said it was the most memorable for him. However, these phenomena are less compared to that evident in the vegetable growing experience with six cases acclaiming it under Theme 4. This suggests that paddy seems second after the vegetable experience in terms of phenomenology. Speaking about their paddy experience, two students (Students 2L and 2M) said that paddy planting provided the best knowledge and most exciting experience of all, respectively. Parts of the reasons that made this theme emergent also culminated from the work attachment and study visit they attended, which gave them real exposure to the working world as agriculturists besides the manual labour at paddy fields that they found challenging and rewarding.

Theme 8: Values and importance of agriculture

This theme emerged since five of the cases saw and realised the importance of agriculture to Brunei, particularly in the drive towards food self-sufficiency and local production to reduce importing from other countries. Two cases (Students 2C and 2L) particularly realised the benefits that agriculture have in terms of food provision and income generation, and could actually surpass heat dislike that one experiences when working in agriculture. Student 2N believed that there is a lot of potential to be harnessed in the agricultural industry, especially in agricultural business and marketing.

Theme 9: Progression (seeing connection)

The analysis showed that more than half of the cases could see some connections between the knowledge they learnt. Student 2N provided the best example of seeing the inter-relationship. She was capable of connecting knowledge in the agricultural production area with business and management. Student 2L could see the connections of agriculture with science, research and humankind. While Student 2M had actively related and hypothesised some concepts between soil-crop-fertilizer requirements with plants environment and growth. All these ideas seemed to engage the students' thinking as they tried to integrate concepts and make progression. Meanwhile, Student 2A seemed to be oscillating and struggling with some concepts and could hardly made any progress, seen from her lack of reflection in terms of evidence of conceptual integration.

Theme 10: Transformation in attitudes

Analysis of data also yielded some evidence in attitudinal transformation with regards to how students viewed their learning experiences from their life perspective. Of significance was the cases Students 2N and 2M. Data from both students revealed interesting and amazing views about agriculture, and their reflections displayed how it changed their life. Student 2N has been transformed to someone becoming more sensitive towards the environment and had some criticisms on certain agricultural practices that people must avoid, such as open burning and excessive pesticides spraying. Two cases, Student 2A and 2M appreciated the challenge of hardship in agriculture (manual labour) as something motivating them to work harder to get good yields and returns. In their eyes, farmers have earned respect because of their contribution to feed the nation, including in the case of Student 2M's father whom he honoured as he is also the sole breadwinner of his family.

Theme 11: Contextual issues

This final super-ordinate theme surfaced from various issues discovered in the data. These were educational, social, economic and historical issues surrounding the agriculture learning context. Issues of disliking heat came out as the top issue under the educational issue where students dreaded to go under the sun when learning or doing practical activities. There was also an issue, as voiced out by students, that there is no agriculture subject offered in primary education. Student 2L believed that agriculture should be offered in primary schools so that pupils get interested as early as possible. Similar to the educational issue, the problem of heat has also provoked the cases as they spoke from experience that they often heard people complain about agriculture due to heat exposure, and tended to dislike the profession. Another social issue is the perception of manual labour as hard work and dirty, which caused many people including students to become discouraged and uninterested in agriculture. On economic issues, students mentioned the problems of insufficient rice production and the general trend of low agricultural productivity which seemed to encourage more imports from other countries. Finally, the most well-known issue that has long persisted is where other sectors including agriculture are perceived as less important than oil. Brunei has been blessed with its petroleum as its top natural resource and revenue source, and the economy is already stabilised by its prosperous oil industry – this probably triggered the perceived less importance of agricultural economies.

6.3 Identifying Recurrent Themes for Key Findings to Research Questions

In order to answer the three main research questions, an additional step besides the four steps already used in the IPA analysis is to identify the *recurrent* themes out of the 11 super-ordinate themes. This was carried out to find out which of the themes are most potent, according to Smith et al. (2009:101). This is also to ensure that triangulation of the data was systematically carried out. Triangulation within cases is the process of gaining assurances and a way of establishing data or validity. This means that if there are evidences from three vantage points, it is worth considering. Stake (2006:33 & 77) asserted that at least three confirmations are important. So the theme is prominent if, say, three students said that plant science is difficult, and therefore worthy of reporting and being valid. Smith et al. (2009:107) proposed that if more than half or at least a third of the cases mentioned the theme, then an emergent or super-ordinate theme can be classified as recurrent – this helps to form the key emergent themes for the whole group.

Hence, following Stake and Smith et al., I have used '*f*' to indicate prevalent frequency or recurrence in my data analysis. It measures recurrence across cases and is also a measure of *validity* of the findings of the group (not to be confused as a measure of incidence as in the quantitative research). Hence, I decided that half or more should be of significant prevalence in my analysis, marked with asterisks. Identifying key emergent themes for the whole group by examining all the cases together at group or multicase level thus could help me focus on the most potent data in order to address this study's problem and research questions. Having employed these considerations, the results are now shown in Table 6.2 below listing the nine recurrent themes from the analysis.

Table 6.2
Recurrent Themes

Recurrent super-ordinate themes:	*f*	+
1. Basic concepts help grasp the idea of agriculture faster – 'agriculture starters'		
- Annual horticulture: planting field crops, seeds, plants' maintenance (weeding, watering, fertilizer application)	5	**
- Soils: pH, types	3	*
2. Concepts give good/deeper understanding of agriculture (integrative/connective/ transformative/phenomenal)		
- Planting and planting techniques – all about plants	3	*
- Plant science – study of plants	3	*
3. Most difficult concepts (troublesome) but useful (connective) for understanding		
▪ *First Year:*		
- Plant science	3	*
- Business	3	*
▪ *Second Year:*		
- Agriculture research method	6	**
- Farm management	3	*
4. Vegetable growing		
- Useful, helpful, meaningful, in-depth understanding	5	**
- Enjoyable, exciting, interesting and fun	3	*
5. Individual research project (on plants)		
- most interesting/enjoyable/exciting	4	**
- most challenging, hard work, sweat, big project	3	*
- high yield	4	**
6. Practical reinforces theory		
- general (overall picture, visualise connection, can understand better)	3	*
- vegetable growing	3	*
7. Paddy planting		
- exposure (attachment + study visit) to real agriculture	4	**
8. Values and importance of agriculture		
- seeing/realising values/importance of agriculture to our country	5	**
11. Contextual issues		
▪ *Education*	3	*
- disliking heat/sun		

Key: *f* Prevalent frequency/recurrence
\+ Present in half or more sample? Yes: * half ** more than half

The yielded recurrent themes from Table 6.2 will form the basis for answering Research Questions 1 and 3, which will be dealt with in the subsequent chapter. Note that Themes 9 and 10 are fading from this list due to the fact that they do not support the validity of the recurrent theme to determine the most potent data. Most findings under these two themes are uniquely dissimilar from case to case. However, they will reappear and are needed when answering Research Question 2 in the progression of understanding within each case. The next three chapters will discuss the key findings yielded from the above analysis or interpretation in order to address this study's research questions. Although Thomas (2009) advised for the discussion to be kept together within the interpretive analysis and findings, due to the long length of the discussion supported idiographically with verbatim extracts from participants, it was decided to keep it separate in the subsequent chapter but it will follow immediately right after.

Chapter 7

THRESHOLD CONCEPTS IN AGRICULTURE

This chapter and the subsequent two chapters aim to discuss key findings yielded from the results of the analysis. In this chapter, analysis findings for the first research question are discussed: What are threshold concepts in the learning of agriculture that could lead to a higher level of understanding in the subject, if any (focussing on critical episodes/experiences, when it clicked in the students)?

7.1 Discussion on Findings to Research Question 1

So what are the concepts that appear to fit the threshold concept characteristics in agriculture learning? Results of super-ordinate themes analysis (refer Table 6.1) in the previous chapter showed that early speculation of threshold concepts could be detected in the area of crop production. For the first seven super-ordinate themes, the most potent seem to centralise around the crop production area, such as annual horticulture, planting and planting techniques, plant science, vegetable growing, individual research project on plants, practical activities reinforces theory on vegetable growing, and paddy planting. All these themes seem to concentrate on the experience surrounding plants and crop production, and therefore are suspected agricultural threshold concepts emergent from this multicase. Likewise, the nine recurrent themes (refer Table 6.2) produced from these super-ordinate themes also showed similar prominence. This confirms high speculation of threshold concepts in agriculture learning for the multicase could come from plant-related areas. Comparisons of all themes also revealed that knowledge about plants has been perceived as being superior by the cases and valued more than other areas such as animals, soils, and agribusiness in agriculture.

Reviewing the first three themes closely, Theme 1 high prevalence on annual horticultural basic concepts was seen in five out of seven cases such as planting field crops, types of seeds, and plant maintenance. These topics were meaningful to students but it was not clear from the evidence if they possess integrative criteria. The initial intention of the interview questions posed for Theme 1 was to try to find out the essential basic concepts for introducing agriculture as starters (i.e. agriculture starters or introductory). Although threshold concepts could not be identified from this particular theme, it paves the way for discovering subsequent real threshold concepts.

However, recurrent themes analysis for Themes 2 and 3 showed that agricultural threshold concepts could come from these two themes instead, since the analysis fits the integrative, transformative and troublesome characteristics of threshold concepts. The findings revealed the following five concepts (Table 7.1) as the proposed threshold concepts in agriculture for this multicase group. Note that plant science appears in both themes.

Table 7.1
Proposed Threshold Concepts in Agriculture for the Multicase

Concepts in learning agriculture:
Theme 2. Integrative and transformative:
1. Planting and planting techniques
2. Plant science
Theme 3. Troublesome:
1. Plant science (in the first year)
2. Agribusiness (in the first year)
3. Agriculture research method (in the second year)
4. Farm management (in the second year)

Planting and planting techniques are integrative and transformative

Students thought that it was essential to learn about the concept of how to grow plants, particularly the techniques and procedures of planting, including how to carry out maintenance activities such as weeding, watering and fertilizer application. This revealed that when they planted any crops they needed all these skills to enhance better understanding of what agriculture is about. They were of the opinion that these concepts or activities were effective in helping them understand agriculture. When asked which of their learning helped them better understand agriculture, they responded:

> For me, it's all about planting, techniques, procedures, profit from planting... so much information to know, before this I don't know anything about agriculture. Nowadays, I know already regarding fertilizers, its application and what types of fertilizers to use. The amount to apply, what are the uses, things like that [Student 2C, Interview 2: Lines 69-72].

> ... planting method techniques that is effective from the beginning till the harvest [Student 2A, Interview 2: Line 12].

Plant science is integrative and transformative

A finding in the first year where a concept was perceived as integrative and transformative by students was plant science – a study about plants. When cases were asked which of the concepts gave good or deeper understanding of agriculture, analysis of interview data showed that the plant science concept was of similar potency to the first concept (planting and planting techniques), where three cases reported this in their interviews. It seems that learning about planting and planting techniques in crop growing alongside knowing internal and external processes in plant science (including photosynthesis and plants' water movement) help students understand better by knowing what to do and how to improve growth, yield and get profit. This knowledge in plant science seems to have integrative attributes in that students can relate to their theoretical knowledge in applying the knowledge in a real context whilst doing practical activities. In essence, knowledge about plant science helped students understood better what happened in plants internally and externally. Learning about plant structures and functions in the plant physiology of plant science provides understanding of the effect of the environment to plants. It revealed that plant science knowledge allowed students to see deeper inside plants and helped integrate understanding at the microscopic level behind the undertaken agricultural activities which facilitated decisions regarding their actions on the undertaken cultural practical activities/practices.

> Like in plant science, since we usually know about external about plants, but learning plant science helps to know about the internals too. Then, if you know the internal parts, then we can know how to improve how the plants grow well. Because we know how the plants make food (photosynthesis), what type of soil is used, like we know how to make the plants grow well and healthy [Lines 1-5]. Our cucumbers have lots of problem – we applied the fertilizer very close to the roots. So, all the plants got burnt since we don't know. Then after that only we knew if applying fertilizer it has to be a bit far from the main roots. So, it helps and helps me understand better what to do [Student 2L, Interview 1: Lines 18-21].

Analysis for themes and similar patterns in the first interview transcription data showed that plant science seemed to be both integrative and transformative, but was also a more integrative and troublesome concept. The reasons why it was also troublesome will be explained in the following section.

Plant science is also troublesome (in the first year)

Plant science was also troublesome as students have difficulty understanding the concept in the first year. Students complained that there was too much information to remember, and it was hard and confusing, causing memorisation as a strategy to overcome the difficulty and for passing their tests. The terms and terminology point to the 'difficulty of use of language' – a source of troublesome according to Perkins (1999). Particular troublesome concepts to them were cell structures and its terminologies, the roles and functions of hormones, photosynthesis processes in the C3 and C4, and water movement inside plants – all of which occur within the cell structures of plants at microscopic levels and are invisible. There was also confusion around concepts that involved processes in plants. Taylor (2006) had experienced similar findings in biology where troublesome conception was evidenced in the 'process and abstract concepts'. However, although students felt that they were troublesome, they also understood these concepts were important for relating their theoretical knowledge to practical applications.

> May be its natural for me like I feel easier for me on animals... we learnt about simple biology in animals rather than plants there is specific name on cells, specific scientific names for each plant – more difficult to remember than animals [Student 2D, Interview 1: Lines 9-11].

> Plant science is most difficult, like this various hormones we have to learn. In school we learn about cell and structures such as chlorophyll, nucleus, cell walls and cell membranes. But this time we learn much more of these, like details of chloroplasts what's inside it, so much labelling [terminology]. For exam, I really have to memorise these in order to remember to write them. Various hormones for what purpose, and then in plants C3 then C4 process in photosynthesis, that's why plant science very difficult. It's useful for understanding because some plants use C3, others use C4 and some grow at night or transpire or what like that... It's useful but it's hard but we need to learn it [Lines 40-48]. ... I think cactus... [whispering] where it respires during the night, and then in the morning it becomes normal. For vegetables if I am not mistaken could be C3...Actually I don't really know if it is the other way round... I cannot remember, but as far as I know, some respire during day some during night. At night they sleep because no sunlight so they cannot make food so they're just idle. But in the morning they respire because they make food [Student 2F, Interview 1: Lines 63-67].

Agribusiness is troublesome (in the first year)

Another troublesome concept of similar potency in terms of difficulty to plant science was business in agriculture (agribusiness). Similar to the perceived troublesomeness in plant science, issues of language difficulty occurred in agribusiness. Concepts in business-enterprise planning and management were difficult but students claimed that it was extremely important knowledge to learn with regard to profit-making and averting big losses in business. The reason for this difficulty seems to come from the difficulty in understanding the technical terms as well the context in which the business operates. Students were of the opinion that they still lacked the knowledge on how to run a business properly through real practice. Thus, this issue could bring on some potential implications to teaching these concepts. These concepts, according to the students, were overwhelming, very difficult, and hard to understand, which led to some students wanting to give up and blame themselves for not being good in business. These findings show how important it is for students to grasp business concepts so as to manage good returns from their efforts.

> My results, I think I did well, some with merits, except for one subject, enterprise planning is a bit spoilt, it's quite difficult to understand; and I had a re-sit once. It's because the context of the subject is more towards business which I am not able to grasp because I am not good in business [Student 2D, Interview 1: Lines 44-47].

> I don't like business planning ...because I don't really understand about business and the words [terminology], too much technical terms for me and very difficult to understand. But it is important that's why I'm trying my best to understand these terms [Student 2M, Interview 1: Lines 16-18].

Agriculture research method is troublesome (in the second year)

Its potency across six out of the seven cases showed that it was most troublesome in their second year. It was troublesome because Students 2F (I2:L2) and 2N (I2:L2) thought it was to do with research. Students 2F (I2:L6) and 2C (I2: L8-9 & 43) said there were too many formulae to use. Students 2C (I2:L3, 5 & I1:L49), 2A (I2:L42), 2L (I2:L5) and 2N (I2:L7) all said that there were too many calculations to carry out. The statistical calculations such as the Latin square and standard deviations had been described as being hard (Student 2F, I2:L6 & L8), complicated (Student 2N, I2:L23), a headache (Student 2F, I2:L12), and confusing (Student 2N, I2:L9, Student 2D, I2:L24, Student 2A, I2:L44). They complained that the calculations were too complex and took a lot of time to do. Student 2N (I2:L29) thought that it was even too advanced for their level of education.

> Because in the agriculture research methods we basically doing research right, and then we have a project and calculation on each ... like if we grow plants we have to replicate and sample. And we have to check it every week. And then the result from each week we compute in the end; and then check the error and everything. If there no error that's mean the project is okay. But if there is error, it's still okay but error means there is a loss of data. There are 11 formulae in the calculations, so it's hard [Lines 2-7]. ... the steps are hard. And, where to put replicates, samples and everything? So that is the difficult parts [Lines 8-9] ... and this is the formula to find this, sampling and everything... that's why headache (confusing) [Student 2F, Interview 2: Lines 11-12].

> ... I think agriculture research methods. Because we learnt about the statistics, and then the survey ...how to do survey that sort of thing, and then the most difficult part I think the calculation like the Latin square design, the standard deviations, all those that you've to calculate. I think it's quite hard to process that one. I think I don't really understand the calculation. Once we learnt, it's okay, but the next day we forgot already because there is lots of calculation... it's quite confusing [Lines 2-9]. ... it's too complicated [Line 23]. I admit it's truly advanced for me [Student 2N, Interview 2: Line 29].

Farm management is troublesome (in the second year)

Another troublesome knowledge was farm management and the parts that involved accounting. Three out of seven cases found it difficult in their second year. The main reasons garnered from their data were that: (1) it involved accounting and it was very difficult for someone who had no basic grounding in accounting, (2) due to the big terminologies used (similar problem to plant science and agribusiness), it was difficult to explain the concepts and describe in their own words, and (3) it related to business and marketing. These led to surface learning or memorising as a strategy to pass the test. To Student 2D all these could be overcome if there are practical activities set aside rather than just relying on theory lessons (2D:I2:L18).

> The topic that I find a bit hard in this second year is farm management. It is hard as it involves accounting since I don't have basic accounting. Though I can cope but it's quite difficult. I don't believe that I can pass it. There are many who fail in our class, if I am not mistaken twelve or ten out of twenty? So, nearly half of us have to re-sit. So, I don't believe that I manage to pass it. Aaa... like... what do you call it... how to understand... the concepts, I mean we learn according to texts... therefore have to memorise all those things. The reason... because of the language. The terms are very big, difficult to describe [Student 2D, Interview 2: Lines 4-12].

7.2 Discussion on Key Findings – Threshold Concepts Revealed from Data

So what are the key threshold concepts revealed from these data? The evidences above could point to some areas of agricultural threshold concepts for this multicase. That is, proposing the threshold concepts for the learning of agriculture for this level. But, which one could be the key for earlier crossing of a threshold? Speculation is quite high in Theme 2, that is, between plant science and the planting and planting techniques, as both appear to possess integrative and transformative attributes. Although plant science has double characteristics (integrative and troublesome), comments reflected from the cases also appear that it has more troublesome characteristics than integrative. Integrative and transformative traits are key attributes of threshold concepts (Meyer & Land 2003, cited in Davies 2003:5), but not the troublesome trait. This final thought seems to rule out plant science as the principal threshold concept in agriculture for this level, although it is still considered as one of the thresholds for understanding. This leads me to identify the actual key threshold concept – *planting and planting techniques* (or generically, planting) as the one left under Theme 2 and most likely the key threshold concept. Planting may be troublesome to a few, but not always. It would fit the definition of a key threshold since it has a key role in transforming thinking.

Planting seems to suggest agricultural threshold concepts focus on skills. Obviously planting is a process skill and its ability to transform thinking fits the threshold concept definition perfectly. Could this mean that the agricultural threshold concept be in the skill area rather than in the theoretical area? This seems a possibility as practical experiences both in the vegetable growing project and paddy planting were regarded as high value by most participants as seen throughout the data. It was seen as having the ability (through emotive or affect) to connect within (crop production) and across knowledge, such as with agribusiness, research and management.

Planting, thus, provides coherence and has an integrative nature. The evidence that planting is the key was further supported by the strongest themes in each super-ordinate theme and other recurrent themes which mostly pointed to an area that was dominated by plants. For example, vegetable growing (Theme 4), individual research project on growing plants (Theme 5), and paddy planting (Theme 7) are all centralised on plants. In fact, results of all the collective findings (identification of super-ordinate themes and recurrent themes) for the first seven themes displayed connections to plants and showed a dominant strength in the plants area. This reveals that *planting* is most likely the discovered *key threshold for earlier transformation*, the concept seen as possessing transformative effects, 'in that it exposes the previously hidden interrelatedness of something' (Meyer and Land, 2003) in the cases, and allows students to grasp the complex interconnectivity of agriculture knowledge.

This result also shows that there seems to be a reciprocal between the theoretical parts in plant science in the first year with practical skills in planting to cause integration of understanding to happen, given that both concepts were recurrently potent under Theme 2. Logically, one will not be good in planting if one doesn't know the rationale or the science behind planting (the plant science), as Student 2L said. However, the power characterised in the planting concept is evident by its capacity to integrate all the other concepts together since it also appeared in almost all of the recurrent themes. Thus, planting is considered the major provisional threshold concept for the multicase of the level of agriculture education in this study. It has significant power as the focal point among the interactions and inter-relatedness of thought and has the combining role among the series of agricultural concepts.

There was much evidence in the analysis of interview data which pointed to planting as a probable threshold concept or a skill demonstrated by phenomenal experiences. Examples of several extracts that can confirm planting as the threshold concept are:

> Oh, this is really fun... planting! Especially when I get the yield... I said to myself... ah this is from my effort [satisfaction from hard work]. The feeling is hard to describe, it's even much more satisfying than cooking. So, now I fall in love with

agriculture... very much so. Especially, if it is about plants... [Student 2F, Interview 2: Lines 37-41].

Additionally, asked what were the best parts of her time (most meaningful) spent in school, Student 2F replied that they largely related to the planting of crops because she said she could understand it better.

> When we do practical... because I can understand better. Such as, in vegetable growing and fruit trees planting. Because I love plants. Moreover, I also love paddy planting... [Interview 2: Lines 32-34].

Student 2A was also of the same view despite her slow transformation in inter-relating her knowledge. She admitted that it is planting that is effective to her.

> Paddy which I think more meaningful that sticks to my head. If talking about subject, it's like... annual horticulture that is planting method techniques that is effective from the beginning till harvest [Interview 2: Lines 11-13].

This shows that anything to do with planting especially in vegetable growing seems to be effective, and also paddy planting. Although for this particular case, Student 2A found that the paddy planting experience was the most meaningful, still she admitted that planting techniques and cultural practices in the annual horticulture gave most effective understanding even though she explained she didn't prefer it due to it being difficult. Despite this, she was the only case interviewed who found it troublesome due to stuckness in relating her thinking practically; this provided me an opportunity to compare and explicate about the significance of planting in its entirety.

All these evidences seem to point to planting as the most potent super-ordinate conception or threshold concept in agriculture for this particular level of agriculture studies. Planting is also evidenced as a threshold concept as it offers the key or fundamental concept that bounds other concepts together (see Figure 7.1). It seems to characterise ways of getting learning integrated and change ways of thinking. Planting has the capability to *unlock* and therefore is a *key to new ways of thinking*. That is, the characteristics that planting could have as a threshold concept which possesses something that could 'integrate, transform, set boundaries to domain and probably are irreversible and troublesome for the learner' (Meyer and Land, 2003). As Meyer and Land (2003 and 2005, cited in Davies & Mangan, 2010:194) suggested, 'within each domain there are certain ideas that present themselves to students as portals that can open up a new way of thinking within a particular domain'. And for this domain (agriculture) as revealed from this study, this portal is planting in the area of crop production.

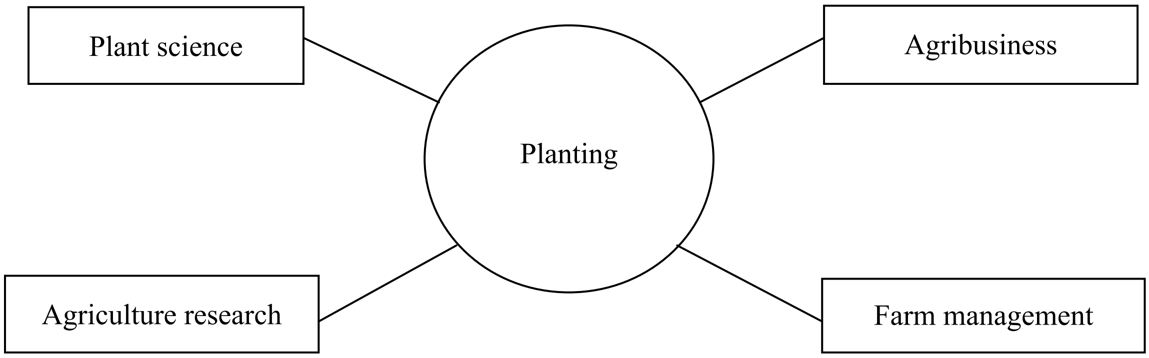

Figure 7.1. Linking planting as integrative to other areas of agriculture.

7.3 Discussions on Threshold Concepts Findings and Meaning Making

Investigation of threshold concepts in this study has provided interesting insights as agriculture is very diverse, ranging from production, science, business, research and management. To cross the thresholds, it seems that students should be able to traverse planting, plant science, agribusiness, agriculture research and farm management, respectively. These concepts seem to fit the definition of a threshold concept as described by Meyer and Land (2003) as having integrative, transformative and troublesome, though not all were found to be problematic by students. But the key to initial crossing is planting which seems to have the ability to provide coherence to bring together all these disparate areas in the aforementioned concepts, and is fundamental to developing a sophisticated understanding in agriculture. Planting is fundamental for basing all other areas in agriculture to link to, and students are expected to make these links as learning progresses prior to becoming transformative as they are increasingly more exposed to the topic.

Planting also fits the 'way of thinking' as resonated by Davies (2006) in his conceptual modelling. Specifically, Davies (2006:72) defined way of thinking in a subject as 'application of key concepts is one of the approaches to defining a way of thinking in a subject'. Learning is a journey and every journey begins with a small step. And that first step is to cross a threshold, before progressing and transforming in the discipline upon traversing a larger threshold to become an agriculturist.

These findings also seemed to show that the threshold concepts in agriculture are not simply due to the build-up of inter-relationships between concepts. Similarly, Davies and Mangan (2008, cited in Davies & Mangan, 2010:194) argued that:

> Increasing complexity of understanding is *not* characterised simply by more connections between conceptions. Within the current thinking in any domain some connections are held to be valid whilst others are not. Moreover, super-ordinate conceptions or threshold concepts require a transformation of more basic concepts, so that these become aligned with an emerging structure of understanding that characterises a way of thinking with a domain.

In relation to what Davies and Mangan said above, as evidenced from this study, students' understanding seemed to have been mediated by engaging in practical activities. Planting is something which has been able to integrate their theoretical knowledge in classrooms to outside classrooms, and therefore is capable of transforming their thinking to that characterised more like an agriculturist. Through planting practicality, students seemed have been transformed by their experiences. This transformation, as seen in the findings, could have been aided by first having learnt the basic topics in the agriculture starters (such as soils, field crops husbandry and maintenance). If not, this transformation will unlikely to take place. That is, like Davies (2002) said, the bits need to be there before integration could take place. This could also imply that the threshold concept understanding will not happen at the beginning until students have gained enough knowledge structure to bind it together in order for it to take place. Therefore, as a precaution, it should not be taught too early within the course. 'It is conceivable that a novice learner should be introduced to fundamental concepts at the outset of their study in order to acquire building blocks which will serve as foundations for their later understanding' (Davies and Mangan, 2006:75).

Another similar finding to that in the literature is the evidence that students found difficulty with concepts that are abstract and related to processes in plant sciences, such that students found it hard to relate theoretical concepts in photosynthesis and water movement to actual plants. One coincidental finding with previous literature is that there are some similar findings in Taylor (2006), which could be due to the fact that plant science is a sub-division of biology, who observed 'process concepts and abstract concepts in biology, often encompassed in the same threshold concepts' (p. 98) are troublesome as these can only be visualised at cell microscopic level. These findings seem to be in agreement with Pratt (2005:11-19) as she mentioned various useful concepts related to sciences particularly the biochemistry of plants growth and functions that must be known in helping agriculture understanding. Taylor (2006:88) mentioned that biochemistry of photosynthesis in plants and water uptake in crops are amongst the most difficult concepts at university level biology, whose application of research opens up challenges to agricultural botany. One of the reasons she mentioned why 'process' was troublesome in photosynthesis was that ‘students didn’t think holistically the significance of photosynthesis in maintaining life on earth’ (p. 90). Similarly viewed in agriculture, photosynthesis is such an important process in plants’ food production, the provision of food for human consumption and is vital for yield productivity.

Planting involves emotional and physical elements (hands-on). Thinking on similar lines to the skills of planting, is caring in health care professionals and also knowing how to judge the rate of heat transfer in cooking (see Meyer and Land, 2006:3; McCormick, 2008:53). In the health care practices, Clouder (2005) argued that touch in caring is a powerful connection; considering the emotional or affective dimension to produce graduates fit for practice to align ‘care-giving involves meeting of needs for care, direct contact and physical work with the person needing care’ (p. 508). She suggested that ‘the catalyst for moving through the threshold is connection with the human aspect of care at a personal level’ (p. 515). Moreover, she underscored, following Ray (1988), that job satisfaction, joy and motivation are part of the emotional factors with intrinsic rewards that culminates from the received response of given care which can increase self-esteem (cited in Clouder 2005:508). The affective human personal factor associated with physical work and contacts has altered the way health care, cooking and agriculture practices are perceived and approached as a result.

7.4 Summary Discussion to Findings to Research Question 1

Is there a threshold concept? Yes, planting is the threshold concept although students acknowledged other areas as also troublesome, but their evidence was not sufficient to uphold the transformative trait. The findings pointed out that agricultural threshold concepts seemed more evident in plant areas than animals. Students felt that much can be learnt from plants as primary producers compared to animals which also rely on plants. There is a threshold concept, as evidenced in the findings, centralised on the plants’ growing area, particularly vegetable growing, and some on paddy planting. However, subsequent comparisons showed vegetable growing seemed to be more potent. Further analysis on what is phenomenal have successfully identified that planting is the key for learner’s thinking integration. Although there was evidence that soil was found difficult, students did not find learning about soil concepts exciting and a phenomenal experience. Indeed, soil was only considered as basic that must be learnt before embarking on planting, mainly because soil is the medium for growing, not so much on transforming understanding.

The findings also revealed that plant science has teamed up with planting to help transform understanding. Together, they have integrative characteristics, although students found plant science also troublesome as without plant science they knew they would not be able to understand deeply the internal connections of plants to its external environment. Unfortunately, the supporting data evidence that plant science could be a key threshold seemed inadequate from the students' perspectives for it to be as a phenomenal experience as planting. Plant science's theoretical knowledge, in fact, was only helpful to complement their practical understandings and problem-solving to rectify the plant's condition.

Successful experience in growing plants and getting subsequent yield prompting home planting of their own initiatives, suggesting that the students were actively connecting, integrating, and constructing knowledge deeply, engaging and reflecting through the planting experience they had in school. Planting, as substantiated in the data, caused students to be very passionate about agriculture. It opened their eyes to real agriculture and made them think, behave and feel like real farmers. They considered the success feeling derived from planting as very important – it brought on more confidence, satisfaction and further motivation. This was reinforced and made possible owing to the context of a real environment in which their learning had taken place (as opposed to only classroom lessons which they didn't enthuse them) allowing them to see, feel and apply their learnt knowledge in reality in the school garden.

Further inferences on the real context provided by the planting experience indicated *personal-physical-practical contexts* where learners cognitively construct knowledge whilst actively carry out various cultural practices and planting techniques. This suggested that the contextual relationship between the *person, plants and practices* in planting seemed have successfully moved thinking and created learners-farmers identity shift/dynamic after they had seen results/consequences/effects (job well done, yields harvested, money, and profits) from their actions. This *person-task-context engagement* and hard work allows thinking deeply and reflects what it means to be a farmer/agriculturist, and brings the whole point of conceptual and identity change (transformation) as embodied in a person.

The above threshold concepts finding on planting together with the triangulated interview data from the students, allow us to deduce a new finding. It shows the threshold conceptualisation occurs at the *skill area* whilst performing planting activities and on seeing eventual consequences – interplay of action and consequence. Planting is action or doing, and thereby (using threshold skills or procedural concepts) helps engage and integrate learners' thinking in agriculture. Hence planting, in learning how to grow plants (through knowing soil properties and via implementing/practising various cultivation techniques and also applying plant sciences knowledge in-situ), is the proposed threshold concept/skill discovered in this study seeing that it has affectively integrated thinking and conceptually transformative. Figure 7.2 helps to explain this further.

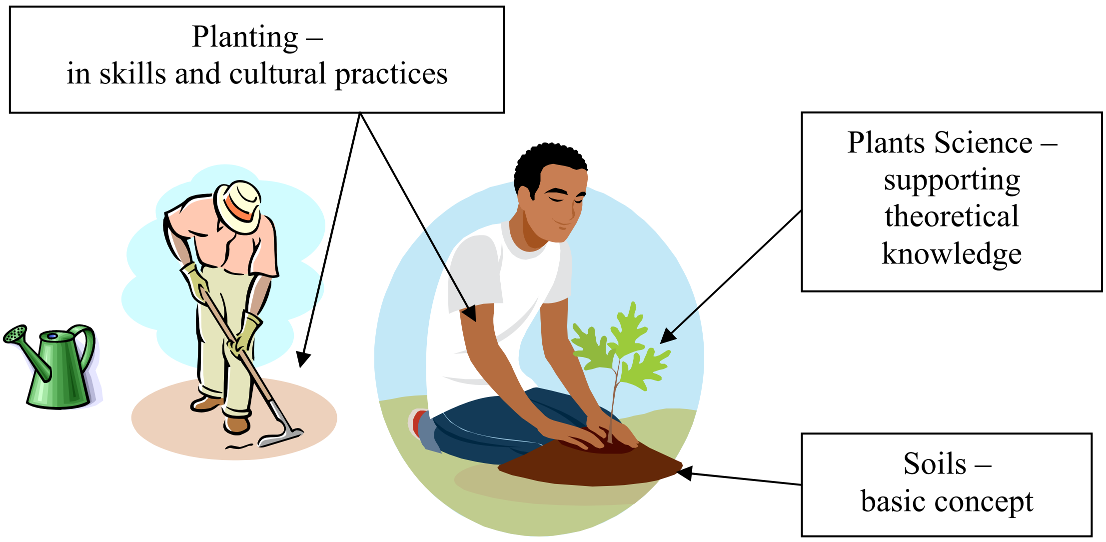

Figure 7.2 Planting – the key threshold concept/skill for earlier transformation in learning agriculture.

Figure 7.2 shows three sites/contexts of threshold conceptualisation for occurring: (1) *soils* (the medium for growing crops), (2) *plants* (the object under study) with cognitive interplay of *plant sciences* (for visualising functions and processes deep within), and (3) *planting* the integrative skill or cultural practice borne by the learner/doer in providing optimum growth conditions for plants. Together, these onsite-task combinations in the planting activity facilitate real connections so students would see real application practices, reinforce their understanding in context, and enable transformed understanding and identity to take place.

The planting practicality thus provides real context and connection that could help students *visualise* and understand learning which indicates that agriculture learning emphasises *active participation and real engagement* to complement understanding of theoretical aspects of knowledge. Its potential, powerfully transformative and effective in impacting students, in the data suggests that mastering and experiencing planting interactively in these contexts is crucial for advancing thinking to other knowledge areas (such as business marketing, research and management). Planting is thus the key concept/skill for an earlier transformational shift in the agriculture learning before any other concepts.

Another finding indicated that the planting threshold concept in vegetable crop production seems sufficient in providing simple meta-cognition structures for thinking subsistence farming at lower level agriculture. It paves the way towards further development of ideas in developing relationships for considering agriculture as an industry in a wider context or commercial agriculture, even perhaps at the higher level education where scientifically research-led, highly technology aspects are emphasised.

Planting thus is central to provide seminal or influential experiences for further development of ideas. It is proposed that planting (in the crop production area aided by plant sciences) is the key threshold concept for inception and the pre-requisite for understanding and further transformation in agriculture learning before advancing to other relevant areas. Specifically, my findings deduced that *planting*, including cultivation and harvesting (complemented with plant science), is the *key threshold concept* that builds agricultural understanding integratively; soil and its properties as the *basic foundational concepts* that needs to be known first; knowledge about tools, equipment, farm machinery, and research method as *supporting concepts* to work with skills or procedures in agriculture; and business, marketing, and entrepreneurship as *complete concepts* to champion in the broader social context.

The breakthrough of planting as the threshold concept in agriculture will unlock a new way of understanding to the discipline, helping to create more individuals that are more transformed and better able to cope/advance knowledge and further develop understanding. This provides a new and powerful way for understanding, a foundation for breeding future generations of agriculturists and producers for the country.

Chapter 8

IS THERE PROGRESSION?

This chapter aims to discuss key findings from the analysis to address the second research question: Is there progression (students' transformation in terms of thinking development from simple to advance or complex knowledge and skills) in threshold concepts understanding? The discussion will centre around Themes 9 (progression) and 10 (transformation) of the cross-cases analysis results listed in Table 6.1 in the previous chapter.

8.1 Progression Findings to Research Question 2

Is there progression in agricultural threshold concepts understanding for learning at this level of education? Evidence in the interview analysis showed that there were increasing attempts by students in trying to link or connect their learning. Especially at the second year, there were progressions from simple to complex in conceptual understanding as students discovered more and more knowledge.

The evidence was generated from various, dissimilar, unstructured interview questions posed to participants, although prepared guiding questions were on hand (which was or was not used at all during the course of the interview). It was also very difficult to focus on which area of agricultural learning in order to assess progression, since there has not been any previous literature and work on this research.

Despite unspecific questions asked (unlike in Ashwin, 2008; Davies & Mangan, 2010 – who examined students' written argumentation from a set of given scenarios), my current findings in this study were quite striking. During the interview, the students were encouraged to think aloud, so there was a free flow of ideas in the conversation and the responses were open to dialogue about what participants judged as important as the word 'connect or relate' were totally prohibited from my interrogation. Unless, the cases started mentioning these words first, then the conversation would continue from there. If not, indirect questioning how they related their knowledge together continued.

Hence in analysing their interview transcripts, my main focus was to see progression if they can, in part, relate some ideas to ways of thinking and practicing like agriculturists and to check evidence of connections of ideas according to the SOLO taxonomy as explained in the previous chapter. As the author, also the sole primary researcher in this study, I have determined to the best of my ability, on the basis of my own knowledge, experience and understanding, whether they have reached the level of agriculturist thinking, since I have also been qualified and knowledgeable in this discipline. Just to make it clear to the readers, I have never been involved in teaching this group of students, nor have I been involved in preparing their curriculum of studies.

8.2 Evidence of Progression at Individual Case

Analysis of the data showed that there was evidence of progression in the students' thinking in trying to relate some areas in agriculture as listed in Table 8.1.

Table 8.1
Progressions or Connections of Ideas from Cases in the Data Analysis

Student:	Connections between ideas:
	▪ ***Progression in the knowledge: seeing connection and relationships***
2C	- agriculture is food for life
2L	- agriculture is connected to science, agriculture and research, humans and plants
2N	- agriculture connection with food, business and management - relationship of crop with soil, environment, fertilizers, pests and diseases
2M	- relationship of crops with soil and fertilizer needs which in turns determined by other factors such as weather condition and temperature
	▪ ***Transformation in attitudes/perspectives:***
2N	- environmentally friendly person
2M	- appreciates hardship, avoid food wastage and respect family more

The various progressions in thinking across the cases showed how they linked agriculture to food in life in general, and within their learning context how agriculture is connected to science and the relationship of how plants grow with regards to balancing needs and the surrounding environment. There was also agricultural relationships to the wider context such as in research, humans, business, management, and finally as embodied in students' transformation via their personal and everyday experiences. Some selected interview excerpts to illustrate these evidences are extracted and the full details of the analysis or interpretation are presented in Appendix 8.1.

8.3 Progression Findings across Cases based on Threshold Concept Framework

Analysis of progression (seeing connections in Theme 9) and transformation/shift of attitudes (Theme 10) in the students' data (Table 6.1) showed that more attitudinal transformation occurred in the first year, but more progression was observed in the second year as more topics were learnt. The shift in feelings and attitudes in the data evidence were imbued by agricultural activities and experiences (especially in Students 2M and 2N) which helped strengthen their progressions in the second year. The evidence revealed that students who had undergone the most transformation in attitudes in the first year had also made the most progression in the second year, as seen by their ability to connect. For easy reference, parts of Table 6.1, to show those results of Theme 9, 10 and 3 are extracted below:

9. Progression (seeing connections):	2C	2L	2N	2D	2A	2F	2M
- agriculture + business						✓	
- agriculture + life (food for life)	✓						
- agriculture + food + business + management			✓				
- agriculture + science		✓					
- agriculture + research		✓					
- humans + plants		✓					
- crop + soil + fertilizers + environment, pests, diseases			✓				
- soil + crop + fertilizers needs, weather condition, temperature							✓
10. Transformation in attitudes:							
- appreciate hardship					✓		✓
- care for environment			✓				
- against open burning			✓				
- against chemical spraying			✓				
- appreciate food (avoid wastage)							✓
- respect family more							✓
3. Most difficult concepts (troublesome) but useful (connective) for understanding							
▪ *First Year:*							
1. Plant science			✓	✓		✓	
2. Business		✓		✓			✓
3. Soil			✓		✓		
▪ *Second Year:*							
4. Agriculture research method	✓	✓	✓	✓	✓	✓	
5. Farm management	✓	✓		✓			
6. Ruminants husbandry						✓	

On another aspect, on cross-checking if any of the troublesome concepts identified from Research Question 1 have also hampered progression (Theme 3 - troublesome) seen under the progression results (where students had been trying to connect); the answer is yes. All the recurrent troublesome concepts as identified under Theme 3 (plant science, business, agriculture research method, and farm management; and also soil which is not recurrent in the analysis) are congruent with the findings on progression evidence (Theme 9). This shows that students had attempted to make connections of various concepts to surmount the thresholds in order to make links to get deeper understanding. Those successful connections had shown a remarkable way of understanding as seen in the data, such as Students 2N and 2M. Their capabilities in connecting ideas have in fact made them more progressive than their counterparts. Those that made little effort to progress, such as Student 2A (seen in both interviews) and Student 2F (in the first interview), did not show much evidence of connection of ideas in their interview data.

They had troublesome or in liminal state because the connections between concepts were weak, perhaps more or less lost, and this hampered progression.

8.4 Relating Progression Findings to Progression Levels in SOLO Taxonomy

My experience of using SOLO showed that it is not easy to assess students' progression since there was no specific similar interview question posed to every participant. But based on the guiding Table 4.6 of the SOLO analysis, as well my personal judgement in the discipline, I could categorise the cases according to the various levels as summarised in the table below.

Table 8.2
Relating students' progression of agriculture concepts to SOLO taxonomy

SOLO level progression stages	Students	Remarks on understanding level achieved	Threshold concepts
Extended abstract 5	2N	Have whole picture	▪Management ▪Business
	2M	A bit of business	▪Research
Relational 4	2L 2D	Science (Not yet achieving business)	▪Plant science
	2C	Conceptual change at production stage	
Multi-structural 3	2F	Conceptual change at planting stage (Not yet achieving science and research stage)	▪Planting
Uni-structural 2	2A	Excitement of agriculture	
Pre-structural 1			

The results show that students have achieved various progression levels at different rates. But not all the students could see connections and show progression at the same time. Students 2N and 2M had definitely transformed at this lower level of agriculture learning given that they had attained the extended abstract SOLO level. Students 2L and 2D could be oscillating between SOLO level 4 and 5 as they showed occasional evidence and a possibility of attaining level 5 with more time. Student 2C was categorised as level 4 as she was able to practice, but was not so good on theorising and reflection. Student 2F was oscillating between level 3 and 4 where she was able to understand the concept of planting but not sufficiently well enough to relate it to plant science. Lastly, Student 2A was in a liminality between level 2 and 3 (since there was hardly any connections in her responses) and this was confirmed when she mentioned adopting a memorising technique and, therefore surface learning, which worked well with her theory lessons.

The findings suggested *non-hierarchical threshold concepts* (not on build-up of concepts) on a web of disparate concept (planting, plant science, research, business and management) connections, slowly expanding to a wider connection of knowledge that students needed to surmount in order to progress. This was supported by the evidence which showed the way the students think was not accumulative but they tried to make links. Progression is *not based on build-up of concepts* like in SOLO, but rather how students try to link from one to another because these concepts are distinct in agriculture areas. The findings also deduced that in order to reach the capability like Student 2N, all the five areas must be surmounted. So, Student 2A would need a lot of help if we want to assist her link up the concepts. Thus, progression assessment is useful for teachers and curriculum planners to classify learning stages. It is useful for diagnostic purposes to identify where the problems lie and indicate learning deficiency, but it does not provide improvement for remedial solutions as Ashwin (2008) argued. The SOLO taxonomy could help teachers to benchmark students' thinking progression, thereby provide assistance for overcoming learning difficulty. Teachers will know how far the conceptual change has occurred so they could nudge (assist/guide) them to reach the threshold level conception.

8.5 Comparison between a Transformed and an Untransformed Learner

As an untransformed learner, Student 2A had hardly any evidence of attempting to link connections between concepts. Even if there is, the connection made was very simple and considered independently (Interview 2, Lines 14-18). She knew that there was a connection of agriculture with science, especially the biology parts, but she could not explain this relationship clearly (Interview 1, Line 32). She also could not link between her practical and theoretical understanding to help her make sense of the practicals. There was also evidence of only a brief explanation being given by the teacher to students of the purpose of practical activities (see Interview 1, Lines 4-6). This implies that insufficient explanation resulted in reduced chances of connecting to theory. As one says, there is hot water but not enough to make tea. This highlights the need for a balance between theory and practice learning, and should be explained in context. It was argued that this untransformed state is suspected to have been carried over from her previous years' schooling experience as she was unable to make connections in what seem to be isolated chunks of knowledge, where she is expected to actively link more inter-connections but find no relevance. Student 2A's issue of inability to connect caused her to be unable to make progress, thus being far from being transformed in the discipline. This issue of hampering progress will invoke a lot of concern in education as it is prevalent that either the student is unable to make the links or the teacher fails to facilitate such connections.

Similarly, Ashwin (2008) also argued that in economics more enforcement should be between the 'acquisition and use of knowledge'. Sfard (1998) also warned us that there is a danger between ignoring just one thing between her notion of 'acquisition and participation metaphors', where a mixed metaphor seemed to be most useful. She argued that we need both metaphors as relative advantages from either of them will offer the other cannot provide (p. 10).

Contrastingly, Student 2N had been able to relate various ideas together in integrative ways. Her progression was evidenced when she actively linked more inter-connections of concepts ranging from production to business and management, from small scale to larger commercial thinking. She understood the need for both good knowledge and skills in crop management and production to ensure success in industrial agriculture. Her progression evidence displayed someone who was capable of thinking at a higher level of practising agriculture well beyond a classroom context.

As a transformed learner, Student 2N's insight into learning is remarkable. Her interview data revealed she could view things holistically in a whole picture, as oppose to a discreet manner. She mentioned a 'picture' (Interview 1, Lines 14-15) as representing her thinking and viewing related to real life context and experiences. In progressing, she took a holistic view of learning by inter-relating concepts actively and constructively to form a whole vision of seeing relevant connections and values of the learning. A picture represents her whole thinking of connections and inter-relationships between concepts and agricultural ways of thinking and practising. On top of that, the way she foresees learning was that 'one should be able to think outside the box' (Interview 1, Lines 70-72) and to 'relate to real life' (Interview 1, Lines 74 & 80). Specifically, the evidence was where Student 2N related her experience to the *wider connections of agricultural relationships* (that is, she has reached a higher level of understanding), whereas Student 2A remained oscillating between some *irrelevant responses,* more towards *simple structures.* Thus the SOLO hierarchical is useful in diagnosing students' level of understanding or quality of seeing integration or connection of students' thinking, and not to be judged in terms of hierarchy in threshold concepts, rather a web of concepts. The detailed analysis, including the interview extracts and findings from both students are found in Appendix 8.

8.6 Summary Discussions to Findings to Research Question 2

My findings showed that there was progression towards broader learning outcomes in the students' thinking. Comparison of analyses of students' interview data taken during their first and second year studies had shown striking progression, both in *conceptual and identity terms*, particularly in the second year. Students' triangulated data (from survey questionnaires and interviews) showed they reached different levels of understanding at different rates of progression. Their *cognitive progression* demonstrated the ability to explain, relate/integrate, and apply, in trying to be relational and reflective of the relevance of their meaningful experiences, although not all of the interviewed students managed to reach progression Level 5 thinking (extended abstract) of the SOLO taxonomy. Their progression was also non-linear, rather jumpy, displaying inter-relational ideas of what could form webs of concepts – almost like islands, but are connected to one another to form a complete view of understanding. To explain this explicitly in agriculture, the concepts were thematic in accordance to the different and various enterprises or project activities that the students were involved in, but they also realised some concepts were linked to one another and commonly shared between projects. For example, they realised some ideas/skills in vegetable planting are also useful in paddy planting. Although not every case participant showed similar progression, overall knowledge progression from basic agriculture production to wanting to attain commercial level production and real practice at a wider context was evident.

Secondly, there were also evidence of *identity transformation in the process of becoming* wherein affective emotions such as shifts in personal values, perceptions, feelings or attitudes to get involved. In fact, students who showed early signs of emotional affect by their first year experiences, showed the most progression in the second year. This is an important finding. In the second year of interviewing, they were getting more confident and talked comfortably at length; actively relating, applying, evaluating and reflecting their ideas/learning based on individualistic and social participation perspectives, evidence of active construction. The interview data illustrated the things they said as though they had become part of agriculture personnel with relative experiences to the broader practices of agriculture and socio-economic relevance. The way they talked about their stories demonstrated they were intellectually engaged. Their awareness and capability of thinking, making decisions, taking actions and solving problems were almost like real farmers when confronting problems. In fact, after two years of learning, I saw that the students portrayed things differently from when they started: they evidenced more qualitative relevant reasoning, rhetoric confidence, and eloquence in their talks. They even conversed about autonomous projects handling, where they admitted that teachers were only consulted when in need unlike in the first interview where they admitted to be at a loss and didn't know what to expect, a sign of uncertainty and unfamiliarity (or liminality). In her second year, Student 2C testified, 'I have confidence now. I cannot believe myself... [with what I have achieved]...' (Interview 2: Lines 96 & 109).

After two years, most students had shown *personal identity changes* and transformation. They were ingrained and determined to become farmers, agriculturists or any other future professions: plant pathologist (Student 2F); agriculture business person (Student 2N); agronomist (Student 2D); paddy and fruit trees farming (Student 2M); to be involved in the farm business sector (Student 2C); plant pathologist, agriculture teacher or working with the agriculture department (Student 2L). These ambitions indicated their transformations are not solely for the purpose of passing the course or as a means to the end (of attaining the highest SOLO level of progression) but beyond that. In fact, it is far reaching and even outside the school context – a testimony that identity change has taken place as the learning outcome. This evidence indicated that threshold concepts could create a transformed understanding in learning and yet has the ability to change identity. As Perkins (2006a) argued a threshold concept should be something that gives 'beyond understanding' and perhaps occurs most notably in professions.

Thirdly, besides academic knowledge and personal experiences, the data evidence also suggested students were progressing in seeing connection and relationships with *general wider connections of agriculture*: its importance and relevance to life, business, and management in socio-economic context. Progressions implied in the data were not composed of a linear build-up of knowledge, but students were transformed by *viewing holistically* as opposed to a discrete manner. They demonstrated the ability to link and connect relationships, use and apply the learnt knowledge to generalise to new situations and circumstances, and use a real world context as in wider connections of agricultural-economic relationships they inhabit. This is fascinating.

8.7 Discussion of Findings and Implications to Agriculture Learning

Another important finding disclosed from the analysis of interview data suggested that the general progression of ideas for secondary agricultural students' threshold concepts in this study seemed to have two stages: (1) the *crop production stage* and (2) the *enterprising stage.* Figure 8.1 illustrates how the two stages are inter-related.

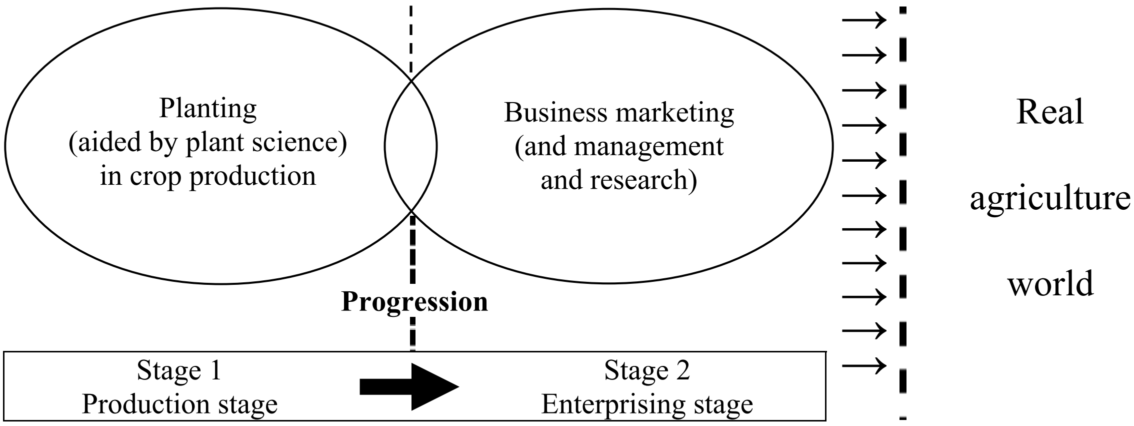

Figure 8.1 Stages of the threshold concepts and progression in learning agriculture at secondary education for the cases in this study.

For novices, the *production stage* (with planting threshold concept embedded for grasping) is perhaps useful in gaining a foothold in the discipline. It serves as a model or key point reference for transformation. Meanwhile, *enterprising* in the second stage is believed only surmountable after overcoming the earlier threshold (Stage 1). Agricultural business marketing (and perhaps including management and research) as indicated by students were mostly troublesome in the second stage.

These stages revealed linkages in concepts that are necessary and must be provided in the agricultural learning experience. Its provision is essential for creating effective thinkers whose knowledge would be functional both for understanding and the application of knowledge to face real challenges.

The findings revealed that with practicality all students could grasp the first stage, but not the second stage (enterprising), which signals another threshold concept to surmount after planting. This may be the reason why many students in the past were unable to pursue their agriculturist dreams, because the second stage is far too diverse and challenging to handle.

The interdependency of the stages implies that the knowledge and skills from the first stage is an essential prerequisite to the subsequent stage and is fundamentally seminal. It reveals agriculture production without the business marketing is insufficient for the holistic transformation of students. Realistically, it challenges students to master the first stage prior to the second in order to allow them to use the knowledge thereafter. It could be argued that it is impossible for learners to think of agricultural business marketing without connecting to its production relationship in the first place. ‘Relationships cannot exist without something to relate’, argued Newton (2000:9). It requires retrieval of knowledge from the former in order to make sense of relationships, and application of knowledge for the latter. The first stage is, therefore, a precondition for implementation of the relevance of the second stage to progress to the real agricultural world context. Quite simply, the second stage is supported by its predecessors, implying that both stages are symbiotically complementary for individual holistic transformation.

This finding also implies that an untransformed understanding in the key concept (planting and how to grow plants) could impede progression to the next stage. It seemed reasonable to imply that learners might struggle in the subsequent stage if they are unable to grasp the earlier stage, like in Student 2A. Students who could surmount both stages and made successful crossings (the borders represented by the dotted lines in the diagram) would likely fulfil the standard performance for the required learning outcomes. Thus, the planting threshold concept in crop production in the first stage is a prerequisite, compulsory, and must first be understood and mastered – it is the key/portal/gateway before any other components on which lays the foundation for the second stage for next successful transformation. It defines the boundedness of ‘bordering with thresholds into new conceptual areas’ (Meyer & Land 2006:8).

As discussed earlier, the students’ progression in agriculture threshold concepts is jumpy; the stages conform to the holistic idea development from planting to business learning on forming a whole or holistic idea on viewing a bigger picture. This also shows that students get affected by what is going on around them and what happened in the social and national contexts. Realistically, real world agriculture production allies with business marketing in order to complete the industry and for commercial success. Production on a small scale will not generate much money. A farmer’s success is determined by the amount of production and sales he is able to make. Similarly, a carpenter may be good at producing nice furniture but his success is determined by the many customers who have bought his furniture (Sennett, 2008b). Perhaps this thinking may also impact the students' feeling of success and profit making when selling their harvests, as it is a portrayal of a bigger picture to achieve later success in commercial agriculture.

Real agriculture as an industry at the commercial level requires practices to be on a large scale. It may be possible that students might be affected by this. For them to appreciate and view the world holistically and relationally to food and business (as in Student 2C's and 2N's finding), they need to connect their thinking to both subsistence farming and commercial farming (the former for gaining personal virtue and the latter for survival and life sustenance in a broader sense). The proposed threshold concept (i.e. planting and its subsets of the plant science in the crop production area) has, therefore, provided enough evidence in the data to affect transformation and relevance of agricultural learning at the personalised subsistence stage for thinking further transformation (with business and perhaps research and management as main components in the second phase) i.e. at the commercial stage. Thus, the students' developmental transformation thinking in agriculture seems to progress from planting to business-marketing-management, traversing thresholds of the production area first before getting transformed to agriculturist or successful farmer in the commercial world. These preliminary findings and the analysis took longer than expected as inadvertently my qualitative data was messy and therefore it took time for me to understand it. This pioneer research on agricultural threshold concept could open doors for future investigations to focus on. The next chapter is on addressing the third research question.

Chapter 9

ARRIVING AT THRESHOLD CONCEPTS UNDERSTANDING

This chapter aims to discuss key findings from the analysis of the third research question: How do students arrive at threshold concepts understanding and what are the implications for teaching and curriculum design? The discussion will first deal with how students arrive at their threshold concept understanding and indications that lead to their evidence. Implications of findings to teaching and curriculum will then follow. The final part of this chapter will provide the general discussion to synthesise the findings from the three research questions.

9.1 Findings to Research Question 3

How do students arrive at threshold concepts understanding? This question looks at students' experiences, thoughts and feelings related to the *most phenomenal experience*, i.e. planting and the experiences/activities that mediated it.

Table 9.1
Students' Most Phenomenal Experiences from Interview Data

Student:	The most phenomenal learning mediated by the activities/experiences:
2C	Vegetable growing as the most enjoyable and exciting in her first year; and more so in the individual research project on vegetable growing project in the second year.
2F	She found the vegetable growing experience phenomenal in the first year, and similarly, the individual research project on vegetable growing in the second year due to the yields.
2L	Vegetable growing in the first year; paddy planting in the second year plus the paddy attachment and visits at the end of the course.
2N	Vegetable growing in the first year; paddy attachment/visit in the second year.
2D	Vegetable growing in the first year; individual research project on vegetable growing and paddy attachment/visit in the second year.
2M	He found the vegetable growing experience helped in-depth understanding but he did not find it phenomenal. Instead he found the paddy planting phenomenal, he quoted it as the best knowledge of all for him. He also realised the paddy economic importance to our country. He appreciated the hard work in paddy production more than what he felt for in his paddy study visit.
2A	Although the vegetable growing experience in the first year that she found to be helpful with understanding, it was not phenomenal to her, because she also found it difficult. Also, though she found the individual research project exciting in the second year due to the yields, she did not find it phenomenal. What she found phenomenal is the paddy planting experience and the attachment both in the first and second year, respectively.

In doing so, I have looked at the essence of each interview transcript for evidence of how the participant arrived at his/her *phenomenal feelings* surrounding the *experiences/activities that mediated it.* As previously discussed regarding what guided the analysis, an indication of achieving threshold conceptual understanding could be pinpointed by the student's most phenomenal feelings. Analysis findings from interview data produced the results set out in Table 9.1, showing their phenomenal experiences mediated by the corresponding practical activities.

At the multicase level, checking the validity of the interview transcripts for phenomenal experience against each super-ordinate theme showed that the potency of the findings centralises around three super-ordinate themes: Theme 4 (vegetable growing), Theme 5 (individual research project) and Theme 7 (paddy planting). Comparison of their most phenomenal experiences against these three themes yielded the following results.

Table 9.2
Comparison of Most Phenomenal Experiences against Various Themes (Theme 4 – vegetable growing, Theme 5 – individual research project, Theme 7 – paddy planting)

	Most phenomenal experiences:	2C	2L	2N	2D	2A	2F	2M	*f*	+
▪ Vegetables	- Vegetable growing:	✓		✓	✓		✓		4	**
	- Individual research project on vegetable growing:	✓ (shaded)			✓ (shaded)		✓ (shaded)		3	*
▪ Paddy	- Paddy planting:		✓			✓		✓	3	*
			✓ (shaded)			✓ (shaded)		✓ (shaded)	3	*
	- Paddy attachment & study visit:		✓ (shaded)	✓ (shaded)	✓ (shaded)				3	*

Key: ✓ 1st interview; ✓ (shaded) 2nd interview
f Prevalent frequency/recurrence
\+ Present in half or more sample? Yes
* half ** more than half

In the first year, four students (2C, 2N, 2D & 2F) thought that the vegetable growing experience was phenomenal. However, in the second year, except for Student 2N, only three students thought that the vegetable growing in the individual research project was phenomenal. Student 2N found paddy attachment and the study visit were phenomenal instead as she was not quite satisfied with her project since she was not doing vegetables, but ornamental plants. Meanwhile, three students (2L, 2A & 2M) thought that paddy planting was phenomenal in their first year and remained so even in their second year. These findings showed that between vegetable growing and paddy planting experience, the vegetable growing activity was providing the best experience and seemed to be a good avenue for facilitating students' phenomenal feelings and understanding of agriculture (indicated by ** in Table 9.2). So what could be attributed to this fact?

9.2 Evidence from Interview Extracts

Results of analysis from recurrent themes above showed that *vegetable growing* was the most phenomenal experience among the cases. It was regarded by students as most useful, helpful, meaningful, provided in-depth understanding, enjoyable, exciting, interesting and fun. The majority of cases (six out of seven) had expressed their positive feelings towards it. Recurrent theme results (Table 6.2) also showed that under Theme 6 (practical reinforces theory), the students' perception of the vegetable growing activity as reinforcing their learning was prevalent. This suggested a strong possibility that vegetable growing activities provide connections for linking their understanding between practical and theory lessons.

But this did not provide detail evidence as to what caused their experiences to feel phenomenal in vegetable growing. Since they had also experienced vegetable growing in their individual research project (Theme 5), the analysis (supported by the essence of their interview data) showed a combination of various factors. There were interplays of *enjoyment–interest–excitement* with *challenge–hard work–sweat* and *high yield*. Yield was one of the factors that brought about phenomenal satisfaction to students (refer to Table 6.1 Theme 5). This was evident where high yield was among the most recurrent items under Theme 5, with four out of seven cases mentioning this in their interview, namely, Students 2F, 2D, 2A and 2C. They mentioned yields in association with satisfaction, confidence and leading success.

> Especially when I get the yield... The feeling is hard to describe... [Student 2F, Interview 2: Line 38].
>
> Yes, I am indeed very happy because there is yield... [Student 2D, Interview 2: Lines 39].
>
> I am satisfied because the yield is more [Student 2A, Interview 2: Line 38].
>
> Doing all these things, I just thought and realised how difficult it is and then the feedback after that is – the benefits and profits, and learn more – something, and about planting. Not just by looking at it, but we handled the management, and lots more to do. We get the yields and we can see the results. At first, it was difficult, like we wait and wonder if it will be alive or not. Basically, management is important. The yield was high, so it was a success [Student 2C, Interview 2: Lines 19-24].

The above evidence shows that the accomplishment from hard work and of seeing yields from it and the profit obtained, seem to be exciting/phenomenal to students. The data also revealed that some students even considered this as a measure of success (Students 2D & 2C) and sense of pride (Student 2D), which in turn built their confidence. When asked about their most phenomenal experiences, they narrated:

> Yeah, I feel so excited to complete the project, even though at first I thought I won't be able to do all these things such as making bed preparations and working with the soil, it's really hard. But towards the end when I did the harvesting, I cannot believe it myself as the fruits are so many, until I cannot manage to do the harvesting myself, so I get the help from my friends. Gosh... they grew fantastically, I was so excited. And also I got the profit from the sales. As a result, I can repay all the expanses for the inputs that I used [Lines 94-99]. ...the experience makes me addictive to plant more... that's why I did it myself again at home [Student 2C, Interview 2: Lines 100-101].

> I've done the project successfully [very enthusiastic]... I've got the yield and I managed to sell it, too. And there was no problem and so on, so it's a total success! ...I managed to grow my plants till maturity, until I get the yield. ...Not only that, I even managed to collect the seeds – which I still keep until now. I am extremely happy [proud moment] [Student 2D, Interview 2: Lines 32-39].

9.3 Discussion to Findings and Implications

The findings from the analysis and evidence showed that the way students arrived at phenomenal/threshold conceptual understanding was through *feelings of enjoyment, success, satisfaction of obtaining high yields and in overcoming hard work and challenges via practical activities* such as in the vegetable growing project. *Engaging in practical activities* seems to have caused students to actively think and practice like agriculturists when they linked their theoretical knowledge to practical experiences integratively. The case participants had been transformed by the experiences and been instilled with a positive liking for agriculture. The phenomenal feelings seemed to be the composite drive to their intellectual and experiential thinking to achieve more in their learning which could potentially develop them into future agriculturists.

This finding also seemed to place importance and emphasis of the *value of practical activities via hands-on*, especially in the *vegetable growing project*. The data indicated that (as also seen in Student 2N's data), for agriculture to be well understood, students need visual and concrete examples in front of them. This implies that agriculture as a subject should not only be taught by way of theory, but most importantly practically through hands-on and practical demonstrations. This further implies that learners would not fully understand if learning is to be based solely on books or inanimate presentations that are far from real, away from the context where it can be visualised and fully understood. This also suggests that agriculture learning needs to be approached via concrete methodology and be visually receptive to students to be effective. Agriculture learning therefore relies heavily on practical information to include practical activities and hands-on experience so as to maximise learners' understanding and connectivity.

It is thus very important to include vegetable growing activities in the curriculum in the first year and to be included as an individual research project in the second year where they can have more ownership and autonomy working confidently in their projects. Why?

- It creates an *avenue for students' conceptual change in understanding various concepts; and in changing students' feelings* towards agriculture. These phenomenal feelings bring satisfaction and build confidence and success. Success is very important to students to help build their confidence.
- *Yields* obtained from harvests allow students to see the *value of realising the importance* of agriculture in food provision for self-sufficiency and domestic level. It is also viewed as a way of seeing connections to agribusiness (through selling of produce), and in relating to commercial production to strive for higher production success.
- The *practicality in vegetable growing reinforces theory*. It reconnects theoretical to practical learning and the context. For a strong-based practical subject like agriculture, learning should not be de-contextualised.
- It *connects learning vertically within agriculture concepts* and also horizontally with other areas of agricultural courses by relating production to business and commerce.
- The *individual research project* provides connection and focus for students, more in bridging and applying their knowledge into a research context. Through their projects, students can enjoy some sense of autonomy as they could think and practise like an agriculturist, leaving teachers to monitor and provide consultancy only when required.

The evidence could be seen in the following extracts:

> ... there is a *link, continuation.* For example, like last time we planted in horticulture where we were trained how to do basics on how to set up the beds in the first year. But the *continuation* is on the second year is where we are going to do the individual research project. Since we know how to do bed preparation already in the first year, so there is no need for further instruction from the teacher since we're quite *confident* in what to do already. Because in the individual research project, we don't really need a lot of help from the teacher. It's just we come and ask our teacher in her office if we have some problems, and then we'll do it ourselves. So, the individual research project is the *most satisfying and interesting for me* [Student 2D: Interview 2: Lines 82-87].

> I think it has to be the individual research project, because I *spent a lot of time* doing my project where I *focus more* [Student 2C: Interview 2: Line 44].

Knowledge and skill development through experience ideally needs to be integrated and reciprocally practiced to transform agricultural learning. Central to agriculture is practicality whose activities are an integral part of getting agricultural understanding. *Learning in context through hands-on experience* seems part of getting agricultural understanding and has a transformative effect. At its best, skills and experiences link up with knowledge of theoretical aspects to create a lasting impact. Practical activities can make learning and the curriculum even more relevant when students interact with their learning environment, as real engagement can build students' confidence and motivation. Students understand and remember more by doing, rather by what they hear and see.

Application of knowledge through practice (hands-on experience) seems also a way of reducing abstraction of concepts whereby theoretical knowledge can be converted to procedural knowledge to reinforce better understanding. Procedural concepts (or agricultural skills) are needed to organise their thinking into a threshold concept schema or cognitive model (Davies & Mangan, 2010:195).

Practicality can not only successfully integrate learning but is also something that students found phenomenal and brought about transformational effects. It also helps extend school learning to the work world. Sfard (1998) argued, the 'acquisition metaphor' mostly exists and carries out during schooling, and the 'participation metaphor' is in the work world. Linking the two in a mixed-metaphor or theoretically a vis-vis procedural concepts (Davies & Mangan, 2008), models conceptual change and orientates learners to the work world.

Employing practical activities in learning reinforces theoretical concepts into their context. So we should never underestimate the physicality and sense of agency as this could make a difference in the students believing in their own capability. Much of the understanding in the data was gained in this way and that practicality facilitated this to an even deeper meaning to providing a holistic individual transformation.

9.4 Emotional Factors in Arriving at Threshold Concept Understanding

As mentioned, students' arrival towards transformational understanding is through practicality via *sweat* when *overcoming challenges of hard work* and by getting feelings of *enjoyment, satisfaction, success* and the *confidence* of obtaining high yields. The data showed physical hard work in doing agricultural activities had successfully affected students emotionally in their attitudes and perceptions towards inherent benefits, values and the goodness of agriculture.

The capability of knowing what to do, improves growth and yield via good skills and management, and was seen by students as important in creating confidence. High yield in their crops was also seen as a measure of their success. Heat and labour intensive work were regarded as challenges. The benefits of agriculture in providing food for human consumption and its importance for our country seemed to surpass the initial disliking towards heat and dirt (see Table 6.1, Theme 8 – values and importance of agriculture) and was only realised after experiencing this practicality.

The features of agriculture learning were not limited to knowing matters pertaining to the subject matter alone but also encompassed the hands-on demonstration of practical experience and skills. The cognitive, social and emotional aspects required learners to master practicality apart from knowing the theory. Due to this, in most of students' data (such as in Student 2M, 2N, 2C, 2F and 2L) the notion of affective labour (Hardt, 1999) seemed worked effectively. There was evidence that their hard work experiences had affected a personal change (cognitive, attitudes, perceptions and perspectives) due to learning involving physicality that engaged them well.

Affective labour is the importance of labour (physical experiences or activities) which affects the body, emotion and mind. It produces or modifies emotional experiences in an individual. Hard work and sweat from physical activities in the agricultural experience seems to have provided a successful link of the emotions to learning. Emotion becomes strongly connected to the cognitive system as it puts the brain into gear. Positive attitudes (such as motivation, satisfaction, confidence and aspirations) connect to thinking, stimulate or engage the person to spring into the thinking mode to process newly acquired and/or already existing information/knowledge into action and into consequences or desired outcomes/goals. The result is deeper understanding or transformed learning (learning is a process of identity change or becoming) which manifests how the person sees oneself and what one talks about – as a display of identity – in 'thinking and practising' like an expert (Meyer & Land, 2003).

The role of affective work as in identity formation, therefore has brought different aspects in a person together, and makes the point about the process of becoming (in identity), that integrates the whole person's identity, agency, attitude and so on. The importance of the positive affect of skills, labour or physical hard work should not be underestimated in transforming agricultural learning.

The phenomenon of affective labour, if placed in a broader context, sees that practical experiences are not only successful in the production of value but also 'social capital' (McCracken, 1998), in terms of agricultural commodity productions for society. It not only produces a positive effect on the quality of life of individuals but also on the community or society as a whole. This is fundamental in terms of how people interact in society, as to conform to the value of social networks and solidarity, and is most probably analogous to local agriculture in building national economy. The resultant social capital produced from education relates to quality of life and societies. This is useful for sustainability of social quality, whereby human development in education is helping a nation's capacity building. It is 'making education the highest political priority' (Young, 1998:182) in every country's term of immaterial labour capital (such as service, knowledge including education, or communication) to form a shared value to work to a common goal or consequence in order to drive the economy.

9.5 Summary Discussions to Findings of Research Question 3

As evidenced, sufficient theoretical understanding (such as plant science) and practical skills (of planting) are important for learning agriculture. Consequent findings from my data then suggested students arrived at their threshold concept understanding when there was emotional interplay of sweat (from hard work or labour challenges), yield and money generated. Through their phenomenal experiences, students illustrated that the way they reached their threshold understanding was through *practicality* and via the process of sweat overcoming hard work challenges. This was manifested in their phenomenal feelings of enjoyment, success, confidence and satisfaction from obtaining high yields and the job well done. Practicality has provided learning in context where students could visualise application of knowledge into practice, localise skills into making a matter concrete and thus reduce abstraction of the intangible knowledge into real. As Student 2N emphasised, having practical activity had allowed her to visualise her learning. The context and experiences created more meanings and sense-making, allowing space for focussing their thinking to create links to piece information relationships together and reflection of emotions for meaning to configure learning identity and transformation.

The physical experience or practicality, as evidenced in the data, had also motivated their interests, enthusiasms and passions in the subject as well in their future endeavours. It has also successfully changed their attitudes, feelings and emotions towards agriculture in particular, and their life in general as a whole (such as feelings of caring towards the environment; understanding hardship and the sacrifice of their parents in food sourcing and where food comes from; and also towards overall appreciation of food). There was also a common shared feeling of enjoyment through team work and cooperation of handling heavy work together, such as soil cultivation, which further added the positive impact of practicality. Team work is very important and useful in the corporate world and would foster leadership ability and communal feelings in commercial agriculture.

The findings revealed the way students reached a deeper level of understanding was fostered through physical and emotional experiences. Physical immersion in the practicality develops cumulative ability to relate and integrate thinking cognitively, which paves the way for deeper understanding of the relationship. This was enhanced through the combination of cognitive process and the physical experience, such as planting, that seems to weave/bind cognitive and emotional aspects together. Physicality has emoted significant feelings of pride (success), satisfaction and confidence. These personal feelings, in addition to value judgements of the importance for living, economy and community together, seemed to foster relevance in the students' eyes, which gives further impetus and motivation in studying the subject and an inspiration for future ambition. The values and feelings they felt seemed to focus their thinking and set their eyes on what was perceived as most useful, valuable and meaningful, and this relevance grips/hooks them to agriculture. Further feedback on this cognitive process leads them towards deeper understanding.

There was strong evidence that yield was such an important proof in the students' eyes – a symbol of success, confidence and pride – which rewarded their hard work and effort. Good yield from harvests established in students feelings of being rewarded, success and euphoria. They cherished the experience which instigated more enthusiasm, further involvement, and a yearning for better success in their actions, achievements, and future aspirations. Crop yields had also made those students who dreaded working under the heat to confront hardship and became more focussed instead on their thoughts and the belief of the best consequences from their efforts i.e. the outcome yields. Yields gave such pride and their parents' praises only added more fuel to the fire.

Findings from the evidence also showed that yield is strongly associated with the money factor – the material gains that bring added benefits, satisfaction and were most often valued by students. This sparked increased motivation. Money and yield together played an important factor in forging students' feeling towards success. This caused them to realise the importance and benefits of agriculture towards life – food and money bring hope and promise for a better living. It made them think seriously about life as an adult which further catalysed serious ambitions of desiring to be farmers/agriculturists in their future profession. This was substantiated when they said that through agriculture they not only get food but also money. In their eyes, both food and money were essential for living sustenance and securing a better future. Thus, feelings from the practical experiences and the embraced values had captured the learners' interest and gave further understanding that underlies the effectiveness of learning, which may likely give a wider vision of learning for their future.

In short, the emotional effects of physical experiences on students were very clear. Physical activities and the experience in preparing the soil, planting, tending and harvesting have allowed learning in context and encouraged a more focussed thinking of agriculture via reduction of abstraction of intangible knowledge. These triggered affective feelings like a farmer, enjoyment, success, confidence, satisfaction and pride in one's work. Knowledge on how plants grow and the physicality of the planting experience, emotional *feelings* and what is judged *valuable* are important transformational effects that get students to grasp the subject.

The experience that mediated the emotion was learning through a *project-based* setting that encouraged hands-on skills, and reinforced conceptual (theoretical) understanding and knowledge application, as agriculture can be best understood by way of contextual/situated practical experiences. Authentic learning experiences (which relate to real world application) has provided motivated learners and raised self-esteem, is effective for identity transformation (see Muschamp, Bullock, Ridge & Wikeley, 2009:307). This is in contradictory to insufficient learning experiences inherent in an overcrowded curriculum (both in theoretical contents and instructions) that potentially mimic understanding. There is no doubt that practicality is most important and is impossible to divorce from quality learning due to the created connectivity that is hosted by physical activities. Its presence in agricultural learning enhances higher understanding and this propels or raises the value of agricultural knowledge, as indeed most aspects of agricultural knowledge cannot just be learnt by intuition or through imagination, as these are indescribable in words, but tacitly through experiential performance and manipulative skills. Doing, to some extent, is unspoken performance, and many activities just need to be conveyed without uttering words, but be demonstrated, felt and witnessed to be understood.

Besides increasing functionality through the application of knowledge via skills, agricultural practices, more specifically planting, also made the learning more relevant, engaging and transformative. Practical learning permits/encourages students to engage in a highly relevant, contextual problem-based and project-based learning environment. To reiterate, practical activities in agriculture learning *create balance* and compensate for deeper understanding, while their absence causes irrelevance, ineffectiveness and leads to rote memorisation. 'We retain 80 per cent of what we do and only 10 to 20 per cent of what we hear or read', stressed Cortese (2003:19). Practical activity thus opens the gateway into theoretical understanding as knowledge and practice together goes hand-in-hand in forging learning. 'Practical work can be a powerful tool for supporting understanding', Newton (2000:63) emphasised.

Thus, in conclusion, to get to agricultural understanding is by mediating through practicality – hands-on skills and contextual practical-physical activities. Explicitly, practical activities put students thinking into gear by combining emotion with experience. Information on how students arrived at threshold conception here is precious and could be used to help students obtain understanding, then transformation, and facilitate ways to encourage it to take place.

9.6 Overall Findings and Discussions to all the Research Questions

What could be learnt from these findings? The overall findings seem to highlight that there is an *integration of mind and body through doing* – seems to be the synthesis of *cognitive, physical and affective* is most important in the findings. Also affective are influencing factors or feelings that refer to the representation of value, in particular positive values (but also negative values), which include preferences, attitudes, dispositions, and emotions and moods (Clore, Wyer, Dienes, Gasper, Gohm & Isbell, 2009:31). Doing physical activity in agriculture causes sweat. The feeling of sweat (inherent in doing strenuous physical activity) appears to bind cognitive processes with the emotional and therefore seems to be an affective aspect for learners' transformation. By entering into physical labour, students feel like farmers, and thereby try to think/talk and act/practice like farmers.

The findings indicated that physical labour in the practical activity is affective in creating feelings like a real farmer and to internalise thinking. Sweating, due to physical action coupled with consequent convincing evidence (yields and money), plays a part. This phenomenal feeling acts like a glue or connector that both excites and affects cognitive thinking and emotional feelings. It engages learners, thereby making them responsible for their own learning, which in turn, creates space for thoughtful learning, encourages long retention of processes and conceptual understanding on the one hand, and at the same time on the other hand, fires their enthusiasms and motivates them to overcome challenges/barriers of hardship (a moral kind of perseverance), and subsequently to foresee consequences and success at the end. Specifically, it influences both the conceptual and ontological transformation characterisation of affects. Metacognitive feelings (the connection of thinking and feeling like farmers in the students here) as reflected in confidence, satisfaction and motivation emanated from the doing experiences, is such an important part of students' understanding and the transformation associated with emotion and self-concept, argued Efklides (2006:50). This forms, what she called, an 'online awareness', as a person performing a task and monitoring the outcomes of the cognitive processing of the brain. Assuming this in agriculture learning, the interaction between actions and consequences of doing something has allowed students to know that they are doing the right thing and get feedback when things grow successfully. This appears to invoke provision for integrative understanding as sequential feedback between consequences and their actions of how they tended their plants/crops led towards the overall affective feelings and dispositions that thereby resulted.

In an analogous way, the whole transformed learner creation seems similar to baking. Sweat emanating from doing physical activity/farming has almost a similar effect to the heat of an oven. After mixing the various ingredients, it is impossible to get them back to their original form due to the irreversibility of the integration processes causing the outcome to taste/look different from before. Transformation in Meyer and Land's theoretical threshold concept (2003) is also an irreversible process. My metaphor and the students in this case study had experienced similar episodes with physical activities, or the sweat had brought a phenomenal effect that invoked their conscience and feelings in order to cause transformational shifts in identity. They were indeed stimulated in the process of becoming farmers or agriculturists by the sweat, where there occurred transformation of thought and identity via combination of these three aspects: cognitive, physical and affective.

This could be a very important point about identity, as a secondary emergent finding from this research. Although, initially, identity formation was not the objective of this study, it emerges as a key issue finding in the end. Agricultural threshold concepts are more about identity (perhaps due to its strong relevance to life) and most research has focussed on thinking like someone of X, and little has been realised about the inner feelings of a farmer, although the two – thinking and feeling as in metacognitive feelings – are connected. Perhaps physical labour allows the students to see themselves and tell stories about their work (as illustrated from their talk in the interview data), which is very important in identity. And identity in the context of agriculture is beginning to see oneself as a farmer – somebody who grows food and can be productive, and even be a commercial farmer.

9.7 Discussions and General Deduction

Eventually, the phenomenal feelings derived from practical learning experiences seemed to be the major factors and were the key determinant for the transformation of learners' identity. Feelings (inside the *heart*) and not just by practical experience (emoted by the participated experience) play an important role in learning or identity formation in agriculture. 'Learning is an emotional as well as a cognitive experience and mastering threshold concepts may be messy/iterative processes', stressed Cousin (cited in King, 2006:2). Phenomenal feelings of farmers are thus very important in integrating, transforming and shaping learners' thinking and their aspirations towards their future pursuit as an agriculturist. 'Mastery of a threshold concept', argued Meyer and Land (2003), 'produces an ontological shift in the learner'. 'New understandings are assimilated into the learner's biography, becoming part of what he knows, who he is and how he feels' (Cousin, 2006c:135). And these feelings have been brought about by experiences from practical activities and the provision of context, especially the physical labour that they went through.

This features some involvement of identity formation associated with emotional feelings and experiences, along with cognition. Using almost similar thinking, but not quite the same, Sennett (2008b:9) argued there is 'the intimate connection between head and hand', mind and body, being and doing, and theorising ('what goes on in the mind') and practising ('what goes on in the body'). The same goes for Meyer and Land's (2003) conceptual and ontological shift aside the duality of thinking and practising in Davies (2006), and in Sfard's (1998) mixed metaphors (acquisition and participation: stressing both on having knowledge and doing, and the danger of choosing just one).

Most learning metaphors and theoretical frameworks emphasise either more on the mind (thinking like) or hands-on (acting like), or both, but less so on the *heart* or emotional feelings. Little was mentioned about *inner feelings* from the metacognitive perspective – feeling like a farmer (indicated in this study) – where grasping agriculture involves psychomotor skills and cherished learning outcomes, along with conceptual understanding. It seems there is a bit of additional perspective to agriculture understanding apart from what has been discussed – emotion is strongly connected to the cognitive system and identity. To be precise, *emotional feeling is strongly associated with identity* to become an agriculturist; this relationship is responsible for the highest level of integration. Damasio (2003:260) clarified this connection of 'the ability to experience emotional feelings and to sense the body' as being attributed to their same locations in the right side of the brain.

Thus, agriculture students' feelings derived from yields, money generated and profit have all indicated meanings and became significant life experiences for them which linked to future career aspirations. The significant evidences they saw in their learning were not just due to chance but from *their very own sweat,* which made them feel useful, capable, and confident individuals. Their feelings and the physical virtues (and values) of agriculture they saw that was perhaps evidence-based (concrete visualisation of learning outcome) thus had convinced/satisfied the learners. These created some sort of enthusiasm that *elevates their status* from students to farmers (and perhaps from labour to enterprise), which invokes further development of thinking, future aspirations and ambitions, which in turn provides feedback/challenge on their procedural performance (physical labour) to activate harder work, and in some, an addiction to become agriculturists.

The importance of the presence of emotional aspects in agricultural knowledge construction in the past could have potentially been overlooked. Previous research has also shown that 'emotions are involved, and even have a key role in the process of identity change, which are strongly rooted in the individual experiences...' (Geijsel and Meijers, 2005:424). This stance seems in agreement to agricultural transformed learning towards identity at this secondary level of education where students began to see environment relationships and connections in a wider context. 'In today's labour market, doing good work is no guarantee of good fortune' (Sennett, 2008a) suggesting that relying on hands-on alone will not do justice to real world pursuit.

Thus provision for experiential learning is central in agriculture for full understanding of its systems, more like Sennett's apprenticeship learning and is also closely related to John Dewey's (1936) pragmatism philosophy where 'experience is central to education'. The significance of practicality in learning has also been emphasised by Pring (2012:160, emphasis added) who argued that 'there is the gradual demise of practical subjects in secondary schools when successful *doing* is replaced by successful *writing* about doing'. Moreover, Dewey (1936:51) believed 'an ounce of experience is better than a ton of theory because it is only in experience that any theory has vital and verifiable significance'.

So we should never underestimate the importance of practical experience and doing, the absence of which could lead to irrelevant learning or 'inert' or non-functional knowledge (a form of troublesome knowledge, Perkins, 1999, 2006a:33) where students could not see the connections/applications of learning to worldly experience. 'Learners couldn't construct their learning if they don't see the relevance of their learning' (Biggs & Collis, 1991). Having practical experiences or activities gives the advantage of being able to apply the knowledge in the form that not only students could see the meaning and relevance of learning but also enthusiastically *motivate* them to succeed and have identity connection. There is 'connection of identity and application' in learning transformation (Osmond & Turner, 2010). Pring (2012:161), who advocates *education for all* also emphasises on practical learning in real contexts:

> Motivation lies in *successful creation* rather than as a means to some further end such as qualification. There is the growth of theoretical understanding – you can't get far in growing your own vegetables without a basic understanding of different kinds of soil or of the right conditions for the germination of seeds. But this growing understanding is learnt within a *context*, the *experience* of which gives the more theoretical concepts *meaning* (emphasis added).

This signifies the importance of practical activity or skills in the *context of learning*, and more so for agriculture. Practical learning is seen to open up understanding and ways of knowing. Thus *contextual-practical-experiential* learning is vital for actual transformation of knowledge in agricultural learning as this study has indicated which pedagogy cannot be overlooked if it is to be effective in transforming learners.

This study however, cannot compare with any other studies since not many studies investigating agricultural threshold concepts exist, except the one by Nguyen (2012) regarding extension workers, which indicated 'care' on the environment among the threshold concepts. Nonetheless, the significance of experiences in agricultural threshold concepts is comparable to health care. Clouder (2005) emphasised direct physical contact and emotional experience with patients. Her study also proposed ‘caring’ as the threshold concept like in Nguyen’s study. Similarly, Kneebone (2009:954) in surgery and health care, has also argued, ‘procedural skills should not be divorced from their clinical context and that oversimplification of a complex process can interfere with deep understanding’. This close resemblance of giving importance to the learning experience indicated that some forms of learning in agriculture and health care training must be done within social/real context participation to be effective.

Thus, we can see that learning in context through experience enthuses us to call for a reflection on the broader aims of education (as also agreed by Pring before), and requires careful thought about pedagogic input and learning outcomes, and the matching of these two. Most political focus on education goals favours learning outcomes, but equally, most importance is in the learning process. Similarly, the teaching and learning researchers at the UK Economic and Social Research Council (ESRC) had also the same concerns. They were puzzled and realised about ‘bigger learning outcomes’ although they couldn’t quite pin this down yet (see James & Brown, 2005). They found that teaching and learning across different sectors (such as schools, further education, and higher education) are mostly dominated by an acquisition metaphor (AM) and less so by a participation metaphor (PM), although they recognised PM seems more likely to cause identity formation. They reported Sfard’s PM complex learning theory in doing and in identity formation and the gradual acceptance to become members of a certain community were caught between *cognitive and situated learning* and between *individual and social* (p. 17). Specifically, they observed that:

> The AM was associated especially strongly with attainments and *cognitive* outcomes, i.e. learning outcome categories of attainment, *understanding/ideas/concepts*, cognitive/creative, higher-order learning.
>
> The PM was more strongly associated with *attitudinal* and *behavioural* outcomes, i.e. *using/practice/behaviours/manipulation*, dispositions/*attitudes*/perceptions /*motivation*, *membership*/inclusion/*self-worth* (emphasis added).

However, they all agreed that bigger learning outcomes should be emphasised from the perspective of ‘discourse, activity, interaction and becoming an integral part of the community’ (James & Brown, 2005:13). Their findings were also consistent with my study. Most of the associated feelings in becoming farmers and most of transformational effects seen in the students of this study seemed to be characterised and aligned along the thinking of PM. That is, the practical activity in a real setting/environment, physical labour in the learning experience, that consolidated cognitive thinking and meaning, which then prepared and ushered students onto the pathway of agriculturists. Nevertheless, this could direct us to quality in agriculture, and hence relevance as I argued of the importance of purpose of education in agriculture and the dichotomy that needed to be ensued, although inextricably linked.

To sum up, there is a strong connection between feelings and identity which practical experiences help to bring about, particularly the practical experiences that are provided from positive physical context. Feelings (hard work, sweat, enjoyment, fun, meaningful value) embedded in the real contextual experiences invoke identity transformation. In the words of Geijsel and Meijers (2005:425), the identities of the learners are very much attached to the way they understood meaningful activities they participated in, through 'sense-making' and 'meaning-giving'. Students of agriculture could learn something that made sense and in which they could see the application straight away. Within the purview of agriculture education, this could be posited in terms of identity formation which comes from the combination of *deeper understanding of meanings* (cognitive-manipulative-affective) *with a sense of purpose* (individualistic, communities, and social perspectives) *and the self,* which tend to *centralise around the experience and skills*. This appears to be the suggested philosophical framework/utility for quality and relevancy in this particular disciplinary area.

My anticipation for using the threshold concept framework as an analytical lens in this study that has allowed me to identify quality learners' transformation is exciting. Learning in context fosters positive identity formation due to the closeness of the feelings relationship with practical experiences. Students indicated positive dispositions from their participation to the experience/activities acquired. This gives rise to quality in that more learners would aspire to become agriculturists, who in turn, will advantage society and the economy. This coincidence has been echoed in the ESRC's TLRP which stated that education learning outcomes as 'both the acquisition of skill, understanding, knowledge and qualifications and the development of attitudes, values and identities are relevant to a learning society' (James & Brown, 2005:8; http://www.tlrp.org/aims/index.html). This indicates that with transformational learning, there are increasingly more realisations in research for the bigger learning outcomes with the acquired knowledge individuals possess to become a functional member of community within their respective disciplines and field.

Chapter 10

AGRICULTURE TEACHER CASES

This chapter aims to present the data, results of analyses and discuss findings from the agriculture teacher cases obtained from the survey questionnaires (n=14) and the interviews (n=2) gathered during the year 2009. It also aims to triangulate the findings with the students' findings to arrive at a new understanding.

10.1 Results of Analysis from the Teachers' Questionnaire

Item 1 of the questionnaire (which agricultural concepts teachers thought useful for understanding) received 157 answers. These later were broadly categorised into 17 content areas (refer to Table 10.1). The results showed differing perceptions of important concepts, across wide and diverse areas, due to agriculture's broad content ranging from farming, business and technology, social and national economic perspectives. Some teachers had also over-emphasised certain areas focussing only one or two major areas such as soils, practical activities and animal production.

Table 10.1
Teachers' Perceived Five Most Important Concepts for Teaching Various Areas in Agriculture

Content areas in agriculture	No. of responses	Position	Combined areas
1. Farming and systems	8	3	
2. Farm management	2	8	
3. Farm machinery, tools and equipment	2	8	
4. Animal livestock production	10	2	Animal Production (13)
5. Poultry	2	8	
6. Fish and prawns (aquaculture)	1	9	
7. Crops and vegetables production	10	2	Plant Production (15)
8. Fruit trees growing	2	7	
9. Paddy planting	1	9	
10. Ornamental horticulture and landscaping	2	8	
11. Soils	12	1	
12. Food processing and industry	1	9	
13. Business entrepreneurship	6	4	
14. Technology – old and new	5	5	
15. Agriculture careers and employment	3	7	
16. Self-sufficiency	3	7	
17. Individual research project	4	6	
Total answers:	74		

Responses to Item 2 (of five most important concepts) yielded only 74 answers since they were limited to five nominations. Table 10.1 shows that soil has received the most number of responses on the perceived importance; animal livestock production and crops/vegetable production both were second; farming and its related systems third; and business entrepreneurship in fourth position. High responses on soil were due to teachers who nominated many soils concepts as important: soil composition, formation and properties including texture, fertility, nutrients, drainage, leaching and erosion – all needed to be understood by their students. Comparison of combined content areas between plant and animal productions showed that plant areas have a higher total response than animal production. This reveals that crop production persists over a wide area and, therefore, was evidence of strong dispersion and domination in the agriculture content areas.

Table 10.2
Looking at Content Areas at the Multicase Level

Content areas in agriculture	Teachers															
	Z	A	H	T	M	R	J	L	N	S	F	K	B	V	*f*	3+
1. Farming and systems		✓	✓		✓	✓	✓	✓				✓	✓		8	*
2. Farm management						✓						✓			2	
3. Farm machinery, tools and equipment	✓			✓											2	
4. Animals livestock production	✓			✓	✓					✓	✓	✓	✓	✓	8	*
5. Poultry											✓			✓	2	
6. Fish and prawns (aquaculture)														✓	1	
7. Crops and vegetables production	✓		✓	✓	✓					✓		✓	✓	✓	8	*
8. Fruit trees growing				✓							✓				2	
9. Paddy planting		✓													1	
10. Ornamental horticulture and landscaping	✓													✓	2	
11. Soil	✓			✓					✓	✓	✓	✓	✓		7	*
12. Food processing and industry		✓													1	
13. Business entrepreneurship		✓			✓	✓	✓	✓							5	*
14. Technology – old and new		✓				✓	✓	✓							4	*
15. Agriculture careers and employment					✓	✓	✓								3	*
16. Self-sufficiency		✓			✓			✓							3	*
17. Individual research project			✓												1	

Considering the multicase level results by measuring recurrence across cases in order to find the validity within the group and also checking the most nominated items under each content area, the analysis gave a different interpretation (refer to Appendix 10.1 for detailed analysis). Although soil was perceived highly, it was not the most important. Some teachers, due to perceptions of their relative importance, nominated certain concepts twice or more under the same content area. Although this was perfectly normal and acceptable, it distorted the results to reach at a different view. For example, Teacher S had nominated soil properties and soil fertility as his first and second choices of most important concepts, but this was considered as one count prevalence. Likewise, Teacher N had also nominated all her five most important concepts about soils. This shows polarised opinions at case by case level, however looking from the multicase perspective helps to reduce the imbalance.

Analysis of results at the multicase level for checking prevalent frequency (*f*) across the cases (considering prevalence of three or more) showed dominance in eight areas (marked with an asterisk in Table 10.2) where the first five most prominent were: (1) farming, (2) animal production, (3) crop production, (4) soils, and (5) business entrepreneurship. This shows that soils only came fourth after farming and the production of animals and crops. So, the potency of soil in becoming the most important or might be considered as the key concept for agriculture, is not validated from the point of this multicase view.

Further analysis looking at sub-ordinate items under each of these eight dominant content areas (see Table 10.3 below) led to the finding of the most potent concepts. On counting the recurrency (*f*), it showed that soil was not as potent. In fact, farming was the most potent concept followed by planting of crops/vegetables, soils and business entrepreneurship. This is an interesting finding as these areas in agriculture are usually the main core activities of agriculture, particularly farming. Livestock production was less recurrent and at par with technology, followed by agriculture employment and self-sufficiency.

Table 10.3
Looking at Each Item under Each Content Area at the Multicase Level with Three and Above Prevalence

Content areas in agriculture - concepts	Teachers														*f*	3+
	Z	A	H	T	M	R	J	L	N	S	F	K	B	V		
1. Farming and systems																
- Farming		✓	✓		✓	✓	✓	✓							6	*
4. Animals livestock production																
- Ruminants rearing and production	✓			✓						✓	✓				4	*
7. Crops and vegetables production																
- Planting/growing vegetables and crops	✓		✓	✓									✓	✓	5	*
11. Soil																
- Soil in general/properties/fertility	✓			✓					✓	✓		✓			5	*
13. Business entrepreneurship																
- Entrepreneurship and agribusiness		✓			✓	✓	✓	✓							5	*
14. Technology – old and new																
- Technology		✓				✓	✓	✓							4	*
15. Agriculture careers and employment																
- Employment and job opportunity					✓	✓	✓								3	*
16. Self-sufficiency																
- Self-sufficiency		✓			✓			✓							3	*

Clearly, this shows that there was a tendency in the teachers to connect agriculture pursuit to a much broader context in terms of business, personal living and the national economy. Technology is usually useful for helping other areas becoming efficient especially for crops and in soils cultivation. Whereas employment and self-sufficiency were indications that teachers were being more aware of agricultural broader objectives.

This also seems to show that teachers in their teaching of agriculture could not be segregated from these wider context inter-relationships of the country's economy, food security and sufficiency, to consider agriculture with such importance for their students.

10.2 Teachers' Ranking to Determine the Threshold Concept at the Multicase Level

The results in Table 10.2 above showed that there seemed to be a network of concepts that must be taught to students. The inter-relationships of these agricultural concepts of perceived importance in accordance to teachers' priorities were determined by their ranking using the five-point Likert scale (1 = most important, 5 = least important) on the selected five concepts (see survey, Appendix 4.1). This informed me the order of importance of the concepts according to their perspective and at the multicase level, to suggest concepts of significant priority and importance for teaching and inclusion in the curriculum.

But, how do we know exactly, what the teachers thought as the most highly regarded important concepts were possible to determine by looking individually at case by case concepts which they ranked as number one from the survey above. This strategy gave me so much information as to determine whether these concepts were considered as prime importance by teachers. Counting those concepts the teachers ranked mainly as first, yielded the following promising result.

Table 10.4
Result of First Ranked Concepts

Concepts ranked as the first most important by teachers	Number of teachers voted the concept as their first	Teachers
Planting/growing vegetables or crops	5	Z, H, T, B, V
Farming	4	H, M, R, J
Soil and soil properties	3	N, S, K
Self-sufficiency	2	A, L
Paddy growing	1	A
Plant propagation	1	F

Note that Teacher H had nominated interchangeably the vegetable growing and farming as her first and second choices. Similarly, Teacher A had also chosen self-sufficiency and paddy growing as her first choice. Analysis of the ranking scores and the results in Table 10.4 showed that the concepts which most voted as first rank were *planting or growing of vegetables or crops* with five teachers voted it as first, followed by farming with four teachers. Three teachers voted soil and soil properties as first, and two teachers voted self-sufficiency as first. This shows that soil is not as highly prioritised as *farming and planting or growing*, even though when the responses were first collected, soils seemed to prevail. Surprisingly, no cases had chosen animal livestock production as their first ranked concepts, but more of second ranked concept (see the breakdown in Table 10.5), which confirms that plants had overpowered animal areas. This suggests that animals in agriculture are not considered to have as much priority in providing key understanding in learning compared to plants. Since the teachers judged these concepts as important, do they think that they are threshold concepts?

10.3 Reasons behind the Teachers' Ranking

Exactly what were the teachers' thought and rationales when choosing the concepts according to their perceived priorities? This section presents the collective reasons/findings behind their choices. Table 10.5 summarised the breakdown of the rankings based on the most frequently voted concepts. Note that not all the teachers' rankings are included in this table if the chosen concepts were not prevailing at the multicase level. For example, Teacher Z also chose farm machinery, tools and equipment as his fourth rank, and horticulture and plant landscaping as his fifth, but these were not nominated by the majority of teachers, and therefore, not included in this summary table. Similarly for other teachers, their missing rankings meant that their choices were not among the voted majority.

Table 10.5

Summary Table of Teachers' Rankings on Their Selected Top Five Most Important Concepts Based on the Most Voted Concepts (Majority)

Concepts	Teachers' Ranking 1 (most important) → 5 (least important)													
	Z	A	H	T	M	R	J	L	N	S	F	K	B	V
Planting/growing crops	1		1	1									1	1
Farming		2	1		1	1	1	2						
- self-sufficiency		1			2			1						
Soil in general/properties/fertility	3			2					1	1	2	1	4	
Animal and livestock production	2			4						5	4			
Business entrepreneurship		5			3	3	4	3						
Technology		3				4	2	4						
Career and employment					4	5	3							

Why planting/growing vegetables or crops or plants?

Five teachers (Z, H, T, B & V) chose planting or growing crops as their top most important concept. Teacher Z chose plant production as his number one most important concept as he mentioned that 'plants is the main source of food for man and animals as without plants there would be no feed for the livestock, and plants are also considered the lungs of the world that provide oxygen to all living things on this planet'. This seems like an interesting contrast between choice based on sense of natural or scientific primacy compared to importance due to teaching and learning considerations. Teacher H gave her reflection that the vegetable growing project in her former course had provided her with first understanding of agriculture. Likewise, Teacher T also agreed that growing vegetables could teach all the necessary techniques in planting.

Besides that, crop growing in vegetables including fruits and rice, helped understanding of the economic needs of the country by reducing the amount of importations on these commodities, expressed Teacher V. Specifically, planting is 'the basic rules for understanding agriculture. It gives a general idea what agriculture is and how agriculture is carried out. Therefore, planting is important', stressed Teacher B. All these rationales seemed to show that the teachers' perceptions can be summarised broadly into three main factors: (1) plants are primary food providers, (2) planting and crop production is the essence of agriculture, (3) and they provide understanding through their activities and economic importance.

Why farming?

The second most important concept chosen by teachers was farming. Six teachers voted for farming where four of them (Teachers H, M, R & J) ranked it as first and two as second (Teachers A & L). Although the votes were considered a bit less than planting/growing, its prominence nevertheless is still considered strong. Similar to planting which was considered as the *basic unit* of agricultural knowledge that must be known, farming was viewed as the basic agriculture unit as it provides the *overall* understanding of agriculture as a whole according to teachers. They said farming explained the whole (Teachers A & L) and was the major activity in agriculture (Teacher R). It provided the overall concepts of agriculture by relating to its technology, business entrepreneurship and industry (Teacher L). Clearly, there was an emphasis on relating farming to its real context and the view of practising it. Teacher M wrote that 'farming involves teaching practical activities (e.g. vegetable growing) which can make the students realise the importance of agriculture'.

In relation to practical activities like in Teacher M and also with regards to self-sufficiency, Teacher R opined that 'farming involves all sorts of farming activities, but most importantly paddy growing as it is our staple food and Brunei's target towards self-sufficiency'. This seems like the reasons for farming importance were inter-connected to paddy growing and other areas. Teacher J expressed that 'farming produces the staple food in agriculture, enables one to be self-sufficient and reduce the importation of agricultural products. Farming includes production of food, basically the everyday necessities'. Teacher L believed that 'students need to understand well the overall concepts of agriculture – farming activities and industries involved. All agricultural activities need to be self-sufficient to the nation, using developed technology and industry. Farming explains a whole activity in agriculture and the production from all farming activities can be involved in a business activity'. From these evidences, farming was the choice as it is shown it broadly encompasses aspects of all agricultural activities.

This brings on the matter of *self-sufficiency* in farming especially in paddy growing – teachers tended to associate both together. Teachers L and A had chosen self-sufficiency as their top most important concept. Teacher A thought that self-sufficiency is an important concept as it is 'not only for individual needs but also for the country's benefit'. She added, 'self-sufficiency is first ranked because it is very important that students should have the mindset of agriculture being able to produce a large amount of self-reliability in production of a certain commodity, for example rice'. As for Teacher L, he claimed that 'self-sufficiency is very important for food security for the nation. Students need to know that the country needs to be self-sufficient in producing crops and livestock production'. These evidences showed that the teachers were thinking at a commercial level via large scale production for national food security and self-sufficiency. Given that most of the country's food is imported, Teacher M who ranked self-sufficiency second, summarised her opinion: 'food production for the population – self-sufficiency, the importance of the country's food security'. These reasons at the national level context showed that farming importance rests upon its usefulness as a means of overcoming the lack of self-sufficiency in Brunei's economy, and hence were translated into their teachings.

Why soil?

The third most important concept across the teachers was soil, particularly Teachers K, N and S, who chose it as their first ranked concept. Soil was the most frequently nominated concept with the recurrence of seven teachers, but fell short of being first ranked (only three) compared to planting (five) and farming (four). Teacher N particularly had the affinity to choose soil as the most important concept where her five foremost concepts were all came from soil. She chose soil as her first priority stressing that, it is 'the basic foundational knowledge before students can successfully carry out any type of planting such as in vegetable growing'. This showed that she knew the importance of planting but regarded soil as more important as a seminal foundation. She mentioned that students should be able to distinguish the different particles of soil nutrient contents, know proper drainage to avoid water-logging and leaching to erosion-prone soil we have in Brunei. This meant that she stressed the soil importance as having the *basic knowledge* in order to help students with growing of plants, contrasting in Teacher S who said something about its troublesomeness. Teacher S argued that 'soil is always the hardest topic in agriculture compared to others like rearing animals or planting crops'. These latter evidences from Teacher N and S seemed to deduce that soil appeared to have basic/foundation knowledge but also was more troublesome than integrative in terms of the threshold concepts framework.

Five other teachers (Teachers Z, T, K, F & B) also mentioned about soil as the inter-dependence of crop growing. They stated soil properties and conditions, in relation to its types, pH, permeability and porosity (Teacher B), affect crop production which would affect others such as the feed for the animals that grew on it (Teacher Z), and were linked to plant physiology and nutrients, farm management and farming systems (Teacher K). These evidences showed that knowing about soil would affect knowledge in other areas and its inter-relationships. Teacher F stressed that 'soil composition and formation is the basic knowledge which students must acquire before planting'. This showed that knowledge about soil must be taught first before planting. In similar tone, Teacher T opined that 'studying soil makes students understand more how plants grow well and vice-versa'. All these evidences seemed to point out that knowledge about soil conditions is important as it could affect subsequent plant growth, yields and production, and therefore, must be taught prior to planting. This confirms that soil is the basic concept and not a key concept for transformation.

The rest of the section now deals with other concepts, which although not as strongly potent as the previous three mentioned above (since no teachers ranked these as their first), could also be perceived as no less important and could help support understanding of the above three.

Why animals or livestock production?

Four teachers nominated animals and livestock production as having importance. Teacher Z explained in relation to livestock production that 'livestock is the most important source of protein for humans'. Two other teachers, Teachers T and S, were also in agreement of the importance of livestock and rearing farm animals. The importance of teaching livestock rearing in school according to Teacher F was that it is one of the most basic concepts that students must know, if understood, would ‘help motivate students to learn more agriculture’.

Why business entrepreneurship?

Although no teachers had ranked business entrepreneurship as their first, this was prominent across five teachers. Three teachers ranked it as third, and one fourth and one teacher (Teacher L) ranked it as third and fifth. Nearly all of these teachers thought that agriculture should be treated as a business for economic diversification of the country and in creating jobs, employment and business opportunities (Teacher M, R and J). With agriculture nowadays, students should be taught and ‘equipped with knowledge on business transactions and entrepreneurship ability’ according to Teacher J. By ‘teaching business-related topics, it is not only farming but also how to become a successful business person’ stressed Teacher A. These findings revealed agriculture should not be taught by way of farming and production only, but to produce bigger learning outcomes such as to be successful in business and entrepreneurship so as to sustain commercial industry and activities.

These teachers’ views showed that they were aware of the current economic situation where the circumstances agriculture faced in the global market were good. However, these views may seem high for their students’ level of thinking if they were to teach these first-hands to their students at the beginning of the course, and may not be appropriate as some may not have reached this stage yet. Although this is in the periphery, but within the boundary of the discipline, there is a danger of teaching tending to pitch highly within the subject, disregarding lower thinking of novice learners during the teaching process.

Why technology?

Four teachers voted technology as among their top most important concepts to be taught to students. Their main reasons for the technology requirement were mainly attributed to the need of efficiency in agricultural production: faster, more quantity, high quality, and profitable within a shorter period of time. There was consensus (Teachers A, R & J) for the need to inform students about new and up-to-date technology on top of the already known existing ones (such as tissue culture, hydroponics) to alleviate students’ traditional farming perceptions. Teacher A stressed ‘teaching these technologies, students will have in mind that agriculture is not just about old-style [traditional] farming'. Teacher R believed that by teaching up-to-date knowledge on the available technologies could make agriculture more profitable, especially if it involves faster production. This could also involve modern farming such as using machineries to develop high quality products, expressed Teacher L. 'Having new and advance technologies in agriculture helps to produce more and efficient production', argued Teacher J. It seemed that all these arguments put forth by teachers insisted their importance, so students would feel motivated about agriculture, especially for elevating their perceptions towards modern farming.

Why employment and job opportunity?

This concept was considered no less important than business entrepreneurship and technology. Teachers M, R and J, were also the teachers that have chosen business entrepreneurship before, and also farming. They seemed to have similar thinking that farming, business, careers and employment opportunities are all linked up. They viewed that agricultural learning should inform students of future careers and employment, and the vast potentials therein, to further motivate students in learning. Teacher M viewed that agriculture could create job opportunities related to science and everyday life to help the economy. Teachers R and J stressed that students should know and must have an idea of the various employment opportunities in agriculture and the possibility to venture into business and entrepreneurship, and self-employment. This reveals that teachers held the agricultural perceptions of importance in terms of extrinsic factors such as its economic potentials rather than immediate emphasis for the need on learners' understanding. Although these economic aspects are important ways of valuing agriculture that could affect students' thinking in the broader context, and that may present in a web of interlocking concepts, they do not give emphasis of how students could get there. By right, it should be through understanding first and then only by inter-relationships to broader contexts.

10.4 Findings from the Interviews

From the survey questionnaire responses, two teachers (Teachers A & H) were selected, and subsequently interviewed based on how vividly they described their survey responses. Analysis of their transcribed data provided rich evidence of their students' learning and how they perceived their phenomenal understanding. Interviews were held at their respective institutions. However, Teacher H was interviewed twice due to technical error thinking that her first interview was unrecorded. While transcribing the data, I found her first interview was accidently bundled together with Teacher A's folder. Hence, Teacher H's interview was much longer in length (a total of more than two hours) and brought much richness to the data compared to Teacher A of only half an hour interview. Detail analyses of their interview data and full interpretations can be found in Appendix 10.

10.4.1 Summary findings from Teacher A

The findings from Teacher A revealed that although she chose self-sufficiency (on paddy) in her previous questionnaire responses as her top priority concept to be taught to students, her interview findings revealed farming, especially vegetables, for allowing understanding in learning agriculture. It seemed that she viewed farming as a way to answer the call towards self-sufficiency. Her findings also suggested that to commence students' learning, the practicality of knowing how to do, and recognise, the various aspects and techniques in farming, especially in vegetable growing, was very important to gain a good grip on agriculture.

To her, farming, especially vegetables, provided students with a good overall understanding of agriculture. She expressed, 'vegetable farming gives the most understanding in learning agriculture' (Line 42). The reasons for this, she reflected, it has practicals where students can visualise their learning in real context – allowing them to know how things look like and how things are done. She observed her students' mood picked up when informed of upcoming activities. She said they get very interested and motivated (Line 25), and felt excited when learning something that they could visualise and felt when doing practicals. She also echoed that 'farming describes agriculture the most' (Line 39), especially vegetable growing. The reasons for this she said was that 'farming has practicals' (Line 28) where students can visualise (Line 5) their learning in real context thus allowing them to view things concretely.

Her interview data also depicted learning as more conducive when her students learnt in real environments where she saw positive reactions from them. They became excited, motivated and interested to participate. The practicals and learning in visual ways have enlightened learners and equally pleased her, as it is no longer necessary for students to feel bored, sleepy, and day-dream due to idleness from the lack of attentiveness in the classroom. Practical activities in farming helped the application of theory, reinforced knowledge in real contexts, and engaged her learners to stimulate thinking. Also, she mentioned vegetable farming possessing *motivational and satisfaction factors* from harvests, yields and sales, besides creating elements of team work among learners. At the same time, it also allows entrepreneurship skills to be incorporated which could be related to food processing and industry, she added. These had given students some broader pictures where they can do business in the future without having to rely on the government for future employment, she explained. The issue of support in the agriculture subject in schools seems to have been augmented since the nationwide campaign on rice self-sufficiency started. Seeing this priority perhaps is the reason why she responded that self-sufficiency was the top important concept in her questionnaire which points to economic needs rather than for teaching and learning.

10.4.2 Summary findings from Teacher H

For Teacher H, planting activities embedded in an individual project is the most enjoyable part of her students' learning. This is consistent with her previous responses about agricultural threshold concepts survey questionnaire. At the very start of her survey responses, she already determined the planting concept in the 'planning and applying knowledge within practical activities', and related its importance to the economic benefits of a country. It seemed that she had already identified planting as the key. Perhaps this was the reason why her responses to the questionnaire were so much different from the rest of the teachers. In thinking forward, she just focussed on planting as the key in the agriculture practical activities; and it seemed at the outset that she showed that she already knew which of the concepts were responsible for getting students enthusiatic and motivated, unlike in Teacher A, who only declared this upon interview probing.

In similar tones to her questionnaire responses, during and throughout in-depth interviewing, Teacher H kept coming back to this very same idea. Her interview analysis gave a picture of agriculture learning *as difficult but enjoyable due to planting or farming practical components in the practical activities*. From the beginning and throughout the interview, she reflected on the importance of *practicality as the trigger for students' motivation and enthusiasms in planting* activities. A larger chunk of her interview data stressed the values of practicality in enhancing learning and understanding.

Results of her interview analysis showed that students did not show much interest until the time they were about to do practical activities, especially planting in the farm or school garden. Teacher H observed that learners became more active and inquisitive once they started doing practical activities in the farm. She noticed the point when students started to get motivated and showed a lot of enthusiasm in the planting practicals. This boost in motivation similarly occurred in Teacher A's findings and was noted in the evidence from students, particularly Students 2C and 2F.

Teacher H admitted that she enjoyed and felt satisfied in her teaching if students were more enthusiastic, inquisitive (eager to know by asking lots of questions), and actively interacting with each other (making lots of discussions and negotiation with her and among their friends, Interview 2: Lines 182-186). To her, *practical activities are something of must-haves* in agriculture learning. Her dialogue showed compassion in her interaction with students, adhering closely to their empathy and exhibiting a display of enthusiasm and indication of deep satisfaction in her teaching experiences and students' interaction. She said agriculture is a *package* subject as it could help understanding of other subjects as well since there is overlapping of contents. 'It benefits other subjects as well, not just agriculture' (I1:98). 'In agriculture, it's encompassing... everything exists within this subject... It has geography, accounting, a bit of maths, in short, everything! Even a bit of chemistry as well, such as in photosynthesis' (I2:114-116). 'Because agriculture is a package subject' (I2:194), 'it is real' (living, can be seen, felt and eaten – I2:189), 'it's so complete' (I2:113), 'it has everything' (I2:113), 'everything is there in agriculture' (I2:106). When Teacher H mentioned 'everything in', she meant that 'most subjects can integrate with agriculture' (I2:110). She said in agriculture, students think like a real farmer and have confidence, besides also providing them with the living skills for self-reliance and in overcoming unemployment if, suppose, they could not get proper jobs in future.

10.5 What are the Concepts?

Soil received the highest number of responses from the teachers which seemed to put soil as the centre for basing their agriculture teachings. However, sifting and evaluating the results on various fronts gave spotlight to other areas of agriculture. Planting of crops was mostly nominated, even more than farming. Farming actually applies to both plants and animals; however, the teachers who have chosen it mentioned that it was related more to *plants* farming.

Planting based on the first ranking evaluation showed dominance. Five out of 14 teachers had planting or growing crops as their first rank, giving it the top most nominated concept, followed by farming in the second place with only four teachers voted it as first. This shows the teachers perceived the planting/growing of crops and farming as the most important concepts before soil. Planting is the unit of farming. Planting gives specific understanding, but farming provides an overall understanding of agriculture, according to some teachers.

Both Teacher A's and H's interview findings revealed practical activities in planting and farming as something students mostly enjoyed in learning and doing. Previous results across teachers in the survey questionnaire also revealed planting and farming as the most potent, with planting in vegetables as mostly voted by teachers. Planting is the 'basic rule of understanding agriculture and it gives general idea what agriculture is and how agriculture is carried out' (Teacher B). Planting is the basic concept whilst farming gives the overall understanding of agriculture (Teachers A & L). Both farming and planting could relate to other areas such as technology, business and entrepreneurship (Teacher L), and that farming could open up students' realisation to the importance of agriculture (Teacher M).

Planting activity is the most enjoyable to students (Teacher H) and this was parallel with the students' findings discussed in the previous chapters. Students 'enjoyed their plants' (Teacher H) when they engaged learning about planting, and got the pleasure from consuming their fresh harvests (taste better) and from generating money from sales, and also the satisfaction of seeing the results from yields and healthy plants growth. Teacher H emphasised 'planting in farming' as a way of providing agricultural understanding. Focus on planting in practical activities is the key to understanding. When asked about a critical episode whereby her students started getting motivated or gained enthusiasm for learning, Teacher H reflected, 'when it comes to planting' (I1:6) and 'especially if it coincides with planting time' (I1:12), similar to Student 2F's findings. She observed her students would become very excited (I1:8 & 43), enthusiastic (I1:7), anxious (I1:7), extremely eager (I1:7 & 8) and even liked it (I1:13) and 'really enjoyed their plants' (I1:15 & 43). These showed how planting experiences are the most phenomenal to students.

A similar experience was also felt by Teacher A where students got elated when mentioned was made about doing practicals (Line 9). Students' mood changed, they got very interested (Line 25), but also became very upset if the practical was suddenly cancelled due to bad weather outside (Line 17). Likewise, Teacher H's students would get bored (I1:10 & 11) if lessons would just be on theory and they 'wished it soon to be over so that they could go out to their garden' (I1:44) as soon as possible.

This seems that there is something about agricultural planting and the practical activities which cause the students to get infatuated. In terms of the threshold concepts framework this suggests that planting is transformative since it *continuously engages learners*. It seems that the students appeared to have found a way or ability to relate and fortify their theoretical/cognitive thinking with their emotional experiences through the practicals in the planting activities. In sum, the key concepts garnered from teachers depicted *planting in farming, particularly vegetable planting,* could give meaning connection, allowed learning to take place via concrete and hands-on through practicality, and could be integrated by the selling of yields from harvest i.e. business. All these seem to come from the critical episodes both in cognitive and emotional feelings culminated in the learners. This is in agreement with the students who also found planting phenomenal and enjoyable.

Judging the results from all aspects of the analyses, both from the teachers' and students' data, it reveals that planting or farming in crop production, especially vegetable growing, seemed to assume the role of a super-ordinate theme and, therefore, a threshold concept. It also showed the ability to connect and internalise inter-relationships between bodies of concepts integratively, within and also across them, to form a web of concepts arising from planting to farming and progressively lead to its wider context in a web-like manner.

10.6 How are the Concepts Related?

Planting and farming in vegetable growing are related concepts in crops, so is self-sufficiency especially in paddy production. Soil is also related and must be known before planting activities could take place. Other concepts from the findings include animal livestock production, business entrepreneurship, technology, food processing and industry, and agricultural employment and job opportunities.

Teacher A viewed entrepreneurship as related to business and emphasised more on selling and marketing as being useful for giving ideas for future employment. She chose entrepreneurship, food processing and industry in her previous questionnaire responses because she regarded self-employment and doing business as important, so students would not need to depend on the government for future employment (Lines 95-99). She also viewed processing of agricultural foods needed to be taught to students as this is related to the agricultural industry (Lines 101-101). She viewed agriculture as a means of self-employment and could develop future potential for business.

All these concepts could be integrated by planting and farming. Planting in farming is considered as the starting point for meaning in students' understanding of agriculture. Teacher A believed plant structure and function could give insight to planting and feel towards the understanding of agriculture (survey responses). This finding is in agreement with the students' finding, where planting and plant science were both viewed as usefully connected for progression in the first stage before the second stage (business entrepreneurship). The evidence showed that farming with the embedded planting concept or growing, plus other knowledge, could complement an overall understanding of agriculture.

10.6.1Webs of concepts

Teachers' ideas of agriculture were driven by aspects of national economies such as self-sufficiency, industry, enterprise and business. They were being influenced by local economies that operate at the national level. Evidence of their reasoning behind the ranking showed that the teachers gave importance to the connection of ideas within and across agriculture disciplines, and its perceived wider importance as forming a web.

There was a tendency where self-sufficiency and technology were also ranked highly showing that teachers have placed their importance and inter-relationship on the wider contexts of agriculture. The data showed that they tried to incorporate technology, employment, and business entrepreneurship connections to agriculture, to alleviate the traditional farming and to motivate students on the potential of agricultural careers. This means that although the teaching and learning of agriculture were happening on a small scale classroom level, their perspectives of viewing were actually beyond the classroom and holistically from the context of the economy. These views seemed also to have been transmitted to their students, in order to stress its value socially and economically, in particular, its connection to careers and employment, and also self-sufficiency. This evidence was seen in Teacher A and Teacher L, who emphasised self-sufficiency, entrepreneurship, technology and processing in the agricultural industry alongside farming. They argued that these inter-relationships and connections were necessary so that students would appreciate their learning and understand agriculture as a whole.

10.6.2 Sowing, planting, growing, farming, farm management, business enterprising

There seems a sequel of inter-connecting concepts that build ideas from sowing, planting, growing, farming, enterprising, and agri-business (all tending to centralise around crop production) that could be linked by planting which suggests that it might be the key or a model threshold concept. Although, soil is fundamental for sowing and to teach at the start, Teacher H recalled and wrote in her questionnaire responses, that she began to understand agriculture when she first started sowing pumpkin seeds during her previous diploma course. She said, ‘in my former experience, I understood agriculture when I first did a sowing practical on pumpkin seeds in my first year after land preparation, and maintenance of pumpkins until the end of the project where we harvested the yields and make a project report’. This finding is congruent to the findings in Student 2C in the previous chapter.

But what are the differences between these concepts? Planting implies plants, but growing is not similar to planting. Growing, besides it applies to plants, could also include animals, such as growing chicks into chickens or in rearing of livestock animals or fish and prawns. Farming on the other hand is quite generic, it implies all that is related to plants/crops and animals production, and therefore, applies to both production areas. Farming necessitates knowledge of farm management in order to manage and run a farm successfully, and therefore, has connections to others as in the overall agriculture, forming webs of all concepts. Farming and agri-business involves production of crops (and animals) and marketing and selling, which necessitates good farm management to complete an overall idea of farming. The display of a network of these inter-connected concepts is what the teachers think as constituting agricultural understanding and successful learning.

10.7 Key to Learning Progression and Troublesomeness

Most of the findings are in agreement across teachers and with the students’ ideas. The students’ findings in this study suggested that crop production (including planting and plant science) and entrepreneurship and business are key for learning progression to become agriculturists. Teachers also saw planting and farming in vegetable growing as a contributing key for overall understanding, while also being related to self-sufficiency, entrepreneurship, business, technology and industry in the wider context. There is a need to make a progression from primary production to business and entrepreneurship. Both the students and teachers realised this in their evidences where concepts that were also needed for progression in students also surfaced in the teachers’ data, namely:

planting, farming, business, and enterprise.

Specific evidence from Teacher H's data emphasised planting as the concept for the immediate need of teaching and learning of agriculture. Meanwhile Teacher A's data emphasised farming and the need to progress to the next stage: self-sufficiency, entrepreneurship, technology. Meanwhile, business and entrepreneurship, management and research, have also been among the troublesome concepts from the students' data. These concepts are inclusive parts of business in the agricultural industry, and also constitute a web. This idea and the needs for progression were similar evidence across the teachers where farming and the farming system, as well as planting, were nominated highly in their survey questionnaire. These findings seem to confirm that planting is the threshold concept at this lower level, before farming at a higher level.

Other concepts such as plant science, business, and soil, were hampering progression (troublesome) for students. Teachers also agreed soils is always the hardest topic (Teachers N & S) since it affects planting and plant growth, and must be known before planting. Teachers, similarly the students, found difficulty in soil concepts due to its abstractness, complex language and terminologies. Teacher S indicated the most important topics in soil are its physical properties and fertility, and to overcome the difficulty Teacher H suggested providing lab practicals, teach about basic soil at the earliest opportunity and avoid complicated ideas by reducing its scientific contents (chemical structure). As Teacher H argued:

> We should be careful not to put too difficult content at the start, just give the basics first, like the functions of soil, make it simple so as not to alienate students [Interview 1:Lines 81-82]. So we have to be cautious with which part of the soil topic to teach first so as not to intimidate (them) as this will have repercussion on their motivation [Interview 1: Lines 83-85].

The soil chemical properties in the curriculum had troubled the students visualising the abstract concepts as they could not see them in real applications. Soil was persistent across all data (students' and teachers') and the majority of teachers' nominating soil frequently showed that teachers were concerned teaching about soil. They worked very hard trying to make their students understand about it (see Teacher H data).

One of the reasons could be that the soil unit in their curriculum is the smallest despite its heavy scientific contents (see document analysis). This calls for curriculum reduction so as to focus on the necessary, reserving the more scientific for future studies. The contents and time allocation for teaching soil concepts perhaps also needs reconsideration to allow proper understanding. Its potential troublesomeness and integrativeness means that soil is a threshold concept but not necessarily phenomenal and transformative enablers since it is only seminal for planting and must be known before planting.

The evidence revealed that teachers have had a hard time teaching the threshold concepts, and it was possible that students could get troublesome also due to this. Should the content be reduced to facilitate students' understanding? Or, should the curriculum content on soil be modified in order to give direct and relevant application to their learning and understanding rather than for scientific theory? Or is it a matter of teaching sequence which one first, second and so forth? Again, it must be remembered that quantity does not equal quality of learning and thinking.

10.8 Do the Teachers' Views and Practices Parallel the Emerging Ideas about These Key Concepts (and How do They Relate to Threshold Concept)?

The majority of the teachers' thinking on the important concepts in the survey findings displayed a holistic view of economic inter-relationship contexts which may have influenced their teachings not for immediate learning and understanding. But their approaches to teaching in classrooms (evidenced from students' findings) seemed to show some thinking of knowledge acquisition as block by block as in the traditional teaching rather than the holistic approach to teaching. Could it be that they have been influenced by the linear curriculum document and followed this blindly? Or could it be that they don't know the threshold concepts in their subjects since the threshold concept is very difficult to identify? Do they move too quickly to higher conceptualisation of ideas?

Teachers' evidence seemed to suggest that some teachers were not able to identify students' key understanding and had underestimated which part of their teaching was really relevant for conceptual change. Their responses showed complicated concepts according to their own perceptions rather than of their students. This raises problems from a teaching perspective. 'It seems the irreversibility of a threshold definition makes it inconceivable for teachers to return to the way they previously viewed understanding a phenomenon they way they did before' (Davies 2006:74), and use this to help their current students' learning. Part of teachers' inability to identify the threshold caused them to teach in a manner like an overloaded curriculum, where everything seems to be important and is just left to the students to weigh out their relevancies.

We would suspect teachers may teach complicated, too factual, wordy, abstract concepts without focussing on the most important, essential building blocks of agricultural knowledge, or did not quite relate to the real context of the subject causing the learning to be difficult. They may also seem have underestimated the gap between their knowledge and that of their students' novice learning by proposing quite high concepts before that of the key ones. This is even made worse with the existing terminology and 'language difficulty' (as echoed by Teacher A), especially that English is a foreign language to students.

These findings led me to the following insights:
1. Teachers had a hard time identifying a threshold concept and were unaware of the threshold concepts in their discipline which might have determined the way they teach.
2. The teachers taught planting in their lessons but they did not realise its importance and connectiveness as key to agricultural understanding (therefore a threshold concept) in agricultural learning.
3. Teachers may think too high in their teaching objectives when in fact it should be to create learning transformation in understanding before leaping into bigger ideas (farming as a business).

The evidence revealed that not all the teachers know the existence of key concepts in agricultural learning. They may not have the idea of the notion of a threshold concept as transforming understanding. The notion of threshold concepts in agriculture is new, as no research has been done before. Teacher A rated self-sufficiency as her top concept for economic purposes and not for the immediate needs of teaching and learning, although she knew farming gives the most understanding and gave it second rank. There is a conflict of what they wanted students to learn with their own priori concepts. Only five out of 14 teachers ranked planting as first, and six (including first and second rank) teachers chose farming, whilst Teacher H alone chose both planting and farming as her first ranked concepts (refer to Table 10.5). It was the realisation of these key concepts that caused Teacher H to have a different view and approach towards her teaching. Not knowing a threshold concept in learning will cause problems in teaching. Indeed, this is where teachers seemed to be getting entangled (as seen in the survey evidences) – where the dichotomy of curricular contents (between novice and expert thinking) seemed unclear to them – whether to pursue teaching for understanding agricultural concepts first or from the economic perspective point of view.

Teachers' evidences have shown broader conceptualisation of what is considered important threshold concepts within the discipline and reflected their perceived importance of the subject to society, economy, future careers, and livelihood. 'What is perceived as most important will always come first, and given this, relevance immediately becomes an item of great importance to learning outcomes for some given concept or material' (LeBard, Thompson, Micolich & Quinnell, 2009:76). This could impose implications in instruction when teachers' expert thinking may not align with their novice students due to the teachers' difficulty in reverting to novice stages.

I found more than a third of the teachers showed hasty development of ideas from their survey responses. They moved too quickly to higher conceptualisation by considering broader areas of agriculture as of greater importance than the basic experience in planting, for example, prioritising new technology and industrial processing. This causes problems as they tend to forget learners are still at novice thinking stages, where they are still struggling to capture the basics in trying to overcome the initial thresholds. 'It is difficult for teachers, experienced and expert within the discipline, who long since have travelled similar ground in their disciplinary excursions, to gaze backwards across thresholds and understand the conceptual difficulty or obstacles that a student is currently experiencing' (Land, Cousin, Meyer & Davies, 2006:199). So how would teachers reduce from a broader knowledge context to the immediate needs of learning in classroom?

The reciprocity of agricultural knowledge and its practices needs to be stressed well in learning and teaching, and these need to be mediated by practical activities and the provision of phenomenal experiences in learning. Succinctly, planting is the 'basic rule of understanding agriculture' (Teacher B) whilst farming gives the 'overall understanding of agriculture' (Teachers A & L). Planting is indeed the most phenomenal to students – which have caused some students to get smitten to agriculture, resulting them to think and act like farmers by growing more crops at home following their school experiences.

Planting in vegetable farming is the best for teaching agriculture due to *motivational and satisfaction factors,* as Teacher A mentioned. The money generated from the sale of harvested vegetables and yields becomes the motivating factor and satisfaction for students. Seeing their own work and effort made them happy and they felt rewarded

(Lines 48-50). The ‘business side of agriculture has actually injected some enthusiasm’ Teacher H asserted (I1:22). The yields and selling (business side) enhanced enthusiasm and sparked further impetus. The planting threshold concept at this lower level has an integrative property and most importantly a transformative effect that could progress to bigger learning outcomes – farming industry and business. It, through its planting practical activities, therefore has the power to transform learners.

10.9 Final Discussions

Teaching worldwide has been captured by an idea of linear learning and that there is a magic pathway where students take one step at a time in that learning based on understanding new small items of knowledge or skills – atomised learning. The threshold concept framework to teaching offers a holistic view to learning as opposed to learning in a discrete manner. Traditional teaching is where block by block views of knowledge are imparted. Teachers are hoping a magic wand will link up the cognitive process in the pathway that seems to encourage mimicry understanding, but where students fail to see the connections. The traditional teaching therefore, has squeezed out any idea of learning as jumpy and rooted in sudden transformation of thinking or ideas based on seminal experiences. Although threshold concepts are difficult to identify, and possibly only visible if we talk with students, once identified, could assist teachers and benefit students greatly.

There was also a question whether we could teach threshold concept understanding, because some students may have already reached there but some may still fail to make the connection. As the data revealed, planting may seem a simple idea and may take only a minute to mention or describe, but it may take days even perhaps months if not years (for those who could not quite surmount their thresholds/troublesomeness) to teach and understand. Teachers, therefore, need to ensure connections across these ideas take place successfully. Teachers could teach some of the foundation knowledge, but otherwise they need to watch students and perhaps nudge them when they are in the liminal stage and encourage experiences and talks (reflection) which synthesise cognitive, physical and affective, to ensure transformation and quality thinking. Kolb (1984, cited in Smith, 2010) had stressed the importance of reflection in his experiential learning theory to form those connections by stressing experiencing, reflection, generalising and applying ideas in students. This corresponds to Kolb’s view of learning style: ‘thinking, feeling, reflecting and acting’ (Kolb’s video on ‘what is experiential learning’, http://learningfromexperience.com). ‘Tell me, and I will forget. Show me, and

I may remember. Involve me, and I will understand' (Confucius, 450BC). Perhaps, teachers could adopt the Kolb's famous experiential learning cycle that involves: (1) concrete experience followed by, (2) observation and experience followed by, (3) forming abstract concepts followed by, (4) testing in a new situation (cited in Smith, 2010).

Chapter 11

CONCLUSIONS

This case study's topic was chosen to search for quality and relevancy in the learning of agriculture and its curriculum, in pursuit of Brunei's search for quality education. As stated earlier, it sought to discover which concepts are responsible for higher levels of understanding and progression, and how learners have arrived at these, via interviewing and survey questionnaire methods. Data findings from fieldwork have provided interesting insights and this final chapter aims to review these findings and propose the assertions that can be made from the analysis. This chapter concludes with considerations for course design and implications for practice and future research.

11.1 Lessons Learnt from this Research

What have I learnt from this research? In this final chapter, I will 'speak of the essence of this study and its inspiration in terms of the value of the knowledge and future directions in my professional-personal life' (Moustakas, 1994:184).

Usefulness of the threshold concept framework in enabling me understand the importance of planting

The beauty of the threshold concept framework, as I have discovered in this study, is that it helps to focus on the key concepts crucial to a deeper understanding and transformation. It therefore reduces overcrowding of curriculum content. It successfully led me to find that pearl in the ocean – planting – as seminal and phenomenological in agriculture learning, useful in advancing learning. This seems in agreement to Lipton et al. (1998:1, cited in Knobloch, 2008:530) who stated a broader context perspective: 'to understand the complexity of the food and fibre system, imagine *farming* as the centre of an interrelated web of industries spreading throughout the economy'. Transformed understanding at a lower level is hence considered significantly important to improve further learning outcomes and provide a gateway for advancing to higher level agriculture. The government policy stated that future long term human resources in the employment should be included in the agriculture sector, and since this is what the government wants, we need to get relevant quality education in agriculture. The threshold concept framework and my findings from this study could help improve quality through research-based curriculum innovation.

The most important trait of the threshold concept emerging from this research is its integrative nature and how would a teacher *teach* for a threshold concept. Although it is potentially troublesome, this is not always the case. It depends on the *subjectivity* of learners' progression and how they overcome the difficulty of crossing their thresholds, with the teachers' assistance. This is why research and practice must go together with instruction and curriculum planning, and current policy making, considering findings such as in this study that become even more important for education improvement, innovation, quality and excellence.

Understanding and making connections

One most important finding from this research is that learning is fundamentally about understanding and making connections. Leonardo da Vinci's famous quote, 'learn how to see, realise that everything connects to everything else' seems absolutely congruent in every sense of learning in this study. Connections can be made by creating linkages, closing/reducing gaps between connections, and to bridge ideas, in order to create deeper understandings. Teachers cannot make students understand but can help provide the context and facilitation for their students to make connections in order to arrive at their own understandings. This study indicated the connections in agriculture learning can be made through *physical experience and actions in order to progress to the state of embodiment*. Deep students' understanding during active, participative and constructive learning when experiencing planting and knowledge application, reduces abstractness and rote memorisation, hence promote reflection and better understanding to form a cognitive model. This results in more meaningful and purposeful learning experiences which are therefore effectively transformative and much more appreciated/valued by students. Thus, to experience connections in planting is to bring transformation together.

Practicality creates balance

The reason why practical activities allow the making of connections is because *activities create balance in learning*. Practicality increases understanding of the knowledge, and therefore, the impact of the meaning which will likely encourage students to learn more of agriculture and apply their knowledge to productive life. Experiences in the form of skills and knowledge application gives *thinking space for learners to reflect and visualise whilst doing – this provides the focus*, where most often in lessons, students 'do not remember much of what their teacher said, but remember more of what they did' (Cortese, 2003). Practicality is also seen as a way of reducing an overcrowded curriculum from being too factual by converting the knowledge or parts of it into performative actions, making it much easier to understand and remember. Planting practicality hence pre-empts an overcrowded curriculum's tendency to overload content and theory lessons, making learning more connected to the real context and reduces the risk of students getting bored easily. 'Children are not built to sit for hours and listen to lectures, but rather to be in motion' (Dewey, 1936). Boring inactive learning tends to disengage learners, whereas active constructivist learning emancipates learners to be involved in active participation, subscribing the teacher's role to only being a mentor/facilitator. Practicality, therefore, empowers student-centred learning and pedagogies, wherein students take control of the pace of their own learning and the time it takes to understand the knowledge construction. In essence, practicality in agriculture learning helps the balance by creating and reinforcing theoretical knowledge into concrete and integratively connects skills with knowledge, thus motivating students to enjoy learning, remember more, and become more confident. Its capacity to strike a balanced thinking, both from theoretical and practical perspectives, ensures an effective transformation of individuals which develops thinking and sharpens reasoning abilities. This should provide a focal point for transformation or identity.

Actions for making connections

Taking my findings to the next level after citing it in the section above, it becomes clear that *action* is necessary in order to make connections, before it leads to full understanding. Actions provide connections and links towards conceptual understanding. In fact, *action swings learner's experiences from imaginary into reality – it bridges understanding.* And connection in terms of agricultural thinking is accessible through students' actions in the forms of practical-physical activities and meaningful learning experiences in both learning processes and outcomes. Performing tasks helps to tackle the invisible intuition by engaging learners' minds through participation (doing) and transformation of metacognitive (affective) feelings. In short, abstract cognitive thinking in their minds need connections via actions to materialise or bridge students cognitively in the form of better organised and integrated understanding, thus reinforcing eventual understanding. Actions in skills and knowledge application therefore form a very important connection/link in agriculture learning and understanding. 'Learning takes place through the active behaviour of the students: it is what he does that he learns, not what the teacher does', emphasised Tyler (1949, cited in Brabrand and Andersen's video 2006). This concrete experience enhances progression towards embodiment of self-transformation – our main concern in curriculum planning which could ensure what students will become in the future. 'High level of competence, or expertise, is seen as largely being accountable for by the acquisition of a well structured knowledge base that bears directly on the task in hand' (Biggs & Collis, 1991:59). 'Learning is the process whereby knowledge is created through transformation of experience' (Kolb, 1984:38).

Dichotomy between education and economy

I also learnt that there seems no boundary between thinking and doing, acquisition and participation metaphors, theoretical knowledge and practice, content and context both in-school learning and out-of-school or real life world, and concept and process. The learnt knowledge will anyway be practised outside of the school context in the future. *School is just a smaller subset of the real world* where formal learning occurs under a closed and regulated environment. Learning and knowledge acquisition in the school environment is a stepping stone for students' participation in the real world out there in the future.

I also realised that there is no dichotomy between individual and social perspectives, and educational and economic purposes. They are equal partners, two sides of the same coin and must be connected between now and the future. The curriculum and teachers should not overstress these purposes, one over the other, but provide inter-relationships to ensure a smooth progression of ideas so as not to spoil the learner's transformation. We, therefore, cannot overstress too much of an economic focus as the main ultimate and only legitimate goal of education. The key in agriculture learning, based on the work of this thesis, is to have a right balance of thinking – coupling cognitive with sound pragmatic practice echoing Dewey's (1938) and Kolb's (1984) philosophies of experiential learning.

Education and purpose

From this study, I also learnt that in education we should not underestimate the power of purpose and sense of agency (feeling able to contribute something to the school, life, economy, etc), especially in the agriculture learning. Purposes give directions and determine what we achieve. As Lave and Wenger (1991:37) pointed, the concept of *connectivity* starts by recognising that learning is purposive. It stresses the need to link the purposes (of what people might need in future for success) and activities of both learners and teachers, with how they relate to developments in the wider society. When addressed to curriculum innovation, Young (1998:90) elucidated, 'for curriculum of the future, there should be links between the available knowledge in schools and future opportunities for employment and further learning; and everyday practices should be linked to schools and debate about future societies.' And with growing understanding of future opportunities, students would be encouraged to develop a clear view of the future path following their learning experiences. My study findings concur to this where students' as well teachers' thinking of agricultural threshold concepts demonstrated close linkages between education and economic purposes. They revealed an integrative thinking phenomenon that connects the concepts of planting (concrete skills/physical activities) with plant science (abstract biochemistry of plants' knowledge application), then developed this into socio-economic connections (people in society and business), technology and entrepreneurship skills in a wider context. Purposive viewings of learning this way informs learners' future directions and decisions, enhances present motivation, acquisition-participation and success, thus psychologically aiding in the understanding and overall individual transformation increasingly within the relevant social context.

Walking on the pathway of quality and relevance

On my personal level, I realised that venturing on the pathway of quality and relevance is not a simple matter. It can never be easy, nor there is a specific route leading to it. While I have gained insights and understandings of learning and teaching aspects of agriculture, there is still more to be explored. From this experience, I realised when concerning quality, the problem is more complex and the solutions more complicated. There is no straight forward answer to the issue of quality in an innovative curriculum in education. As such, this often compels us to take the shortcut, easy way out, by being teacher-centric tending heavy reliance on pedagogic strategies and fixing whatever we think might be appropriate. This eventually brings forth frustrations, undesirable outcomes at the learners' end. I agree from this study's experience, research inquiry consumes a lot of time and energy since it is to do with creating philosophy and advocacy. But yet, if we care for our children, their future and quality of life, we cannot avoid the difficult path of combining research with empirical evidence, and translating these into practices. My work challenges the idea of learning in agriculture as reducible to a linear series of learning objectives, whereas in fact it should be making connections and getting students to transformation. Thus, in an effort to tackle this pressing curricular issue and promote the holistic view of learning, this case study on threshold concept based on inquiry and findings will be extremely helpful.

Issue of quality and relevance, content and context

Reflecting back on the issue of quality and relevance that I raised at the beginning of this study, I still find these two concepts complex and hard to distinguish. These two concepts seem inseparable, mainly for the reason that agriculture learning seems to be ingrained in-between a content and context interface, just because by nature the agriculture discipline is both abstract and concrete in its theoretical knowledge content and practical skills-context application, respectively. Quality content in learning, as I began to conceptualise it, is more to do with *sense-making intuitively* in individual's understanding of making *connection between ideas and/or concepts*. Context, on the other hand, is to do with *experience, meaning-giving, and relevance*. Relevance from the aspect of context, especially in this study, is *making connection to reality by having real context experiences through actual application of knowledge*. It is the question of connecting understanding within the self with the surrounding, as in individual and social collective aspects. Explicitly, relevant findings from this study seem to have two facets: (1) *individualistic* relevance in learning for understanding, and (2) relevance to *broader social context* (see Table 11.1).

Table 11.1

Quality and Relevance in Learning Process and Outcomes in Learning Agriculture for This Case Study

	Quality - emphasis on content and relationship between concepts/ideas cognitively	**Relevance** - emphasis on context, epistemology and application of knowledge
Learning process	The learning that is capable of connecting to deeper understanding (such as in the **planting** threshold concept)	*Individualistic:* The connection of learning to the understanding of everyday and real-life applications
Learning outcome	The learning that is capable of transforming learner's perceptions and identities	*Broader context:* The perceived values and benefits that could improve individual's life and the socio-economic perspectives of a country

It could be said that *relevance is the connection between real world and academic content*. As Knobloch (2008:529) also argued, there has to be 'connection between academic contents to real life experiences'. Students will connect to the real world and their communities if they could see the *value* of their learning. This reciprocal relationship between relevance and quality of understanding is vital for achieving a higher level of understanding in agriculture. Quality and relevance both reflect individual and social construction of meaning and significance from learning.

There is a slight difference between the two however: relevance places greater emphasis on context, epistemology (position) and *application of knowledge* (situation); whereas quality is more on contents/concepts of understanding and the final overall learning outcomes. To differentiate them is hard and often quite confusing, but their relationship eventually becomes clear – the link that connects knowledge plus skills on what you know and is applicable to thrive in the worldly context. Therefore, quality and relevance are both in the learning process (of transformed understanding or progression) and its outcomes (of creating shifts in value, perceptions and identities).

My planting threshold concept therefore sits comfortably under the quality-learning process grid (as in Table 11.1), capable of making links and advancing knowledge (indicated by arrows). Planting fosters an enjoyable, yet convincing experience, and promotes desirable future. Due to its transformational effect, I thus consider planting as the king of concepts in agriculture learning capable of unifying/integrating many other concepts (based on this particular case study), and perhaps also central to agricultural learning in the wider claim. My work has sufficient evidence that planting could successfully provide the content and context necessary for learner's individual and social transformations, in terms of quality thinking and relevant knowledge derived from conceptual understanding and integration. The threshold concept thus helps pinpoint 'the quality of the experience, not just any type of experience nor even an activity in the experience that is largely of the wrong kind and is unpurposeful' (Dewey, 1938). This strengthens his firm view that in order to help decide quality of further experiences, 'the central problem of an education based upon experience is to select the kind of present experiences that live fruitfully and creatively in subsequent experiences' (p. 9). Deciding on experiences that are worthwhile is thus vital for relating quality and relevance, content and context towards future sustainability. And, one such worthwhile experience I found is planting.

Agriculture learning close relationship to experiential and situated learning

This case study suggests that forming deeper understandings in agriculture learning requires making connection via physical-experiential activities in a situated context. It demonstrated, as discussed, the process of learning and outcomes as individual and the social broader context of agricultural systems, i.e. individual transformation of personal identity and gradual acceptance into a community of practice. The philosophy of situated learning emphasises context or situation. Whereas that of experiential learning emphasises activities and connections of experience with personal feelings, it involves a 'direct encounter with the phenomena being studied rather than merely thinking about the encounter, or only considering the possibility of doing something about it' (Borzak, 1981:9 cited in Brookfield, 1983).

Consequentially, combinations of *context*, *experience* and *feelings* from these two learning theories match well with ways learners get transformed in this case study. My finding evidence is also similar to Knobloch (2003) who asserted the four pillars of experiential learning in agricultural education constitute of learning in *real-life contexts*, learning by *doing*, learning through *projects*, and learning by *solving problems*, to provide a sound psychological framework for learning and transformation. Kolb's (1984:21) four modes of experiential learning which allow students to learn through experience (concrete experience), reflection (reflective observation), application (active experimenting), and abstraction (abstract conceptualisation) stressing 'feeling, watching, doing and thinking' are also significant here. This linking to other work strengthens my claims that this is not just something that happened to my case study participants, but indicative of general experience.

Raising up to the globalisation challenge

Ways of confronting globalisation effects mentioned in the earlier chapter includes: increasing flexibility of students' choices and improving coherence (Young, 1998); broad-based curriculum (Conroy, 2000); increasing science integration (Osborne & Dyer, 2000); and making classroom connections to the real world (Knobloch, 2008). Another method found in this case study is through mechanisation, which students believed will negate the traditional farming perceptions and help esteem agricultural professions in line with an industrialised farming economy. Thus, the notion of agriculture modernisation is needed in future curriculum. Modernisation and a shift to technology-based agriculture could give potential creative ways to affect alleviation of scorch heat stigmatisation on agriculture labours or learners during practical activities in the fields. In this modern era, today generations lack the willingness and perseverance to expend their labours as in the traditional way. 'We need to increase our efficiency, but nobody wants to work in the fields', remarked Stavros Vougioukas, professor of biological and agricultural engineering at the University of California, USA (Wozniacka & Chea, Borneo Bulletin, Tuesday 16 July 2013:29). So, the only way possible could be using machines or robots to ease labour woes, they said.

Furthermore, Volanen (2009:44) stressed, ‘if the classical economy was grounded in agriculture and craft tools, the first modern economy was grounded in machines and machine systems’. Additionally, in globalisation and the modern economy, he stated that ‘the role of expertise changed in the economy, expertise cannot be based adequately on merely knowing things’ but ‘seen ownership, enterprises’ (ibid.), which also appeared to have impacted my case participants. He suggested Finland has ‘being, doing, making – a paradigm for the connective curriculum’ where *making* or creating things placed emphasis on production, as the third metaphor of learning – an additional to the two Sfard’s existing metaphors (1998). I argued in this study, similarly, we ‘tend to leave out the third element – the heart’, we sometimes forget ‘human being as someone with a head, hands and a heart’ (p. 43-44). Volanen’s study helped me to distinguish some aspects of my work. Although we have a similar stance from the heart, a slight difference of focus is that he mainly argued about *enterprise in the context of production in the real world*, which is a broader form of understanding. He stressed ‘feel for the making’ (p. 45), that is, creative feelings arising out of interests making by hands, originated from the heart. However, even though Volanen’s feeling comes from the heart, it focuses on *the hands or the object of production* as a result of reality making/production, while my findings focus on the affective feeling as *embodied in the person/subject* as a result of encountered phenomenal experiences in the process of learning during schooling. Hence, as far as agriculture in school is concerned, this study found *being, doing and affective (emotional feelings)* helps successful learner transformation, i.e. *affective* precedes Volanen’s making/enterprising, to persuade more transformation at lower level learning.

11.2 Considerations for Course Design and Implications for Educational Practice and Curriculum

My findings from this research for the understanding of threshold concepts, stress *transformation* and *experiences* for a course design in the curriculum as opposed to learning in tiny factual steps (although this tiny steps might be needed to support transformational leaps), in order *to create a sense of meaningful engagement, valued feelings and beliefs in the learners.* These considerations need to be highlighted in the new curriculum. This study’s assertions that intimate connections between cognitive-affective feelings in physical experiences and identity transformation are a paradigm for holistic learning outcomes towards embodying future farmers/agriculturists need to be embedded. This is quite different from I intended when I started this research. Identity was not in the intended objectives but it has emerged through my findings. To some degree, average teachers may find it hard to understand the view of research because they focus on the cognitive. Most teachers when they are thinking about planning their teaching, think about their teaching and curriculum planning as being normally framed in terms of knowledge, skills and perhaps understanding. In the case of agriculture, say, this might be knowledge of soils, skills in planting vegetables or paddy, and understanding how plants grow and need to be taken care of. Very few teachers, especially those average teachers, have any understanding of the fact that identity might be an important learning outcome.

This emerging claim is now part of my new understanding and thus causes this section to place emphasis on the focussed implications towards combinations of the followings:
(1) *identity* as in *individual* transformation in learning and in *social* community of practice ('transformation in discipline' – Ashwin 2008);
(2) phenomenal emotional *feelings* of success, from sweat, evidence from courses of actions and consequences (such as yield, money, profit, and so as motivation, confidence, enthusiasms and self-esteem); and
(3) physical *experiences* from situated learning and practical activities.

All the above could be inflicted by and achievable via the learning experience of the planting threshold concept, stressing knowledge integration and transformation revealed in this case study. These complement the connection between the mind, body and soul; as also paralleled in Sennett's (2008b) head and hands intimate connection, in Sfard's (1998) mixed metaphors (AM and PM), unity of theory and practice in Dewey (1938), as well the embodiment of identity transformation in the threshold concept work. But, none seem to have mentioned the strong connection to feelings that results from positive experiences in identity. This expounds identity transformation in agriculture as intricately connected with *emotional dimension and meaning-making, and most importantly values and beliefs related to experiences*. The notion of 'identity configuration' in the work of Geijsel and Meijers (2005:426) is also consistent, in which they argued learning identity needs a 'double dialogue concerning the meaning of the boundary experience for the community of practice as well as one's personal sense of the boundary experience'. My work on this case study gradually invokes particular concerns about quality related to identity transformation and hence the stress on innovative curriculum.

As disclosed, students' phenomenal feelings of being like farmers have significant importance for shaping thinking progression and aspirations to become successful agriculturists in future. This, therefore, calls us to ensure that our students have a heart-felt passion in their agriculture learning as love and passion can drive learning to greater heights and further interests. This could be done through raising self-confidence, enhancing perceived values and usefulness, increasing the effort in learning they are willing to expend, and offering learning activities deeply embedded in contexts to afford bigger learning outcomes and identity. 'Students who see how academic instruction connects to real-world applications and their lives would be more interested in learning' (Lynch, 2000 cited in Knobloch, 2008:536). *Situated learning* or learning on sites emphasises 'situation and context' (Vygotsky, 1987; Lave, 1988; Rogoff, 1995; Greeno, 1997; cited in Cobb & Bowers, 1999) which complements individualistic and social interaction relevance (as also agreed by Sfard, 1998) and promotion of cognitive development as well as participation in social practice in the broader practice of agriculture. Situated learning, emphasised by Cobb and Bowers (1999:10), *enhances cognitive processes* mediated through 'experience and meaning' to result in qualitative effectiveness of learning and transformation. Situated learning emphasises context and/or relevance, and is a way of 'legitimate-peripheral participation' (Lave & Wenger, 1991:37), a term to describe how new comers through learning/participating in context become transformed/modified to develop *core* practitioners within the community.

So, here are some practical suggestions for acting on my findings to enhance the agricultural curriculum:

1. The best way of doing practical activities and for maximising thinking transformation as seen from this case study is by *project-based learning* which could come from the following activities, such as: vegetable planting, paddy planting, chicken rearing, individual research project, and entrepreneurship projects, and any other supporting activities deemed relevant including work experience and attachments. This is by no means an exhaustive list. But, with a curriculum devoted to developing knowledge application and skills required to excel in the various areas of agricultural knowledge, *well-equipped facilities are critical* for hands-on, experiential learning. Schools and colleges should need a lot of support in terms of budgetary matters from the government and private sectors.

2. *Learning is much more meaningful if it takes place in context.* Context (or the set-up of the situation in which a person is engaged) provides the environment and conditions where an individual can engage and interact, implying that the educator's duties are to influence directly the experience of the students and thereby create their education as worthwhile experiences. Learning in context, such as sustained experience from planting to harvesting to see the product of effort, could relate the abstract to concrete so students can see/understand their learning. *The context of the learning environment that takes place thus should be conducive, challenging, compelling, engaging and interesting, and as real a setting (relevant) as possible to local and social contexts, away from being imaginary.* That necessitates 'learning involving procedural concepts should not be de-contextualised' (Biggs & Collis 1991:69; Sfard 1998; Davies & Mangan 2010:194). Transformational learning has taken effect only when learners emotionally feel and think by physically *being in it (immersion)*, involving neither imaginary world nor surreal, but a *real* feeling as if in the actual community of practice to experience and explore in actuality.

3. Real teaching-learning environments and local practice exposures (including visits, work placements), have definitely supported and strengthened learners' development in attaining high quality thinking outcomes through skill developments and knowledge applications, and identity transformation is seen among case participants particularly at their second year of study. So, *schools and colleges need to include more of these sorts of activities in the curriculum to give more experience-based learning* for their skills development and insight provision into potential career paths, by finding partners for practice and projects. This could also be a chance for them to put theory into practice, experience real-world challenges, develop network and team aspects not taught in the classrooms. It is worth mentioning here also, that youngsters in this study fascinated me with their energetic minds as they took serious considerations about their own learning given that they held tightly to their inner emotional feelings and the convincing beliefs from seeing actual relevance/application of the learnt knowledge. 'Lack of relevance reduces students' willingness to engage with the subject's challenging aspects and difficulties in transforming knowledge functions into a form that allows them to use it effectively in their chosen areas' (LeBard, et al., 2009:72). Thus, education must encourage a genuine/authentic learning environment, for this can bring on to bear learners' trajectories to involve future plans as evidenced from all interviewees' talk of agriculture careers despite some being uninterested in the beginning. Application of

concepts in real-life context will help learners 'to see career, community and real-world connections' (Knobloch, 2008:537).

4. *Value-driven experiential learning* accentuates agricultural knowledge acquisition as learners can see for themselves useful benefits reaped from their learning activities to their families and communities. The relationship between learning identity and community of practice, as discussed, implies that there should be a kind of *evidence-based learning* to win the heart, trust and beliefs of the learners of the values, benefits, importance and relevance of their learning, and also to convince subject accountability to a wider public. Most valued and cherished experiences were of a job well done, healthy plants, successfully harvested yields, sales and profit, and money generated. These are some of the ways for achieving value-driven and evidence-base learning seen in this study. Teachers can also play a significant role, as in this study (which I am extremely pleased to know) had consented for students to keep a significant proportion from their crop proceeds, which created feelings of excitement that their efforts were commensurably rewarded. To teachers, this may be some form of learning encouragement to impact further enthusiasm, unaware that they actually had actively aided in construction of a positive identity and meaning. This good practice could inform discussions of educational practice and innovative curricular materials for *instructional designs incorporating small manageable project-based learning activities sufficiently convincing yet also feasible to fit the academic duration of a course schedule.*

5. This study saw planting as useful mastery in the agriculture learning at secondary education. Planting and growing a crop provides a gateway for transformation, inherent progression and advancement of knowledge. The discovery of agricultural threshold concepts in this study (indicated via phenomenal and seminal experiences) is extremely useful to pave potential opportunity for enticing more youngsters to be interested in agriculture in the future. To ensure more youngsters transform to agriculturists, a novice learner's progression must first be conveyed via a physical planting experience, in which they must master the *planting concept* prior to anything else. We, therefore, need *to develop an agricultural curriculum that centralises around plants and its science, crop production and enterprising ability.* These areas need to be taught foremost before touching any other knowledge, so students could form a sound foundation to relate well to this core fundamental knowledge as a point of reference or a model for subsequent learning. What it means here is that of foremost importance is to establish a sound

foundation first, to emphasise personal individual transformation by firstly understand the planting concepts (knowledge, skills and application) before that of the social-broader context participation. In other words, only after addressing individual development the attention goes to social community practice development. *Transferable skills or concepts* in the vegetable growing and/or paddy planting activities which students found phenomenal in this research are central for conceptual integration and transformation, and therefore serves as a useful introductory focal point, as a platform, situation and context, to advance learning progression. This implies that the proposed sequencing of contents (and concepts) inter-relationships comprising the planting concept and its boundedness as illustrated in Figure 11.1 are central and be the first focus area in teaching in order to cross a threshold.

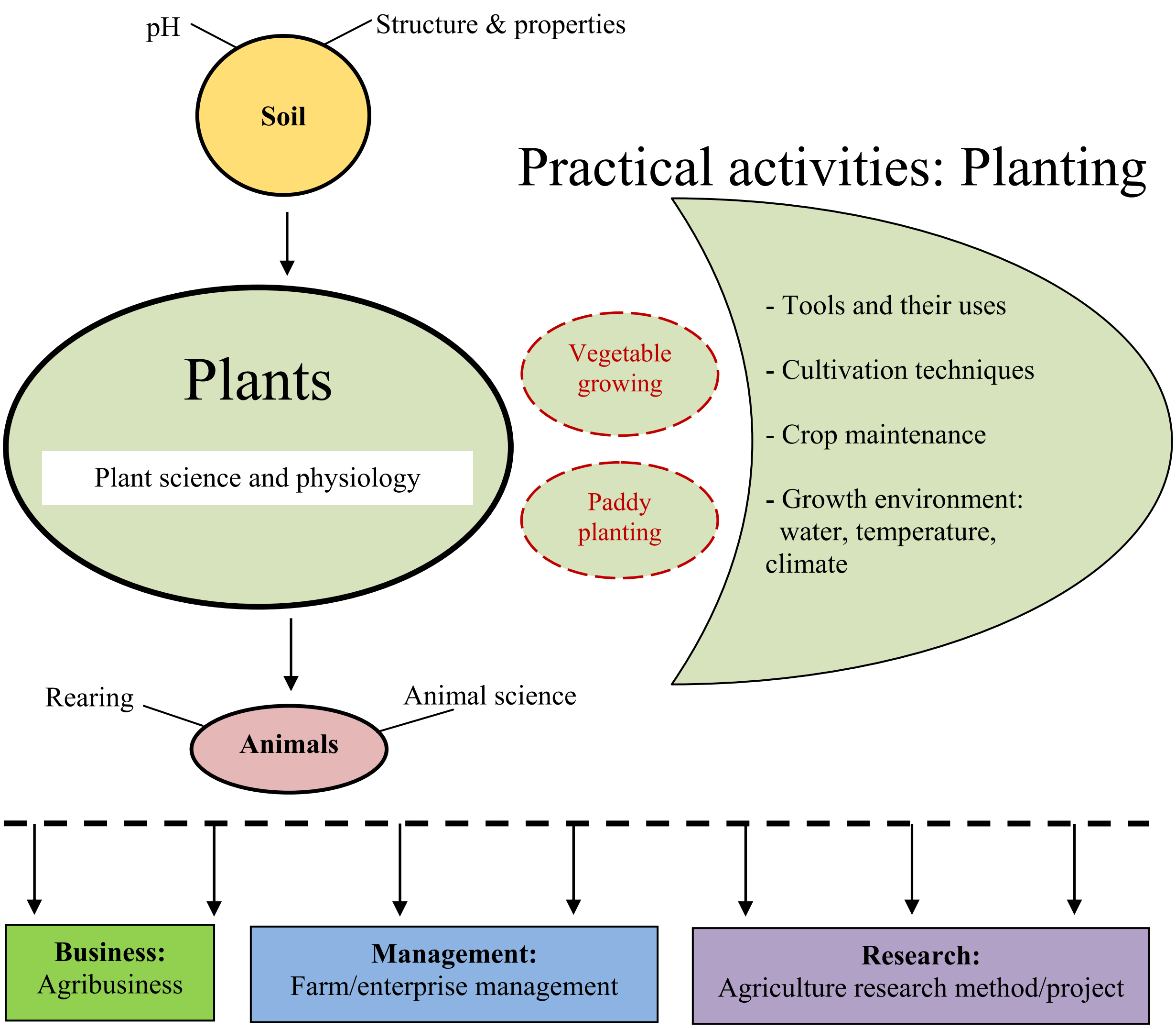

Figure 11.1 Proposed sequence of contents (and concepts) for getting/grasping agriculture at secondary level of education.

6. Teachers, as discussed earlier, may also find implications of their teaching inconceivable to identity transformation because research on psychomotor skills and

manipulative teaching has no sophisticated integration of metacognitive-behaviour-affect on how people feel. This disparity therefore has challenges to curriculum and teaching implications in that quality is not just on teaching the subject well, but it is teaching in a way *to connect* experience and skills, and almost to the fulfilment of feeling, enactment and being. It is therefore crucial for *teachers to be aware of the existence of troublesome knowledge* in this discipline and *monitor closely the point of learning where critical crossing exists* while teaching key concepts, so they could afford more assistance and guidance to free up students from being stuck in liminality, like in Student 2A's experience of disconnected and mimicry understanding. This awareness and ways for internalisations could perhaps be enhanced via teacher training and workshops for using the curricular materials efficiently.

7. Teachers need to *give students some time to come to terms with internalisation of basic understanding in their learning, and watch how they progress*. This is because 'students who have not yet internalised a threshold concept have little option but to attempt to learn new ideas in a more fragmented fashion' (Land et al, 2006:195). Although the teachers' awareness regarding agricultural knowledge and the situation within the economic broader context is laudable, for the purpose of motivating students of the importance of agriculture, it should be done cautiously, not exceedingly fast, nor too early at the beginning of the course, leaving students un-grasping. The key step should be the right balance – teaching for understanding while also considering economic relevance. A threshold concept understanding is 'iterative process and messy' (Cousin, 2006a:5) requiring continuous reconstitution of ideas. Thus the implication may be that there is the need for teachers to: adopt a recursive (repetitious) approach to tackle the complexities of learners' transformation; reduce the gap of knowledge between them and their students (i.e. avoid mentioning complicated concepts which students could not understand at the start); and reduce the level of difficulty (by providing sufficient practical, hands-on, in-context learning familiar to everyday and real world experiences to increase motivation-confidence-satisfaction, proper knowledge transformation, and success), all to be done in a way not to hamper progression by making it too simplistic or straightforward.

8. This also implies that teachers are challenged to be active in making continuous efforts to make *connection* in their students' learning. They need to constantly relate theoretical to practical, academic with everyday intelligence, in-and-out-of-school experience or worldly context. They should also be able to relate all forms of

knowledge from tacit, intuitive, and declarative to theoretical (Biggs & Collis, 1991). To foster such conceptual connections within the premise of a classroom often causes the injustice of overcrowding the curriculum, as everything seems important and needs to be taught. At the same time, teachers and curriculum planners also need to be aware of the inevitable relationship of learning with the work world where professionalism is to match professional practice which requires a gradual move from general education to discipline-specific knowledge and skills. So where is the dichotomy for all these? Unfortunately, there is no specific dividing line for teachers/planners but they have to *be creative in allowing gradual transition of knowledge according to learners' stages and ways they learn, in-line with purpose or goals of education, and to align/suit these in their instructions and day to day teaching systematically.*

In sum, this study has heard the voices of the students on what they considered phenomenal and meaningful. It is high time that we educationists should listen more to their voices. Ellsworth (1997, cited in Meyer & Land, 2006:31) recommended that teachers should 'cultivate a third ear' to listen to what 'shape a student's knowledge, her not knowing, her forgetting, her circles of stuck places and resistances' and 'not for what a student knows'. The curriculum design must therefore enhance the teaching and learning, be especially relevant to the people being educated, as well as their future needs. Quality of learning is foremost important and equally interwoven with curriculum development and implementation – the three together being regarded as one single interactive process.

From the experience of this research, to really understand learning in a particular discipline and to come up with a quality curriculum for its respective learners, we need to understand its purpose, how students make the connections and what they found valuable and worthwhile. My pleas are for a more *balanced curriculum, blending theory and practice, integrating local contexts and placing emphasis on experiential learning*. Given that any agriculture course by and large has strong roots in economy and an affinity to local interests, and is likely affected by globalisation; its learning therefore should not be completely divorced from its context. Its coincident strong links and affinity to broader contextual economies, hence, summons implications for a course content re-designing and innovation in terms of sequence, structure and forms of engagement necessary in agriculture learning and curriculum.

The dynamic importance of learning to do with identity, as something that is constructed from experience, is not independent from one's personality as 'affective feelings feedback cognitive' (see Clore et al., 2009). There is a goal in education that people argue that it is to do with building positive identity, which in this study, students feel like farmer as important part of economy in agriculture because transformation is quite personal. However, it is questionable whether agriculture teachers have any idea about identity at this lower level of inquiry. Learning of agriculture between lower level and higher level serves a different purpose, although there is continuation from individual practice to community of practice. It could also be incongruous to think that high quality thinking outcomes are based on the number of students that become farmers, and this has appeared to mislead curriculum planning by enforcing too much emphasis in terms of careers rather than complete learner's transformation intuitively and actively at the very start.

11.3 Future Directions

Due to the small sample involved in this pioneering inquiry of agricultural threshold concepts, a bigger sample in schools is needed in a future study. Although the findings are conclusive, a more comprehensive study would be needed to involve other agricultural areas, as well as a higher level university degree course within the discipline to be explicit. Also, due to scant agriculture threshold concept inquiry available in the literature, in addition to the survey and interview methods I used, written transcripts data collection to determine closely the progression in thinking development, as done in Davies and Mangan's study (2010), could be carried out. This ensures that the future research will have more explicit findings on agricultural threshold concepts.

Nevertheless, the work of this study found out pedagogic approaches based on experience must be emphasised in the curriculum, to achieve deeper understanding, as in quality, relevant knowledge application and identity transformation. There is a great sense of accomplishment and self-satisfaction that comes from being able to use their hands to create things and produce something when learning, so all the above implications need to be considered. Inquiry-based curriculum using a threshold concept framework based on students' voices points to a destination in curriculum innovation – to not just include any sort of core concepts, but most importantly, key threshold concepts that are capable of transforming learning and understanding through experiences.

Of foremost importance in education is that students can understand certain concepts so they can use knowledge for problem solving and real life application, and not just answering exam papers. To remain relevant and of excellent quality, this study stresses putting more *actions and being* into the agriculture curriculum for learning at secondary education to facilitate the process and progress to the state of embodiment. This places emphasis on physical-practical-meaningful experiences and actions through skills development and knowledge application in the understanding of key concepts and connection to contexts via practical-based, project-based and outcome-based learning. While it is important to design outcome-based curriculum in alignment with the job market, the study particularly points to the importance of experience-based curriculum to encourage identity transformation for the development and sustainable knowledge-based economy both for learning and working in the 21st century.

Faced with such challenges, here are what we should be aware of:

1. We therefore need to build our generation's future by investing in curriculum research and innovation. 'Worldwide, educationists have come to realise that innovations always require careful planning, and thinking. If educational change is to keep pace with changes in society and if education is to maintain standards, and values that transcend particular times and societies, the education system needs to be carefully and thoughtfully managed, instead of merely left to happen' (McDonald & Van Der Horst, 20007:2). The search/quest for quality calls for intensive and intrusive intervention of curriculum innovation and development, hence for a dynamic review of educational policy. The dynamic nature of curriculum improvement can never allow us to catch up with future quality and global challenges, but rather we can only reduce the gap, minimise the effect and make do with what we can with current reality. 'We cannot change the past to rewrite a better beginning... but we can work for the future and strive for a better ending' (Yasir Qadhi, a famous scholar, USA). The work on quality therefore can never be finished, and should never be stagnant, as quality can only be achieved through constant and consistent search for improvement, so that we could have a better tomorrow for our children.

2. Although current policy guidelines may change with time and future needs, consider this: fundamental principles of understanding don't, i.e. the fundamental *understandings* in any subject – the key threshold concepts. Knowledge may change with advancement in technology and the discovery of new findings, but not the fundamental principles of human understanding. Thus, the capacity of threshold concept understanding is phenomenal to unlock and synthesise a subject, because if we could understand we feel

better and this indicates quality. As Luke (1996, cited in Newton, 2000:1) said, ‘when we understand we can do useful things, like invent things, develop better strategies for business success, and we even feel better’.

3. Nothing is more important than providing our children with quality experiences and a curriculum that remains relevant. The quality of the curriculum today determines the relevance of tomorrow. Future change cannot be left to the future, rather it must start today. Learners, I believe, must fall in love and be passionate with their learning in order to excel and be truly successful, and this could be realised through learning threshold concepts coupled with positive, authentic learning experiences. When we invest in our children, we are investing for the future. The human capacity building in education through provision of such curriculum will spark economic growth, diversify skills, create jobs, and augment a stable and sustainable development to citizenship.

> Quality could not be achieved without efforts and (could be done so) with vision to always upgrade oneself. If effort turns cold, don’t dream of reaching the top. It means the graduates would continue to become thinkers. This is what we want to produce a credible generation. [His Majesty’s speech, 23rd UBD Convocation, Borneo Bulletin Online, Friday 30 September 2011].

Finally, having trained in agriculture then become an agriculture teacher and curriculum developer, later a lecturer in technical education, I believe education and training is the key for changing people’s mindsets towards improving agriculture in Brunei Darussalam. Learning is a journey, a journey towards a transformed understanding and personal success. The process in the journey begins with a small step, where in the case of agriculture this learning success starts with the planting experience later developed into farmers/agriculturists community of practice as an eventual outcome. Everyone endures their learning journeys through various ways or different routes at varying stages of life experiences with learners encountering a mixture of elements, problems and issues challenging thinking and understanding which in turn determine the formative level of transformation. Inherent complexity of individual subjectivity can vary the level or speed of understanding each one can reach. Teachers, therefore, need to be creative and empathise in facilitating this journey. So, learners can reach their final destinations, or goals, with the desired end results. Specifically, learners aim to be conceptually transformed (consequent of deeper understanding and mastery), and they aim to be a passionate expert in their own chosen area and to be successful, as the fruit or overall outcome of our education system.

Quality of the understanding and its connections to everyday relevance, our life and local economies, in creating successful individuals, lies in the curriculum provision that matches these desired curriculum outcomes. Everyone may have a different view of quality, but quality learning reflected in this study is transformational in terms of thinking and identity formation. To attain quality education and for avoiding an overcrowded curriculum, it is high time that we explored and researched curriculum innovation, and identified and make known key threshold concepts responsible for the biggest transformation in learning a subject.

The discovery of an agricultural threshold concept in this research is crucial for linking the disciplinary understanding in learning/education and professionalism preparation in the socio-economy. So much so that our future agriculturists are currently in schools and it is up to the country, policy makers, educational leaders, subject specialists, researchers, practitioners, and individual stakeholders to realise and harness their potentials in less than 20 years time from now for a better tomorrow. 'The present affects the future... the person who should have some idea of the connection between the two are those who have achieved maturity' (Dewey, 1938:21). What better way to start other than the threshold concept inquiry and curriculum innovation. The prospect of threshold concept research is great, thus it could be one of the ways to assist Brunei's commitment to quality education and excellence. What we plan for tomorrow must start today, that is innovation!

APPENDICES

Appendix 4

4.1 Open-ended written questionnaire – threshold concepts perceived by teachers

4.2 Open-ended written questionnaire – threshold concepts in students

4.3 Instructions for teachers administering open-ended questionnaire to students

4.4 Interview schedule - guiding interview questions for checking threshold concept understanding and progression in students

Appendix 4.1

Open-ended written questionnaire – threshold concepts perceived by teachers

OPEN-ENDED WRITTEN QUESTIONNAIRE – Threshold concepts perceived by teachers

You can either respond in Malay or English. Your responses to this questionnaire will be treated as confidential. Please continue on a separate sheet of paper should you need more spaces. Return the completed questionnaire to Hajah Jabaidah (contact: 880XXXX or through email: jb_6616@yahoo.com). **Thank you for your participation**.

Name of school you are teaching: ____
Name of teacher:___________________________ Gender:_______________________
Age: [Tick ✓ in the appropriate box]

21-25	26-30	31-35	36-40	41-45	46-50	50+

Year when you start teaching: __________________________
Number of years teaching experience in agricultural subject: ______________________
Number of years teaching at the current school: ________________________

Academic qualification:	*Title of qualification: e.g. BSc (Hons) in Biotechnology*	*Year obtained:*	*Place obtained: e.g. Nottingham University, UK*
Master degree:			
First degree:			
Diploma:			
HND			
Teaching qualification:			
Others, pls specify:			

Levels and classes you are teaching:

Agriculture Level	*Year*	*Classes: e.g. 1C, 1D, 2F, etc.*	*Session: Am or Pm*	*Number of students*	*Ratio of boys:girls e.g. 9:6*	*Period / week*	*Arrangement of periods e.g. 2+2 or 3 together*
SPN-21	Yr 7						
	Yr 8						
Level I	Yr 7						
(old syllabus)	Yr 8						
	Yr 9						
Level II	Yr 7						
	Yr 8						
	Yr 9						
Pre-Voc	Yr 7						
	Yr 8						
	Yr 9						
PMV	Yr 9						
	Yr 10						
O-Level	Yr 9						
	Yr 10						

Diploma	Yr 1						
	Yr 2						

Your teaching timetable:

Period:									
Time:									
Monday									
Tuesday									
Wednesday									
Thursday									
Saturday									

Other subjects taught besides Agriculture:
1. ____
2. ____

Other responsibilities (apart from teaching) within your school, with MOE and other ministries:
1. ____
2. ____
3. ____
4. ____
5. ____

****

The purpose of this questionnaire is to seek teachers' opinions of the concepts in agriculture which you think would be helpful or useful towards your **students' understanding** of agriculture as a whole.

1). There are many concepts of agriculture that students need to understand in order to master the subject. List down all the key agricultural concepts that you think are very important in order to provide a very good understanding of agriculture to students' learning.

2). Which **five** of these concepts you have listed above do you think as the most important? And explain why?

3). Rank these five in their order of importance, with 1 – the most important and 5 – the least important.

4). Please explain the reasons behind your ranking order.

Appendix 4.2

Open-ended written questionnaire – threshold concepts in students

OPEN-ENDED WRITTEN QUESTIONNAIRE – Threshold concepts in students

Secondary Students

- This is not a test. There are no right or wrong answers to these questions. It is simply to know your thinking about the learning of Agriculture.
  Kertas soalan ini bukanlah satu ujian. Tiada jawapan betul atau salah bagi jawapan soalan-soalan berikut. Soalan-soalan ini hanyalah bertujuan untuk mendapatkan maklumat mengenai pendapat kamu terhadap pembelajaran matapelajaran Pertanian.

- You can either respond in Malay or English.
  Kamu boleh menjawab dalam bahasa Melayu atau English.

- Please continue at the back of this paper should you need more space.
  Sila gunakan ruang di belakang kertas jika bahagian yang disediakan tidak mencukupi.

- Please answer the following questions as **honest** as you can. Your responses will be treated **confidentially**. Your details are needed for future references only.
  Sila jawab soalan-soalan berikut dengan JUJUR. Jawapan kamu akan dikira SULIT dan tidak akan diberitahu kepada mana-mana pihak. Sila isikan butir-butir yang dikehendaki di bawah bagi memudahkan penyemakkan semula.

- Thank you for your participation in completing this questionnaire.
  Terima kasih atas penyertaan awda.

School: ....

Class/Programme:..

Name: ....Gender: Male / Female Age: ....

Have you studied Agriculture subjects before when you are in lower secondary school? Yes/No
Adakah kamu pernah mengikuti matapelajaran Pertanian di peringkat menengah bawah sebelum ini? Ya / Tidak

---

1. Describe which of the topics you have learnt in agriculture you find helpful for understanding of agriculture.
Sila nyatakan tajuk-tajuk dalam matapelajaran pertanian yang telah kamu pelajari yang mana kamu fikir boleh membantu kamu untuk memahami mengenai ilmu pertanian.

2. Could you explain what factors or experiences have influenced this?
Sila terangkan apakah faktor-faktor atau pengalaman yang kamu alami yang telah mempengaruhi pemahaman kamu tentang ilmu pertanian itu?

3a. Do you think that you have used what you have learnt? Yes / No.
Adakah kamu fikir kamu telah mempergunakan/memanfaatkan apa yang telah kamu pelajari itu? Ya / Tidak.

3b. Could you explain it in terms that someone else would understand?
Bolehkah kamu terangkan bagaimana kamu menggunakan atau memanafaatkan apa yang telah kamu pelajari agar seseorang boleh faham atau mengerti mengenai ilmu pertanian itu?

4. Do you think what you have learnt is beneficial to you? Yes / No. Explain in what way?
Adakah kamu fikir apa yang telah kamu pelajari itu berguna kepada kamu? Ya/ Tidak. Sila terangkan bagaimana ianya berguna kepada kamu.

Appendix 4.3

Instructions to teachers

Instructions for teachers administering the open-ended questionnaire to students

Dear Teachers,

Please help me administer these sets of questionnaire to your students whenever you have time with them during your class.

Whilst answering the questionnaire, please remind them not to discuss their responses with each other. It should be done in as quiet environment as possible so that everyone is given the space and opportunity to think properly.

You can help explain the meaning of each question to your students but please don't help them with the answers in order to ensure authenticity and the reliability of their responses. Please also give them ample time to think and write down their responses properly.

At the end of the session, please help me check that each and every item in the questionnaire is attended by individual student. Also check that all students have written down their names at the allocated spaces.

Once all the sets of questionnaires are completed, kindly seal them in the provided envelope, and return to me as soon as possible.

Appreciate very much your assistance on this matter.

Many thanks.
Hajah Jabaidah
Contact number: 1234567

Appendix 4.4
Interview schedule

INTERVIEW SCHEDULE

Guiding questions and probing for checking threshold concept understanding and progression in students

1. Purpose of interview (for the interviewer)

TC understanding – The aim of this interview question is to check for connectivity or integratedness in students' understanding of agricultural concepts. The first and second items serve to find out if there is positive feeling or interest and value perception towards agriculture which points to the quality of the subject.

Students will also be asked whether they find conceptual difficulty or troublesome in understanding certain concepts. These findings will be useful for incorporation in designing a future curriculum so that teachers should spend more time and effort in teaching learning experiences that students found difficult. The questions on troublesome will be asked provided there is plenty of evidence showing that students face difficulty, and that they try to memorise isolated chunks to overcome some misunderstanding.

TC progression – The second time interview is aiming to see individual students' progressions in their level of understanding of agricultural concepts as they progressed to the upper academic level.

2. Procedure

Please make yourself as comfortable as possible.
Greetings....
How are today?
How do you feel at the moment?
Is the room too cold for you?
Are you nervous? Please don't be. There is nothing to be nervous about.
Explain the data to be collected and for what purpose it is to be used.
Can I record this interview?
Explain that the recording will not be revealed to anybody. It's just for the researcher to remember the conversation.
Can you tell me your name?
Which class are you from?
Which school are you studying in?

3. Guiding questions

Easy and spontaneous questions to encourage participants to talk at some lengths:

- Are you happy in this school?
- Do you like your school?
- Do you have good friends in this school?
- Do you enjoy studying agriculture?
- What do you like to do during weekends?

Beginning of interview:

- Try to remember the last time you have understood about agriculture and tell me anything about the situation, how you felt, did or said?

(Stevick, 1971 cited in Moustakas, 1994:115, agriculture word added).

Probing questions with respect to 'TFEIS' = thoughts, feelings, examples, ideas, situations (Moustakas, 1994:47).

- What are your thoughts about it?
- What are your feelings when ....?
- Can you give any examples of ..... ?
- What are your ideas when ....?

- Can you provide any situations where you think you could understand agriculture fully?
- Which part of the learning of agriculture do you think will make students understand agriculture better?
- What is the best experience you ever had in learning agriculture?
- Which is the most meaningful experience for you while learning agriculture in this school?
- Which part of learning experience is best for you so far?
- Which is the most enjoyable experience for you so far?
- When is the most memorable learning experience for you?
- From the many topics that you have learnt, which is the most enjoyable for you? Why?
- What learning of agriculture do you enjoy most?
- Why do you like (or hate) agriculture so much?
- What made you fall in love with agriculture?
- Do you think that agriculture is useful (important)?
- Are you happy or satisfied with the things that you learnt so far in agriculture?
- What have you learnt that provides you with the best understanding of agriculture? Why?
- What do you think will make someone successful in learning agriculture?
- What aspects in agriculture learning do you think is important?
- What would you like to show people about agriculture that is best?

Closing of interview (analytical part):

'Invitations to be more analytical can be introduced as the participant begins to ease into the interview' (Moustakas, 1994:116).

- How did the experience affect you?
- What feelings were generated by the experience?
- What thoughts stood out for you?
- How do you share what is significant with others?

4. Interview questions

1st Round Interview – *Year 1 (August 2009)*

Questions on TC understanding

1). What topics have you learnt this semester/term?

2). Which did you find the most helpful in improving your understanding of agriculture and why?

3). Which did you find the most difficult (troublesome) and why?

1st Round Interview – *Year 1 (August 2009)*

Questions to see TC progression

- What do you understand about agriculture having studied it for one year?
- Can you remember what you have learnt in your first year?
  [e.g. student's response might be hydroponics, etc.]
- What do you understand about hydroponics?
- Does that help you to understand {connect /relate*} anything else?

* avoid mention

Questions to see TC progression

These interview questions are purposely set to see progression in understanding of agricultural concepts as they progressed to upper level. There are three sets of questions prepared to be administered at different time of fieldwork and depending on the academic year of the student, i.e. whether first year or second year of study. The selected interviewees would be chosen based on their responses on the previous written questionnaire and the belief that they can provide the best interview responses. As a precaution, the word 'connect' or 'integrate' should be avoided during the interview as these are the words the researcher will be looking for as indicative of a threshold concept. In other words, a more indirect interview question would be posed. The items in the interview question are as follow:

2nd Round Interview – *Year 2 (August 2010)*
- How different is it your study from your first year?
- Anything new or is it just the same thing?
- How do you feel your understanding of agriculture has progressed compared to first year?
- Can you explain by giving an example?
- Does that help you to understand {connect/relate*} anything else?

* avoid mention

2nd Round Interview – *Year 2 (extension questions during August 2010)*
- What is the most important you have studied this year?
- How will this help you with your future plan?
- Have you thought of applying this knowledge after finishing the course?
- Can you explain by giving an example?
- Does that help you to understand {connect/relate*} anything else?

* avoid mention

These sets of interview questions will be interviewed to the same students in the group on every year of their course. This means that a particular student will be interviewed twice.

5. Note to the interviewer

Be transparent – do not interfere with the participants' opinion.
Remember to remain neutral.
Beware of your body language – don't provide leading gestures or responses.
Practise 'Epoche' = freedom from prejudgement or presupposition to set aside biases.
Be naive as if for the first time encountered freshly.
All previous knowledge should be bracketed off.

The purpose of these interview questions is to serve as guiding questions. The order may not be the same during the interview and they may not be used at all. As Moustakas (1994:114) emphasised that although a series of questions developed in advance 'aimed at evoking a comprehensive account of the person's experience of the phenomenon, these are varied, altered, or not used at all' when the participants shared his/her full experience.

Appendix 5

5.1 An example of a case interview transcription

5.2 Student 2C first and second interview analysis

5.3 Student 2L first and second interview analysis

5.4 Student 2N first and second interview analysis

5.5 Student 2D first and second interview analysis

5.6 Student 2A first and second interview analysis

5.7 Student 2F first and second interview analysis

5.8 Student 2M first and second interview analysis

Appendix 5.1

An example of a case interview transcription: Student 2C first and second interview transcriptions and key words extraction (corresponding to 'emergent' and 'super-ordinate' theme clustering

Student 2C – 1st round interview 2009 – (25mins)

Original transcript:	Line No:	Researcher's comments:	Emergent themes:
(Paragraph No.)			
Informal chat with the student to find out the background and for warming up.			
Didn't do agriculture at lower secondary.			
(1)			
I: Okay, how do you feel taking the course so far?			
2C: Okay, the course made me more interested in the agriculture. Like...it's exciting. I can	1	Positive feeling about agric -	
know now some of the things that I don't know.	2	getting more interested +	
		exciting	
I: So which part of agriculture do you love to learn?			
2C: Perennial horticulture – types of fruits.	3		
(2)			
I: Anything on agriculture learning which makes it easier to understand?			
2C: Umm... annual horticulture, because we were taught how to create beds etc. Previously,	4	Annual horticulture makes her	Easy to understand
I didn't know bedding is for what and how, now I know there is measurement for it,	5	understand agriculture easier and	
management, and we first see how its growth, stages and processes like pruning and	6	better because of the farming	
thinning.	7	activities.	

I: So I see that's what makes you understood agriculture better. And before this have you any experience in growing anything?

Better understanding

2C: A bit, but just observing my dad. So, now I know a bit. And at home I practised myself after learning from here (this school) trying to create a small garden... and see if it will be the same as in school. I planted 'sawi pahit', just for trial at home.

(3)

I: Wow...I'm impressed. So, at the beginning of the course previously, what should be taught first in your opinion so that people would understand agriculture faster?

RQ3 Implication
Topics to be taught first / Ag starter.

2C: Before we should do any planting, we should be taught how to plant – the techniques, procedures. However, sometimes we were asked to plant straight away without knowing which step needs to be done first. So we're a bit shocked. And then, we didn't know what to do. So we have to wait for instructions. It should be that we should be told step by step before we start doing any practical. So, I prefer like this...it should be that the teacher should explain first what we have to do before we start the practical. So, it's blur and shocked what to do. Like, its sowing first right then thinning then only we transfer the plants. Like previously we don't know that...we were straight away doing the practical. It should be that some bits of explanation and then do, then only inform what we have to do next. Because there are some who got confused who don't know what to do.

Implications to instruction:
Planting techniques + procedure should be taught first.

I: So, previously in the beginning you got confused?

2C: Yeah, it's like we kept wandering and asking what to do. But now whilst doing this project, we know what are the steps already as we have experienced this last year the ones that we didn't know to do... So now it's okay we know what to do. [Confirming and confident].

(4)

I: Besides teacher explanation during lecture, and teacher's demonstrations or briefing, how else do you learn more about certain topics?

2C: Hmm...sometimes if we didn't understand we asked the teacher individually like asking for the explanation until we understand. So, it's a two-way, rather than keeping silent without asking. Personally, I always asked rather than not-in-the-know. I think we have to know how to communicate with the lecturer as well.

(5)

I: I'm sure there are many topics that you've learnt this whole year, but to you it seems that it's the practical activities on vegetable growing that seems to be most important, not on livestock or rearing animals.

2C: We didn't really have a lot of involvement in livestock as last time the poultry are already mature. Most of the times, it's the boys that did the feeding. Except that I involved during the slaughter - holding the chicken before cutting, dressing the chicken, weighing and selling, that's all. Actually, we were not asked to rear the chickens from chicks, so... not so much experience in looking after the chicken. Moreover, we learnt but mostly theory, not much on the practical. Mostly from papers (lecture notes)... and that the chickens are already big, all we know is about feeding, providing drinking water, and slaughter, that's all we did.

Lack of practical activities on animal rearing in schools does not seem to provide a good impact/effect on learning agriculture as students become less confident. It seems that they need to be taught or experience about it from the beginning until the end to be confident.

RQ3 Implication 'lack of resources'

(6)

I: O I see. So what do you plan in future once completing this course?

2C: Actually, I planned to work first. But, I shall see first. If I still can accept more, I'll try to study further. But, if I do work, I would like to be a technician [giggle] maybe that's it but I'll see what's suitable for me with my qualification.

I: At the moment, which are you most inclined to? Like, if you are given a choice, which area in agriculture would like to become?

2C: Actually, I wanted to become an agriculture teacher. But I need to have my degree first.

(7)

I: So of all the experience that you had whilst in this school, which one is the most

Confirm: veg growing - phenomenal to her.

RQ1 phenomenal:

enjoyable for you within this one year when you're learning agriculture? 2C: Hmm... gardening on my own and get the income or yield, doing team work in a group with friends.	Implication to instruction: to provide team or group work in a collaborative learning.	RQ3 yield + income
(8) *I: I see, so next time you have an ambition to become an agriculture teacher. So, in your opinion what are the characteristics of a good agriculture teacher?* 2C: Aa... knows how to guide students on doing agricultural activities, teach them more about agriculture and make them interested in agriculture because agriculture is going to be Brunei's future economy. Encourage them to love agriculture even though it is difficult and hot. Because like me last time, I totally don't like agriculture but after sometimes it's getting exciting. And then there are a lot of benefits for the future. Difficult + hot ---against--- benefits of agric + enjoyable (the benefits, enjoyment of agric surpass the heat + difficulty)	Analytical question: She admitted that she disliked agriculture in the past due to heat and the difficulty associated with the activities, not knowing after experiencing it she began to enjoy the subject more. She also saw the importance of agriculture for Brunei in future. [Importance = implication for teaching, i.e. students will learn if they know the importance of their learning. Biggs – learners construct their learning if they see the relevance of their learning!]	RQ3 Implication Stud value practical activities. Value of Ag RQ3 Dislike Ag b'cos of heat. - difficulty
(9) *I: So, what would you advice to someone who is interested to join the course?* 2C: I would say, those who are really interested to do the course can join the school and learn more about agriculture, it's an interesting course!		
(10) *I: But of all the topics that you learnt, which is the most difficult?* 2C: The most difficult... what ah? I think at the moment I think it's agriculture research method. At the moment I haven't started, at the moment we're just started learning the theory, and know what we have to do and prepare the proposal, etc. Because I am choosing to plant pumpkin so I have to prepare my project proposal on research on spacing treatment.	Most difficult – research method	RQ1 Troublesome - research method

The distance between plants 20 cm or ... for the other three beds 30 cm... I’ll see the	53		
effect on their yields whether more or less. I hope It will be easy and exciting for me.	54		
I am really keen and looking forward to find out the results from my research.	55		
(11)			
I: So, just now I asked you about the difficult ones. How about the easiest ones for you?		No easy ones for her.	
2C: A... the most easy... ahm... I think there is no easy ones, they’re all moderate.	56		
(12)			
I: So, regarding your practical activities in this one year, what sort of vegetables you			
planted so far?			
2C: We planted fruit vegetables such as long bean and leafy vegetables – kalian.	57		
(13)			
I: How did you feel when His Majesty visited the school?		HM visit is seen as a gesture of	Positive perception
2C: I felt really proud because His Majesty came down here and it shows that he really cares	58	the increasing importance of	on Ag.
about the people in agriculture sector especially paddy as we have planted paddy last time	59	agriculture to Brunei’s future	
and he himself planted some with us.	60	economy.	
I: So, how motivated were you at that time? Are you really motivated?			
2C: Of course I was made extremely motivated by it [convincingly]. I see that His Majesty	61		
really puts his attention on agriculture and for the school also.	62		
(14)			
I: Hmmm....which of the course content or concepts that must be taught so that one can			RQ3
understand agriculture? I mean if not taught properly, one will not understand agriculture.		Ag starters:	Ag starters
2C: I think it has to be the basics of planting... don’t just straight away jump to doing it.	63	- basics of planting	
As I said, it will create shock especially those who haven’t experienced it, planting. Besides,	64	- use of various tools + purposes	
I don’t like waiting for instructions before moving on to the next tasks, and I wanted to know	65	- types of seeds	

why are you doing this, why doing that, what are the purpose? And introduce us to the various tools... like last time we kept asking what is the purpose of this tool, such as the sickle – the weeding sickle...we're wondering on its purpose. We were sort of don't know, at least inform us for what. As sometimes in the phase test, we were asked the use or purpose of certain tools, but we don't know despite we've used it and we don't know the name in English but we were only told the name in Malay. And introduce seeds – tell us the names. Sometimes there are seeds we've never seen before. Like last time, we saw radish seeds - we asked ourselves what seeds are these since we haven't seen it before. Only after sometimes we knew. So that's what I meant by tell the basics.

(15)

I: So now you're happy in this school? No regret even though to some extent you feel that attending this course is a bit late for you?

2C: Yeah... no regret. I mean, even if in future, if I don't get employment, I can always work on my own on a land.

(16)

I: So, in terms of daily sustenance and everyday life, to you is agriculture useful? Previously, you never learnt agriculture in secondary school and now you learnt agriculture, so what is the difference between learning last time and presently?

2C: Hmm... previously different because it's in the secondary school. But now, it's more connected to our life where our food supply we get from ... I think there are lots more in everyday life ... even what we eat everyday where the food source comes from agriculture like rice, food, chicken meat from poultry – so these are all agriculture subjects...all are connected to real life.

Usefulness of agriculture is seen through the eyes of connection of agriculture to everyday and real life connection thru' food.

RQ2 Transformed - see connection of Ag to our life.

I: All connected to real life? O...I am very interested, can you explain more?

2C: Like... especially food. Beef is from ruminants. Chicken from poultry we also learnt. Then vegetables all we planted. Then rice as our food source, so all our life is connected to

Connection of our life to agric

RQ2

agriculture. For me, this is my own opinion.	84		
I: So you can see connections on plants and animals and the food that we eat and how agriculture provides for our life, where the supply of food comes from. Does this make you into someone different? I mean previously you don't know about agriculture but now you know that these things are connected, do you feel your thinking is different from previously?		No wonder she can relate to her experience well, since she can see these connections!	RQ2 See important of Ag to life.
2C: My life is not different, but my thinking is. Agriculture is important now for life. Indeed,	85	"Agriculture is important for life"	
truly. When I think about it logically, it is truly that agriculture is important.	86		
(17)			
I: So, the topics that you learnt how are they connected?			
2C: In real life they are connected. The topics we learnt are also connected. To produce and	87	'To produce is to plant'	RQ2
to plant, so crops so connected.	88		
(18)			
I: Hmmm...there are so many things I learnt from you and I have asked you a lot of questions today. Do you have any questions for me?			
2C: Hmmm... I think no [giggle].	89		
I: Okay, all the best to your study, and happy fasting. Thank you very much for your time.			
2C: Thank you.	90		

Student 2C – 2nd round interview 2010 (27mins)

Original transcript:	Researcher's comments:	Emergent themes:
(Paragraph No.)		
Informal chat with the student for warming up.		
(1) *I: Okay, you've studied agriculture for two years now, right. Of all the topics that you've studied within these two years, which do you think is the most difficult and troublesome, i.e. something that you find difficult but important to study?* 2C: Actually the most difficult for me last time was ARM (Agriculture Research Method) and IRP (Individual Research Project) because these are very important subjects.	Same response as last year's. i.e. ARM difficult, IRP most interesting for her.	RQ1 Troublesome - ARM IRP - most relevant/interesting
(2) *I: Why ARM very difficult for you?* 2C: Because it needs a lot of calculation and at the time we were doing the survey with the price of vegetables. We go to supermarket, we go to retail shops. So we collect it together And then we gather the information that we get from there. Thus the calculation takes a long time to calculate and all, but thankfully I managed to do it.	ARM difficult due to calculation involved.	
I: So, it's very important this topic. Why is it very important? 2C: ARM is about research which needs calculation, but useful and we have to do it. And we must pass also.	Must pass the subject puts emphasis on the subject and is perceived considered important.	
I: But what will be its usefulness, later on or in future? 2C: For me, to see the difference of prices between retails and the way they packaging, its selection of products whether it's local production, which ones customer likely to buy either local or from outside the country...the import percentages of vegetables.	Useful as student can see the application of knowledge in everyday life.	RQ3 Implication

(3) *I: Like your IRP, you felt difficult but at the same time you also enjoy it, but important also. Why is that?* 2C: Yeah... doing IRP at first is hard, and then in the middle it's okay and at the end. Besides, it is done individually, bed preparations from the beginning till to the final, I learnt something such as gathering data, checking all the treatments as we had three treatments to see the differences between three treatments. So the best treatment will be recommended for practice. Moreover, at that time, I also sell and make profit [smile... satisfaction] besides at that time there was no pest disturbing, no diseases but a lot of management and drainage as it was wet season.	Difficult but enjoyable and satisfying experience = IRP	RQ1: IRP RQ3 satisfying
(4) *I: But by doing this project, how is your knowledge developed? I mean for yourself, what sort of satisfactory feelings do you get? Do these mean that all these while what you've learnt in agriculture has really given you some useful knowledge?* 2C: Yes, of course when doing all these things, I just thought and realised how difficult it is and then the feedback after that is – the benefits and profits, and learn more – something, and about planting. Not just by looking at it, but we handled the management, and lots more to do. We get the yield and we can see the results. At first, it was difficult, like we wait and wander if it will be alive or not. Basically, management is important. *I: So you feel satisfied? You feel you are successful in your project?* 2C: Yes, and the yield was high, so it was a success.	RQ3: how students arrive at TC? Difficulty experienced, hard work, and seeing the results – yields, profits returns. Yield = profit = success in mgt = satisfaction: → yield and profit from hard work are a measure of success and satisfaction.	RQ3: Hard work, difficulty, yield, benefits, profits, success in mgt → satisfaction!
(5) *I: What were you planting?* 2C: Pumpkin. I planted nine beds. I managed to harvest over 100 fruits. The breed is from Taiwan, and the flesh is orange in colour. Selling is no problem because the fruits are long	Phenomenal experience: Talking at length about the money generated from sales of the yield.	RQ1 Phenomenal: Veg planting

lasting, that's why I chose it. It was the first time I planted on my own. So, a high yield. I managed to sell around 40 and some I've given away because too many as not all can be consumed and some I sold in the shop [giggle]. The biggest fruit is 1.6 kg a whole fruit, the smallest was 1.2kg. So, its long-lasting fruit, unlike vegetables where if planted during wet season can easily spoilt. This one was lasted for three weeks. Besides my expanses for inputs such as buying seeds can be recovered from the sales. Profit...yeah.		RQ3 Profit
(6) *I: So I see, this is difficult but important during this second year. But, generally on whole of these two year course, what else is most difficult?* 2C: Actually, there is not so much difficulty, all can be handled. But, last year I had a re-sit on farm management for my accounting. This is the first time in my life I had a re-sit. It's because the account is confusing when I sort out the items in different columns.	Difficult concepts: Accounting in farm management.	RQ1 Troublesome
(7) *I: Is farm management very useful?* 2C: Yes, it's very useful to record all the things that you buy and spent in your farming. So when doing field crop, we need accounting because we need to check that 30% of the profit goes to the school and 70% goes to us.	Monetary distribution from sales is also an encouragement to student to work hard.	RQ3 Implication
(8) *I: So, how much did you get?* 2C: During field crop, not so much as we planted water spinach and amaranth. For school, $6.00++. [$14.00 for her]. We sold to the main office and also at roadside stalls. We ourselves sell it at the office because it was a lot, and they asked us to go there, but we managed to sell all. But we sell it cheaply at 50 cents per bunch as we might not be able to sell all, since there are plenty.		RQ3 Implication - real selling of produce
(9)		

I: Hmmm...what else, seems like I am running out of questions for you. Alright, the best experience for you so far throughout this course? Which one?		
2C: I think it has to be IRP, because I spent a lot of time doing my project where I focus more. Even though on Friday (school off) also I come to my crop – weeding and setting up the trellises which is most difficult to set up the trellises as it is very high. Luckily, my dad helped me to get the woods, but I was the one who set up all along with some friends. My dad just helped me obtaining the woods from the forest.	Best experience = phenomenal and meaningful = IRP Implications to instruction: need to spend a lot of time for the experience to be meaningful so students can focus more.	RQ1 Tc: IRP RQ3 Implication
(10) *I: Wow that sounds exciting. How long was the IRP running?*		
2C: If I am not mistaken, for 6 months. But I just went out of the hostel on Thursday evening to go home, then come back again in the morning, just so, so that I could attend to my project in the school farm. My teacher stressed on the IRP, so I have to work very hard because the percentage mark for this project is high. So it is important, and I have to work hard. And at the same time we also have field crop work, we need to water the plants in the morning. At first it was hard...arghhh...but as time went on, we enjoyed it. So now we are on attachment, so I drive home every day from attachment place. I planned to grow pumpkin at home. Besides being not so perishable the fruits can be sold anytime, the shoots can also be sold to be eaten as vegetables as well.	High mark allocations on some curricular task is seen as important by student - indication to them to put in extra efforts on such task.	RQ3 implication: Allocate high marks for activities that students must master.
(11) *I: Okay, last time you mentioned that agriculture is connected to everyday life, that was the best part of your interview previously. Tell me more, what happen to your life now with regards to agriculture since you've studied agriculture for already two years.*		
2C: Yes. At the moment, we are focussing on paddy, so that's mean paddy is getting important for Brunei. Brunei wants to be self-sufficient in its own paddy production. We will be given a place to plant paddy.	Relating the importance of the country's need in rice self-sufficiency that relates to everyday life.	Economic issue: Self-sufficiency in rice.
I: But it doesn't mean that you couldn't plant pumpkin? [giggle]		

2C: Of course... I can [giggle]... depends on the type of soil there is. But we have to venture into paddy. Even now, we are monitoring paddy at the green house, we were delegated to check paddy, but very tiring so much monitoring to do, and then frequent disease occurrence and we have to replace the missing tillers.		

(12)

I: Hmm...seems a lot of work, but of all the concepts in agriculture, apart the difficult ones you mentioned such as the ARM and IRP, anything else difficult to you? 2C: I think management (of crops) is important, as without it, the yield will not be high. Less management will affect plant growth.		RQ1 Management of crop (husbandry – mgt of resources; the art or skill of farming)

(13)

I: So there is a difference between first and second year of the course? 2C: Yeah, because in the final year, we are mostly dealing with paddy. Previously at the beginning, its mostly mixed, but now we are focussing on paddy.		

(14)

I: So, if someone intend to study agriculture come to you and ask, after these two years what makes you understand agriculture so much? What would you say to him/her? 2C: For me, it's all about planting, techniques, procedures, profit from planting... so much information, before this I don't know anything about agriculture. Nowadays, I know already regarding fertilizers, its application and what types of fertilizers. The amount to apply, what are the uses, things like that.	TC in agriculture for her, confirmed!	RQ1 Phenomenal Planting and techniques, procedures.
I: Like soil, is it important to know about soil? 2C: Yes, everything about soil, before planting, we should first find out if the soil is acidic or too acidic. Sometimes some plants cannot grow if it is acidic.	Soil before planting	Ag starters - soil pH

(15) *I: If someone doesn't know about soil straight away planting how? Will the plants be defected?* 2C: O, yes, sometimes if the soil is too acidic the plants are stunted and won't grow. In the first year we were taught about soil. So, the knowledge is useful now, as even now we were asked to check pH in the paddy plot and the type of soil. So these all are important to know before planting start.	She can relate to the importance of her learning to real practices, which means she has transformed in her agricultural knowledge.	Progression RQ2 - able to connect
(16) *I: So the best experience for you is doing the project, is it?* 2C: Yes, definitely. It's very challenging. I would want to do it again, God willing.	TC in agriculture, confirmed! Best experience = very challenging!	RQ1 – planting Project
I: Was it once only you did IRP? 2C: Yeah, once only, because at the same time we also did Field Crops planting, such as paddy, sweet corn, amaranth, water spinach, mung beans. But sweet corn was a bit difficult to grow – very sensitive, and moreover there was pests such as monkeys disturbing. Like last time when we planted mung beans and sweet corn but not long after that we had to replace with water spinach and amaranth – leafy veg so as to complete our field crops duration. Then paddy also. Leafy vege won't be looted by monkeys as they don't know how to eat these vegetables. Similarly, pumpkin is also not attractive to monkeys, except the tender shoots they picked up.		
I: So pumpkin is quite easy yeah? 2C: Yeah, but except the tentacles you have to keep pruning them so the fruits can grow bigger, especially the lower tentacles must be cut off.		
I: Wow, I feel so interested. Talking with you like this makes me feel like I wanted to become a student again. I'd like to go back to this enjoyable experience myself.	Exciting → from seeing fruits	RQ3 Seeing plants

Transcript	Line	Comments	Codes
2C: Yeah, it's really exciting, as even me, before this I haven't experienced all these	90	grow bigger.	growing →
planting. Especially when seeing the fruits grow bigger. At the time I was less watering my	91		phenomenal
pumpkin plants because it was a rainy season. So, I see that the leaves have these white	92		
specks due to presence of much water.	93	Think like agriculturist!	
(17)			
I: So when you finished the project, how do you feel? Do you believe what you've done? Did			RQ3
you feel, was it really me doing all these things? What are the feelings occurred to you like?		Accomplishment of hard work	
2C: Yeah, I feel so excited to complete the project, even though at first I thought I won't be	94	and seeing the fruits/results from	
able to do all these things such as making bed preparations and working with the soil, it's	95	the hard work, and profit = are all	
really hard. But towards the final when I did the harvesting, I cannot believe it myself as the	96	exciting/phenomenal to students.	
fruits are so many, until I cannot manage to do the harvesting myself, so I get the help from	97		
my friends. Gosh... they grew fantastically, I was so excited. And also I got the profit from	98		
the sales. As a result, I can repay all the expanses for the inputs that I used.	99		
(18)			
I: So, in yourself, you gained satisfaction. Then from the point of view of your thinking			
development in agriculture, how?			
2C: Hmmm... more like... the experience makes me addictive to plant more that's why I did	100	Positive liking = quality	RQ3 Implication
it myself at home. And see the difference between the soil at home and in this school.	101		
Because the soil around my house is sandy whereas in this school it's a bit clayey. So, I	102		
wanted to try planting at home and see for myself the difference.	103		
(19)			
I: Regarding your future, will the knowledge gained here be useful for future undertaking?			
2C: Yes, since I wish to work with the agriculture department. But, if not, I will venture into	104		RQ3 confidence
my own business such as opening up a farm because since now I am equipped with	105		
agriculture knowledge from here.	106		

(20)
I: So you feel confident now?
2C: Yeah...because my father is also involved in farming, and also we have a farm some 107
where inside Labi. 108

(21)
I: How about your personality, what changes have occurred to you? Confident = transformed!
2C: I feel confident with the information I obtained from here. Because we were taught all, 109
though not necessarily on plants. Such as on animals also. Both we have to know, plants and 110
animals. 111

(22)
I: So what's your plan after this?
2C: I think I will work first, and then study. 112

(23)
I: Okay, I think that's all I wanna ask you. I don't know if I can see you again. But so far so good my interview with you, I really enjoy very much talking to you. All the best to your future. Thank you very much.
2C: Thank you. 113

Appendix 5.2

Student 2C first and second interview analysis

Student 2C First Interview Analysis

Super-ordinate theme - Sub-ordinate theme	Line	Key words	Line
Easier to understanding + better RQ1			
- annual horticulture	1	Interesting + fun	1
		Knows bedding, see how plants grow, activities like thinning, pruning	6-7
Agriculture starters			
- planting – how to plant	11	We should be taught how to plant – techniques and procedures	11
- the basics of planting	63	Tell the basics	74
- use of various tools and purposes	66		
- types of seeds	71		
- soil pH	I2:73*	Before planting, need to know if soil is acidic, plant cannot grow if acidic	73
Most enjoyable	40	Gardening, get income or yield, team work in a group	40-41
		Fun and enjoyable	46
Difficult (hard work/laborious) and dislike			
- heat		Difficult (hard work/laborious) and hot, dislike agriculture	45
Realising the importance of Agriculture		Brunei's future economy	44
		Lots of benefits for the future	46
A good agriculture teacher	42	Guides student on doing agricultural activities	42
Valuing agriculture			
- benefits, fun and enjoyment of Agriculture **surpass** heat + difficulty of hard work		Don't like agriculture due to difficulty (hard work) and hot but now fun and enjoyable (after seeing the benefits).	44-46
RQ2 Transformation – see connection			
- Usefulness of Agriculture to life	77	Connected to our life, everyday life, what we eat every day, food source comes from agriculture	78-79
- "Agriculture is important for life"	85	Our life is connected to agriculture	83
- 'To produce is to plant'	87	In real life, topics/concepts are connected.	87
*Key: I2:73= Interview 2 Line 73			

Student 2C Second Interview Analysis

Super-ordinate theme - Sub-ordinate theme	Line	Key words	Line
Most difficult/ troublesome RQ1			
- agriculture research method	1, I1:49*	A lot of calculation, takes a lot of time to do	3, 5
- accounting in Farm Management	34	Confusing when sorting out the items for various columns, she re-sit	34
Phenomenal concepts RQ1			
Most important (useful) /relevant/ interesting/hard**	2	** hard at first (due to intensive laborious work with soil)	12
- IRP (individual research project) – planting project	44	Satisfying – make profit	16
		Help student to focus more	44
	I2:79	Best experience – very challenging, would want to do it again	I2:79*
- Vegetable planting	25	Harvest over 100 fruits, managed to sell around 40	25, 28
Fun/exciting RQ1	90	Seeing fruits grow bigger They grew fantastically, I was so excited	92 98
Deeper understanding of Ag RQ1 /RQ2 (progression + transformation): - planting + techniques & procedure	69	... all about planting, techniques, procedures, profit from planting...	69
RQ3 How students arrive at TC? About planting	21		
- satisfaction and success		High yield is a success;	24, 27
- yield, high yield		We can see the results – yields Fruits so many	22 97
- hard work, difficulty (sweat, challenge),		Realised how difficult (the hard work). making bed preparations and working with the soil, it's really hard	19 95
- profit, profits from sale, benefits	20, 32	I got profit from sales	98
- success in management (crops husbandry)	23	Crop management is important, without it yield will be low	65
Economic issue - self-sufficiency in rice production	59	Brunei wants to be self-sufficient in its own paddy production.	59
Positive liking RQ1	100	Addictive to plant more	100
* Key: I1:49 = Interview 1 Line 49		* I2:79= Interview 2 Line 79	

Appendix 5.3

Student 2L first and second interview analysis

Student 2L First Interview Analysis

Super-ordinate theme - Sub-ordinate theme	Line	Key words	Line
Provide deeper understanding of agriculture RQ1			
- plant science	1	Know internal and external processes in plants too	1-2
		Know how plants make food (photosynthesis)	4
		Knowing internal process, know how to improve plants grow well	3
		Understand better what to do	21
		Understand better what happens inside plant and why	23
		Need to know what happens inside and outside	I2:85*
		Can increase yield + profit if on commercial basis.	I2:87*
		Much easier to manage plant since we know what's inside.	I2:90*
Most memorable experience RQ1	52		
- paddy planting & harvesting		I really like it a lot. Eat rice easy, but produce difficult.	52, 59-60
		We know how hard + tiring. Know where rice comes from.	60, 61
		Hard but we get benefit	62
Practical reinforce theory	22	Learning without practice, never will understand deeper	22, 23
Agriculture starter			
- soil	35	It should be about soil	35
- soil pH	39		
- plants and planting technique	41		
- plant management and procedure	43	Weeding, watering and fertilizer application	50
- animals	45	How to rear. Boring if about plants all the time	49, 45-46
Agriculture for primary	72	So that children will love growing	73
		So they know basics. Don't hesitate to study Agriculture	75, 77
Social issue: heat turns people away from Agriculture	93	People find heat difficult. Heat drives people away.	93, 95
Benefits surpass heat:		Heat from sun difficult, but they don't know the interesting parts in Agriculture.	93-94
		*Key: I2:85 = Interview 2 Line 85	

Student 2L Second Interview Analysis

Super-ordinate theme - Sub-ordinate theme	Line	Key words	Line
Most difficult concepts RQ1			
- agriculture research method	4	Lots of calculation	5
- farm management	4	Related to business	5
Best experience RQ1 + most memorable (phenomenal)			
- paddy planting	18	Learn a lot.	20
+ study visit on paddy		More than we get from here (i.e. study visit in the Philippines)	23
- activities on paddy in school (most memorable)	101	Insight into how agric practice elsewhere (in the Philippines)	33
Social issue			
- People mindset		Agriculture is just holding a hoe	50
- Not many interested in Agriculture	74	Not many interested in agriculture. Need more people to join Agriculture.	74, 79
		Need more experts in Agriculture.	80
Agriculture related to science	51	Most agriculture is related to science. Applied science is important in Agriculture.	51. 52
Transformation RQ2			
- connect human to plants	83	Plants are like human. Plants have similar needs like humans.	83, 84
- connect agriculture to research	95	Agriculture needs more research	95

Appendix 5.4
Student 2N first and second interview analysis

Student 2N First Interview Analysis

Super-ordinate theme - Sub-ordinate theme	Line	Key words	Line
Useful to help agriculture understanding RQ1- transformative – TC!			
- vegetable growing	6	In-depth understanding	8
		Gives an overall picture for other agriculture topics or subjects	16
RQ3 How?			
- practical activities	6	Informs practicals at site, "picture in front of you"	6, 14
		NB: Theory – encourage memorising because cannot visualise practical	10
		NB: practical overcome troublesomeness	10
		"Infuse theory with practical"	13
		Incorporate into real life	68
		Think outside the box	70
		Agriculture is more to practical, more to planting and farming	75-76
		Usefulness in real life when doing your farming	79
Lower secondary experience benefits current course	19	Provides some earlier basic knowledge in agriculture – basic grounding	25
		Helps me a lot	30
		One step further than the rest	24
Agriculture starter			
- field crops		The basic – how to raise plants or grow vegetables	36
- and animals		How to raise farm animals	38
Most difficult			
- plant science			
- soil management		Too much information, memorise for the test	45, 46
Helpful for understanding agriculture RQ1			
- water movement inside plant	58	Does help	58
- photosynthesis	59		
Positive likings to agric			
- future oriented	60-66		
Change in perception RQ3			
- care for environment	83	Affect a little bit on personality – towards environment	86
- against open burning	88	Dislike open burning – number one dislike	88
- against chemical spraying	91	Organic way	91
Agriculture connect to business (money)	98	In agriculture you can also do business	99
Social issue:			
- people's mindset	101	Agriculture not necessarily hard work and sweat under the heat - machinery	101
		Agriculture work is very hot and sweaty since manually done	106
		Manual as low	109
Economic issue:			
- low agriculture production		keep importing from other countries	114

Student 2N Second Interview Analysis

Super-ordinate theme - Sub-ordinate theme	Line	Key words	Line
Most difficult/ troublesome RQ1			
- agriculture research method (ARM)	1	It's about doing research	2
		Latin square, standard deviation	4, 25
		Hard to process	5
		Confusing	9
		Don't understand the teacher	7
		Too much calculations	7
		Too advanced for me	29
		Too complicated	23
		Don't understand the formula (and when to apply it)	20, 14
Most challenging RQ3			
- IRP (individual research project)		Because done individually, manage by ourselves	30, 33
		Have to research for reliable info	30
		Quite a big project	34
Important concept RQ1			
- soil		This is the basic, the medium for the plant growth	45
- & soil science		An eye-opening	48
- soil properties		One of the keys to understanding agriculture	58
RQ2 Connection of soil, environment, fertilizers, pests, and diseases			
		Very complicated world the plants are living in.	61
Seeing Agriculture production and management & business connection			
		The end product of agriculture is food which people buy (business)	62
- management of crop production		You 'manage' your agriculture first – your farm (via skill and knowledge). And then business comes next.	74 -75
		It's connected	79, 103
Agriculture success RQ2			
- commercial scale		For better result and more yield, need more agriculture knowledge and skills	69, 71
Historical issue: oil		Brunei has oil, so agriculture is only second industry	130
Social issue: People's mindset - poor perception on manual labour		Who would want to get dirty and do manual work, especially youngsters	131, 133
		Don't want the dirt and mud	134-135
		Excited to see technology	134
Agriculture value	150	Massive/wide opportunity in agriculture	151

Appendix 5.5

Student 2D first and second interview analysis

Student 2D First Interview Analysis

Super-ordinate theme - Sub-ordinate theme	Line	Key words	Line
Interesting, provide good understanding of Agriculture but difficult/troublesome: RQ1			
- vegetable growing/planting	2	Animal science is much easier than plants	5-6
		Animals simple biology compared to plants	9
- plant science	10, 48	Plants have specific cells and scientific names	10
		Plants more difficult to remember than animals	11
		I like animals better than plants	14
		Plants outside, expose to sun, tiring/exhausting	17
		But harvesting is fun	20
		I like everything about animals from starting to slaughter	21
		Cannot separate between the two (animals & plants), both useful for understanding of agriculture because agriculture is both.	42
Difficult/troublesome to understand: - enterprise planning		Context more towards business	46
		I am not good in business.	47
Lower secondary experience in Agriculture motivates studying the subject further	27	Basic knowledge/previous experience in agriculture, made him interested in Agriculture.	29
- vegetable growing - phenomenal	33	This helps me so much especially growing vegetable project.	32
		My very first experience in planting	32
		Really like vegetable growing	32

Student 2D Second Interview Analysis

Super-ordinate theme - Sub-ordinate theme	Line	Key words	Line
Difficult/ troublesome RQ1			
- farm management (FM)	4	Involves accounting	5
		Have no basic accounting	5
		Have to memorise all (surface learning)	10
		Difficult language, very big terms (terminology),	11-12
		Difficult to describe in own words	13
		Difficult to explain	14
		Accounting is really hard	14
		FM is mostly accounting with a bit of marketing	15
		No practical just on theory	18
		[accounting, difficult language, no practical = troublesome]	
- agricultural research method (ARM)	22	Involves calculations on statistics	22
		Confusing explanation by the teacher	24
Most challenging and most liked/most interesting, fun, satisfying:			
- individual research project (IRP) on plants	24, 54	More challenging	24
		I like it best	25
		Because doing research	26
		I've done the project successfully	32
		I've got yield and managed to sell it	33
		No problem, so total success!	34
		Extremely happy (proud moment)	39
		Very very happy because there is yield	39
		I met my objectives of my research and get results from investigation	42
		IRP provides continuation/link (connection) RQ2	82
		Give confidence	84
		Most satisfying and interesting for me	87
- paddy planting	63	Paddy planting is also challenging – doing work manually	63
Exposure to real Ag world: RQ3	88		
- through attachment (attachment gives exposure to Ag)		Quite enjoy the work	89
		It's fun	91
		Very important experience on learning something new	92
		Newly exposed to new idea	95
		Enjoyed the role given – be junior researcher	98
		Attachment experience makes me feel ready to enter employment "feel of being employed"	102
		It's really interesting, I feel like I am on employment already	111
- overseas study trip		The best experience	114
		Felt like being on employment already	115
		It's fun	116
		Very good, useful experience for us to take home	118

Appendix 5.6
Student 2A first and second interview analysis

Student 2A First Interview Analysis

Super-ordinate theme - Sub-ordinate theme	Line	Key words	Line
Gives stronger impact and understanding in agriculture but difficult/challenging RQ1			
- farming like vegetable growing (annual horticulture)	3, 25	Annual horticulture difficult/ challenging	25
Factor that influence understanding/feeling towards agriculture: RQ3			
- hardship + yield	11	The difficulty/hardship makes one work very hard to get excellent yield and profit	11-12
Most meaningful and enjoyable experience RQ1			
- paddy harvesting	14	We played with mud - fun	14
Topics liked most:			
- soils		Know what to do with soil if infertile	18, 21
- and animals		Know animal diseases and their treatments	19, 22
		Soils and animals are fun/interesting	23-24

Student 2A Second Interview Analysis

Super-ordinate theme - Sub-ordinate theme	Line	Key words	Line
Most difficult/ troublesome RQ1			
- agriculture research method (ARM)	8	A lot of calculations and too many formulae	8-9, 43
		Too much to calculate	42
		Confused which formula to use	44
		I don't like much calculating	49
- soils	51	Difficult to identify soil types	51
Meaningful RQ1			
- paddy	11	sticks to my head	11
Effective learning of agriculture although difficult RQ1			
- annual horticulture (planting method)	12	Planting method and techniques are effective, beginning till harvest.	12
Most interesting + enjoyable + satisfying: RQ1			
- individual research project (IRP)	37	Because the yield is more	38
RQ3 Implication: exposure to agriculture via			
- attachment	55	Fun/exciting monitoring paddy	55
- overseas study trip		Enjoy the experience	63

Appendix 5.7

Student 2F first and second interview analysis

Student 2F First Interview Analysis

Super-ordinate theme - Sub-ordinate theme	Line	Key words	Line
Provide relevant and good understanding of agriculture RQ1			
- plant science (also difficult see Line 40)	1, 40	All regarding plant science	1
		Plant science which are from vegetable growing	3
Most difficult/troublesome + useful for understanding (transformative) RQ1			40, 46
- plant science		It's useful but it's hard, have to memorise	48, 44
		Cell structures and terminology	41-44
		Hormones and purpose	40
		C3 & C4 in photosynthesis, confused	47, 63
Help grasp the idea of agriculture faster RQ1			
- soil			3, 9
- water management			3
- plant science in vegetable growing/ planting			4, 9
Practical reinforce theory RQ3	6	Teacher needs to demonstrate practical and give examples	6
Enjoyable and interesting: RQ1 (could be phenomenal)			
- vegetable growing	13	Talking about yield	25
Personal preference of plants over animals		I prefer plants	38
		I cried when the animals got frightened	37
		I feel it's a bit cruel treating animals this way	38
Value/importance of agriculture to economy (RQ1)			
- self-sufficiency (RQ3 - economic issue)	53	Shouldn't rely too much on foreign countries	53
		Not happy about our agriculture, we must stop depending on other countries	56
Relevant agriculture (RQ2 progression+think like agriculturist = not yet! She just saw the connection but not yet transformed see L68)			
- agriculture + business = successful	60, 62	Get involved with agriculture, can do own business	58, 60, 62
(able to see connection between agriculture and business)	60		

Student 2F Second Interview Analysis

Super-ordinate theme - Sub-ordinate theme	Line	Key words	Line
Most difficult/ troublesome RQ1			
- agriculture research method (ARM)	1	It's about doing research	2
		11 formulae, so it's hard	6
		Headache (confusing)	12
		Steps in the calculation are hard	8
		Gathering data is tedious	16
- ruminant husbandry (only in some parts)		I think I am 'a plant person'	19
(A plant person – preference on plants)		I love plants	21, 33
Meaningful (best part of 2F's time) experience RQ3			
- vegetable growing	32	Doing practical because can understand better	32
Fun/exciting - phenomenal			
- planting	37	Especially when yield is obtained	38
		Feeling is hard to describe	39
		Especially when it is about plants	40
Positive likings to agric			
- future oriented		Want to become a plant pathologist	45, 48

Appendix 5.8

Student 2M first and second interview analysis

Student 2M First Interview Analysis

Super-ordinate theme - Sub-ordinate theme	Line	Key words	Line
Helpful for agriculture understanding RQ1- transformative			
- vegetable growing		Get the experience to plant.	1
		Get the chance to learn new stuffs	2
		Gain knowledge to improve my plants and manage them to get good yield	3-4
Meaningful experience RQ1 - phenomenal			
- paddy planting	6	Something new for me	6
		Really interested	6, 8
		Important for the country: self-sufficiency	7
		Very exciting to learn new stuffs	8
Easiest			
- management of plants: watering, pruning, trimming, weeding and transplanting	14		
Most difficult/troublesome but important:			
- business planning	16	Don't like business planning	16
		Don't understand about business	16
		Too much technical terms	17
		Very difficult to understand	17
- business management		Important for knowing how to gain profit	I2:39
		Absence of knowledge will encounter big loss	I2:40
		After two years, I still have some difficulty	I2:42
		All the basics only: to start, plan and manage the business, but not sure how to run the business (so need to learn through practice)	I2:45
Agriculture starters: RQ3			
- types of tools and their uses	19		
- factors needed for planting: climate, temperature, soil pH	20	Knowing factors help planting successfully	25
RQ3 Change in attitudes	31		
- appreciate hardship		I now know how difficult to get rice	31
		I now know it is hard to get yield from the paddy	32
		Appreciate the farmer	33
		Now with the experience, I am getting more appreciative	38-39
		After experiencing paddy planting, appreciate the difficulties of farmer	I2:49
		I now realised how difficult it is to produce rice.	I2:51
- appreciate food (avoid wastage)		I try to clean my plate	35
		I now hate such wastage	36
		I never want to waste anymore, never again.	37
		If I eat rice nowadays, I wouldn't leave even single rice grain on my plate, I finish it all.	I2:50
- respect family more		Become more appreciative of my dad to feed us	40
		I realised how hard it is for him to sustain the family	41

		The hardship makes us aware how hard our parents work to feed the family	42

*Key: I2:39= Interview 2 Line 39

Student 2M Second Interview Analysis

Super-ordinate theme - Sub-ordinate theme	Line	Key words	Line
Integrative RQ2 and troublesome concepts RQ1			
- Connection between available nutrients in soil + soil types + fertilizer application to soil to meet plants' requirement [inter-relationship between soil-fertilizer needs and crops needs]:		Seems new to us, we are not familiar: a lot of different types of soil and types of fertilizer	2, 7
Soil [types, available nutrients, fertilizer needs] + fertilizers [types] + plants' [needs, types, environment]		Soil nutrients so many, it's a bit difficult to remember	5
1. How to distinguish the different types of soil (i.e. the pH, what nutrient contents in various types of soil).		Not really sure how to differentiate the soil types and the required fertilizer for the crop	9-10
		It's rather confusing	10
		Yes, the inter-relationship	13
2. Too many types of fertilizers to know, so how to know which one is suitable for the soil?		One cannot just plant any crop as you like, it all depends on the soil types.	14-15
		You have to know your soil	15
3. Certain crops will only grow on certain types of soil, so how to know which crop will be suitable for a certain type of soil?		Need to know suitable weather conditions, temperature, soils.	67
Best knowledge RQ1 – gives good understanding of agriculture:			
- about paddy		Best knowledge is about paddy	17
		It needs more work, tiring and challenging	18
		Important for self-sufficiency for the country	21
		Paddy is a package for someone to understand agriculture better	28-29
		Paddy is one of the ways for getting to the understanding	32
Best experience, most interesting and exciting of all RQ1			
- on paddy	53	What we really focus on	53
		Interested to do further study on paddy	57
Most useful due to **practical activities**			
- soil, water management and poultry	69	Because mostly learnt by practical, easy to remember and understand	69-71
		Hands-on activity we can understand since we experience and feel it	73-74
		Teach me I will learn, show me I will understand	75-76

Appendix 8

8.1 Detailed descriptions of the evidence of progression

8.2 A case of an untransformed learner – Student 2A

8.3 A case of a transformed learner – Student 2N

Appendix 8.1

Detailed description of the evidence of progression

Student:	Connections between ideas:
	▪ ***Progression in the knowledge: seeing connection and relationships***
2C	‘agriculture is food for life’
2L	‘agriculture is connected to science’, ‘agriculture and research’, ‘humans and plants’
2N	‘agriculture connection with food, business and management’ ‘relationship of crop with soil, environment, fertilizers, pests and diseases’
2M	‘relationship of crops with soil and fertilizer needs which in turns determined by other factors such as weather condition and temperature’
	▪ ***Transformation in attitudes/perspectives:***
2N	environmentally friendly person
2M	appreciates hardship, avoid food wastage and respect family more

Agriculture is food for life – relevant and important towards life

Interview question:

Now that you have learnt agriculture, is there a difference between what you’ve learnt previously and presently in terms of usefulness of agriculture to you?

Student 2C’s responses (Interview 1):

Line

Hmm... previously different because it’s in the secondary school. But now, it’s more 77
connected to our life where our food supply we get from ... I think there are lots more in 78
everyday life ... even what we eat everyday where the food source comes from agriculture 79
like rice, food, chicken meat from poultry – so these are all agriculture subjects...all are 80
connected to real life. 81

I: All connected to real life? O...I am very interested, can you explain more?
Like... especially food. Beef is from ruminants. Chicken from poultry, we also learnt. 82
Then vegetables all we planted. Then rice as our food source, so all our life is connected to 83
agriculture. For me, this is my own opinion. 84

I: So you can see connections on plants and animals and the food that we eat and how agriculture provides for our life, where the supply of food comes from. Does this make you into someone different? I mean previously you don’t know about agriculture but now you know that these things are connected, do you feel your thinking is different from previously?
2C: My life is not different, but my thinking is. Agriculture is important now for life. 85
Indeed, truly. When I think about it logically, it is truly that agriculture is important. 86

I: So, the topics that you learnt how are they connected?
2C: In real life they are connected. The topics we learnt are also connected. To produce and 87
to plant, so crops so connected. 88

The response began with Student 2C comparing her previous agricultural learning experience whilst in her lower secondary school to her present course. There was an increasing realisation in her present course that she could see more connections of the importance and usefulness of agriculture towards food we need compared to when she was in her previous schooling. There was also an understanding that agriculture is the primary food supplier to everyday life and what that means to our real life connection [Lines 77-81]. She gave several food examples coming from agricultural activities and declared that all our life is connected to agriculture via food production [Lines 82-84]. She also admitted as a result of her current learning that there is a shift in her logical thinking of how she viewed agriculture differently from her previous time: she viewed agriculture as getting increasingly more important for life [Lines 85-86]. She concluded that the agricultural topics she learnt were related/connected in real life, which is 'to produce and to plant' crops, so connecting concepts to real life [Lines 87-88].

From this evidence, Student 2C has demonstrated how she tried to link/connect her understanding of various agricultural topics to their relevance, usefulness and importance in a real life context, and how these issues have brought about her conceptual thinking shift. She reflected as a learner who is capable of relating in context, where she could link and integrate several parts into a whole by seeing the applications of her knowledge in a real context situation. In terms of SOLO progression, this would be the thinking expected at the relational SOLO Level 4. Besides relating she was also able to apply, compare and explain. This seems to indicate a deep understanding, a reflection of the thinking like in an agriculturist's view at this level of learning.

The evidence also showed that there is progression in the student's thinking development as she began to relate to or connect various concepts together as learning takes place over time (after one year). It implies that a student who learnt agriculture via practical activities could develop a deeper understanding of its relevance and importance towards life. Such understanding involves awareness of the usefulness of agriculture in terms of food production and its connection to everyday life, and food sources mainly come from agricultural production. The belief that all the concepts in agriculture are connected to real life, because 'to produce [is] to plant' (Interview 1: Line 87) and 'agriculture is important [...] for life' (Interview 1: Line 83), is such a strong sentiment seen in Student 2C's views. It suggests that whenever students think of the everyday food that they eat or need, they connect it to the agricultural activities they have experienced in schools and therefore they brought some realisation of the usefulness of agriculture towards their lives.

Agriculture is connected to science, humans, business, management and research

Interview question:

But so far do you like what you have done in learning agriculture?

Student 2L's responses (Interview 2):

	Line
Yeah. But most people think that agriculture is just like holding a hoe [working with	50
soil], toiling under the sun, but they didn't realise that most agriculture is related to science.	51
So, I am more interested in how plants live, so applied science is very important in	52
agriculture, not just worrying about the production side such as people who got turned off	53
from the heat. Like... how to explain this? I wanna be a plant pathologist so I wanted to	54
know how to improve the rice yield, then which diseases encountered by it and many more	55
to learn. And then the management, etc, and many more.	56

There was a realisation in Student 2L that agriculture is not only about working under the sun but mainly related to science, especially in the field of applied science, which to him is the more important. It seemed that he was trying to link his agricultural learning experience with the science knowledge he learnt in classrooms. Due to his interest in how plants live, he had the ambition of becoming a plant pathologist in the future. It seems that his interest has encouraged him to wish to become an expert in this area. And when he has become that expert, he aimed to improve rice production in future.

Further interrogation on how he saw the relationship between agriculture and science yielded the following interview extracts.

	Line
I: I am interested to go back to your previous interview which said that "in order to understand agriculture fully one has to know the internal and external processes that happen in plants and animals". Do you still hold the same view now after two years of studying agriculture?	
2L: Yes, still. Because we need to know what their needs, etc. We know like... plants are	83
like human, right? So, what we need what they also need. So, therefore we need to know	84
how to make them grow healthy, so we need to know what's happening outside and inside,	85
what to be applied and what should we give to the plant so that it grows healthy. So	86
knowing this is very useful if in commercial basis can increase our yield and makes more	87
profit. It's like we are learning more knowledge. We get the knowledge than we implement	88
it then we know what is happening. Then we won't make any lost so we know if we are	89
expert already so it is much easier to manage the plants since we know what's happen	90
inside. And when something happen then we know what's the problem and then we know	91
the solution for what to do. So we need to know both inside and outside.	92
I: Now that you are towards the end of your second year course, is there any difference between your first year compared to this second year?	
2L: Hmm... not much difference, still the same. But a new subject with the research and	93
something new. At the beginning it's a bit difficult, but as we did it, it goes well.	94
I: Has it opened up your mind towards agriculture all about?	
2L: Yep, agriculture needs more research. Cos I like the research, the individual research.	95

The evidence revealed that Student 2L has valued highly his science knowledge as a way of understanding agriculture. He related theory to practical applications of the knowledge in context through science, which informed him to use his science knowledge to visualise problems and carry out the necessary steps to improve his plants' growth. He understood that knowing the internal processes in plants helped him understand with how plants lived. His argument underscored the importance of knowing science in relation to agriculture understanding in practice.

This is a remarkable understanding in Student 2L, especially when he wrote 'in order to understand agriculture fully one has to know the internal and external processes that happen in plants and animals' (quoted from his survey questionnaire responses). His evidence showed that he understood agriculture by connecting theoretically and experientially via science, and linked it to research and procedure, and wider areas such as in business and management (see Lines 87, 90 & 93). He emphasised that 'not many people know that most agriculture is related to science' and that 'applied science is important in agriculture learning' (Lines 51-52). He even noted that 'plants are like human and their needs are more or less like us' (Lines 83-84). He also has the view that agriculture needs more research (Line 95) if it is to be successful.

The evidence shows that he was able to use his basic, everyday and personal experiences to provide an analogy that plants have similar needs to humans; and via procedural skills in planting activities to transform his agricultural understanding, relating to business lost and profit and the importance of crop management, to ensure success. Although his responses did not reach the highest level in the SOLO taxonomy where one would be able to hypothesise, he was able to criticise the need for future research by saying that the country would need more experts in agriculture. So, it would seem to me his understanding could be categorised in the SOLO level 4 relational level, seeing his capability to relate, analyse, argue and criticise based on the evidence.

Agriculture is connected to food, business and management

Interview question:

But like you said just now in the beginning of this interview, you would like to do business. What is business to do with agriculture since you know the agriculture world is very complicated? And then you are also interested in agriculture business in the future, why do you foresee business besides it's one of your interests? I mean with regards to success of an agriculture world, do you feel that business is part of it? Why is that?

Student 2N's responses (Interview 2):

2N: Because the agriculture's end product is food. And people live on food. And people buy food. Food is a necessity for us. And I don't know if it just comes naturally, I also like business and I also like agriculture. So, from there it starts to develop. I tend to see opportunity in agriculture business since a long time ago. Yeah... because I see Brunei is quite slow in agriculture.

I: I often heard people said that, 'Oh, actually planting is very easy, production of crops and raising animals, ...are very easy if you know how, but they still fail sometimes, why?

2N: If people say like that, I would say although easy, and of course you can get results in the end as everybody can grow something. But then in order for you to get not just good but best result, you have to improve your skills and knowledge on agriculture. If your plants in one metre area can have 10 fruits, mine can have 30 fruits, do you see the difference? That's why the knowledge of agriculture is also needed if you want the best result. That's what I think.

I: So, in a way to be successful in getting the best results, is it management or business?

2N: Management. Of course knowledge is there. If you say business, business is also management. It's like business is only a part of it. You have your agriculture – skills and knowledge, that is, where you 'manage' your agriculture first – your farm. And then business comes next. Like, how are you going to sell your goods? You have to know that also right? And you have to see the business opportunity, like in Brunei, what is in demand? We cannot just, oh because I like this fruit, I want to plant this fruit. And then say, but nobody is going to buy it. So that's why, that is where it's connected.

Student 2N was able to explain why agriculture is connected to business, when she explained that 'the end product of agriculture is food which people buy (business)' (Line 62). She also had the view why proper training in agriculture knowledge is necessarily important as to be successful, especially in the commercial scale agriculture: 'commercial scale - for better result and more yields, need more agriculture knowledge and skills' (Lines 69 & 71).

From her responses, there was an understanding of how agriculture is connected to business via food production and marketing, and the need to do more business in this industry. It seems that she was viewing success in agriculture through the lens of business. There was also a realisation on her part for the need to contribute to the slow development of the country's agriculture, seen as an opportunity for her to open business in this sector in the future.

It is interesting how this student can relate her thinking through the output of agriculture and the way she connected it to business; that is, business in agriculture is mainly to do with food that people buy, which usually comes from agriculture. Her explanation as the reason for explaining the connection between agriculture food production and marketing with business seems to centralise around her interests to embark on business in future.

But upon further probing (Line 67), she was able to connect her understanding beyond the context of her school learning, where she seemed to almost think like a commercial producer already. This is a remarkable reflection from Student 2N, the thinking level which could only be attained at higher level than her current education. It seems that she was able to think like a commercial farmer despite her course was only providing conceptual thinking at a small scale level. This is an example of advanced thinking demonstrated by Student 2N.

She even hypothesised for the success of agricultural production and the need for proper training in this area if one is to be serious about it. She viewed that agriculture on a small scale is easy but not on a commercial scale, where a lot of skills and knowledge are needed in order to get better results. Her commercial thinking perspective, in relation to proper training and skills, was evident when she said, 'If your plants in one metre area can have 10 fruits, mine can have 30 fruits, do you see the difference?' (Line 70).

She also demonstrated an understanding of the relationship between business and the importance of management in the farm for successful commercial production. There seems interplay of production with business (demand and selling) in her connection of thought, the thinking that not many students at this level can reach.

It seems that she even went a bit further than the relational stage of SOLO thinking when she was able to see connections between business and management. She generalised that business is part of management and justified, 'you manage your agriculture first – your farm (via skill and knowledge), then business comes next. It's connected' (Lines 74-75 & 79). This is a thinking that is quite high for this particular level of education. It seems that she was able to think and practise like an agriculturist already and therefore her progression seemed to have reached SOLO Level 5 at the extended abstract level for this level of education.

Relationship of crops with soil, environment, fertilizers, pests and diseases

Two students, namely Students 2N and 2M, have demonstrated progressions of understanding under this category. I will focus more on Student 2M due to the longer deliberations in his interview, although I will also show some evidence from Student 2N's extractions to illustrate another point.

Both of them have been able to see connections and relationships between plants, soils and fertilizers and the balanced requirement in optimising the plants' growth environment. These connections are complex and they were seemingly baffled by these concepts (and astonishingly in Student 2N), as clear conceptions can only be reached at higher order thinking level. Both students seemed able to reflect and hypothesise beyond what has been given from their learning. This seems like extended abstract level 5 in SOLO being displayed.

In the case of Student 2N, she seemed to have a good understanding of the impact of over-tilling of soils and its repercussion; and other important connections between soil, environment, fertilizers, pests, and diseases in order for plants to grow healthily. These interacting factors in plant environments made her come to the realisation how 'it's a very complicated world the plants are living in' as she viewed the importance of understanding soil properties, as illustrated in the following extracts (Interview 2: Lines 56-61):

I: So we have this problem for Brunei?	Line
2N: Yes, we have just only recently discovered this problem. So, it's a surprise. I also just	56
knew about it, that we cannot till the ground too much. So knowing about soil properties is	57
one of the keys to understanding agriculture. Because, there are a lot of factors that can	58
involve in the crop production. So, not only on soil, there are others, even the surroundings.	59
The environment can develop into disease for your plants. It can invite insects and so on.	60
Fertilizers, and all sort of things. So it's a very complicated world the plants are living in.	61

As for Student 2M, his troublesome stemmed from connecting various concepts together, as seen from his Interview 2 extracts below:

I: Okay, any knowledge or concepts so far you find difficult and troublesome to you, like very difficult to remember but very important to agriculture?	Line
2M: Aa... like fertilizer, soil nutrients because we are focussing mostly on paddy but don't	1
focus so much on the soils and all the nutrients, so it's seems still new to us so we are not	2
familiar.	3
I: Not familiar with the soil nutrients? What, you mean the different types of fertilizers, but aaa when you said soil nutrients is difficult... is it the difficulty when comes to applying it?	
2M: No. I mean to know which nutrients are important to be used for paddy planting.	4
Because in soil there are many types of nutrients (essential minerals), so it's a bit difficult to	5
remember, till now I haven't been managed to remember all.	6
I: So you are thinking like you don't know when to apply certain types of fertilizer to paddy, when does it need, is it?	
2M: That's seems like it, but its regarding the soil – since there is a lot of different types of	7
soils and also types of fertilizer, so basically we used the recommended fertilizer. And as for	8
soil, there are a lot of different types of soil, so we are not really sure how to differentiate	9
which types of soil is better and the suitable fertilizer for the crop. So, it's rather confusing.	10

I: So, is that means, whilst planting crop, you don't actually know which fertilizer to use?
2M: Basically, we usually used the common fertilizer that is recommended such as the NPK. 11

I: So knowing different types of soils and the nutrients it contains, and the different types of fertilizers, so like different types of soils do you need to know also?
2M: Yes, of course. Because certain crop can only be compatible with certain types of soil. 12

I: So your answer is actually revolving around soil (types of soil and the nutrients it contains), fertilizer and crop, I mean between these three in order to grow crop better?
2M: Yes. The inter-relationship. 13

I: Okay, that's if for fertilizer you are confusing about the types, if for plants how?
2M: If for crops, depends on the types of crop. One cannot just plant any crop as you like, 14
because it all has to depend on the types of soil. So, you have to know your soil such as by 15
finding about its acidity, and the type of soil, so that's it. 16

The inter-relationship between the soil, fertilizer and crops seemed to be very important to Student 2M. His perplexity has caused him to invoke deep reflection over the multitude presence of the types of soil nutrients and the need to supplement their loss (due to weather conditions and temperature) with the various types of fertilizer application in order to meet the plants' requirements. He observed that not all crops could be grown on any type of soils – he fully understood these relationships as evidenced in his various generalisations which could be interpreted as: (1) How to distinguish different types of soil (in terms of pH, nutrient contents in various types of soil)? (2) Too many types of fertilizers to know, so how to know which one is suitable for the soil and crops? (3) Certain crops will only grow on certain types of soil, how to know which crop will be suitable for a certain type of soil?

Clearly, his active construction of trying to relate all these inter-connections, i.e. between soils-fertilizers-crops which are dependent on one another and to apply them into his practice, is higher level thinking in Student 2M. There was interplay about which soil should go with which fertilizer and with which crops. Although at first he found this difficult, further probing showed that he actually understood the connections except for certain parts that still puzzled him: how to differentiate which soil type is better and which suitable fertilizer to apply to crops (Line 9-10). He was fully aware that not every soil will support any type of plants (Lines 14-15) and stressed that 'you have to know your soil' (Line 15). So basically, his problems revolved around soil types, fertilizer and crops: the inter-relationship between these three in order to grow crops better, which he confirmed at Line 13 of the interview transcript.

All these require higher level thinking in agriculture. Student 2M had reflected a lot about his learning experiences and was able to connect different ideas together.

Agricultural scientists would resolve such problems through carrying out experiments of plants growing in different types of soils and to rectify nutrient deficiency by applying various types of fertilizers; potential solutions can also be based on one's previous experiences and practice. Clearly, this thinking resembles agricultural research level, or more like undergraduate university education.

Student 2M had overcome his troublesomeness and his interview data analysis showed that he was successful at some points. He understood the concept links except that he had no idea what determined as suitable and appropriate in the working mind of an agriculturist. His constructive thinking and way of visualising problems presented something that is beyond classroom level already. There was also evidence that he was trying to solve problems by speculating between weather unsuitability and soil incompatibility in his planting of onions (Line 65).

I: So basically, you have no problem in this course?

2M: Yeah, there is no particular one that is most difficult, but last time we have problem whilst doing our research on planting onion when there is no yield produced. There was problem with either not suitable weather or not compatible soil. This is the difficult part due to unfamiliarity of us planting onion. We never planted it before so we don't know how to manage it... Need to know suitable weather conditions, temperature, soils. So that's mean before start planting we need to do some research about the crop.

Transformation in attitudes and perspectives

Some evidence of students' attitude transformations were detected after studying agriculture for one year. Students were seen not only to have made progression in learning in terms of their *thinking, knowledge and skills* in agriculture, but they had also shifted from their original attitudes and perceptions. There was a connection of emotional feelings with the learning, environment, attitudes and perspectives. These included care towards the environment, such as against open burning and chemical spraying; appreciating hardship and food; and respecting their family even more. It seems that an understanding of pest control, its effect and consequences via agriculture learning, enhances care towards the environment. This is a similar finding to that of Nguyen (2012) where 'caring' is the everyday threshold concept in integrated pest management.

Student 2N thought that it is not good for the environment to practice open burning when plant materials could easily be turned into compost heaps (Line 88). Similarly, applying chemical sprays which could also harm the environment and natural living things should be minimised through organic farming she said (Line 91). Her reflection indicated her preference for environmentally friendly practice in agriculture, and favoured alternative ways. Student 2N expressed in her interview (Interview 1):

Line
2N: Yeah... [giggle] ... Hmm...I can say yes, a little bit, because there is always something 82
which ... like I say ...like about environment and the plants. It looks like I know better 83
than others in the family because I take agriculture. So, anything they don't know they'd 84
asked me. But I said, I am not a specialist in this but then this is what I know. I think that 85
does affect a little bit on my personality. For example, the way I am thinking on the 86
environment. 87

I: I see.....what if for example, burning, someone wants to burn something behind your house backyard how would you react? Will you stop that person?
2N: That is my number one dislike, I don't like burning. I always thought why don't they 88
compose it or why don't they bury it? It's an ecosystem you can always recycle back. I 89
think that's how my mind think ... more like environmentalist. 90

I: You can see that there are some good and bad practices, it seems that through learning agriculture you are able to choose between things we should or shouldn't do. Like spraying chemicals some people tend to overdo that.
2N: Yeah, in using pesticides people know that there is an alternative like organic way, it's 91
just that you need to learn about it. You have to learn to mix some of this or that using 92
organic materials, your pests are no longer there. So what is the difference between with 93
chemical pesticides? So that is how my mind thinks. Sometimes I know it's bad, it makes 94
me think what are the other alternative. 95

For Student 2M the hard work, such as that involved in paddy planting activities caused him to transform his perspective of agriculture. It made him aware of the challenges farmers have to endure in order to produce rice. This created a tendency in him to appreciate that food, especially rice, should not be wasted. He said, 'if I eat rice nowadays, I wouldn't leave even single rice on my plate, I finish it all' (Interview 2: Lines 50-51). Ever since the paddy planting experience, he became more respectful of farmers and their determination to work hard, including his appreciation towards his father in his role as the bread winner of the family (Interview 1: Lines 40-42). This evidence shows that physical engagement in labour work and contemplation of associated emotions could connect the learner's experience to what farmers do. His paddy planting experience had impacted him so much that it has transformed him to view life from a new perspective – thinking and practising like farmers. Additionally, his desire to help his father with his fruit orchard and the need to support the country's self-sufficiency motivated Student 2M even more to further his interest and pursue an agricultural career in future.

Student 2M, Interview 1:

I: Okay, from your previous questionnaire response you wrote: "the experience from which I gained during the paddy planting gave me the opportunity to appreciate the hardship of a farmer for their hard work in managing the paddy and helps to produce more yields." Can you explain to me more about the hardship and appreciation that you mentioned in this statement. Line

2M: Before this we don't know how difficult it is to get the rice. In this school I get to learn 31
the hardship, I now know after I experienced on my own that it is hard to get the yield from 32
the paddy.

I: So you appreciate the farmer or the paddy/rice?
2M: Both. 33

I: So, last time before this, when you eat rice your attitude was...what...?
2M: There's some left over rice, wastage on my plate...[giggle]... 34

I: So now how do you feel?
2M: Now, I try to clean my plate...[giggle]... 35

I: O yeah ah... it's not easy as you said, even a single grain of rice left. Sometimes there are children who are so ignorant that put so much rice on their plates and end up throwing them away if they can't finish it. Such a waste.
2M: Hehehe... Now I am okay... And I don't like wasting my rice anymore. I hate such 36
wastage.

I: Wow, hmm...that's good [feel amazed on his realisation]. So, your attitudes have changed?
2M: Yes, and I never want to waste anymore. Never, never again. 37

I: So, it's tiring and hard as farmers. Did you not ever experience how hard work is before this?
2M: No, never, I just experienced light work only. So now with the experience, I am getting 38
more appreciative. 39

I: So, how is your relationship with your dad?
2M: Good. But now I become more appreciative of my dad and how he tried to feed us as 40
the bread winner of the family. I realised how hard it is for him to sustain the family. 41
The hardship makes us aware how our parents work hard to feed the family even for a 42
fistful of rice.

Student 2M, Interview 2:

	Line
I: But, last time, you mentioned the hardship causes you to appreciate about food, do you still hold the same view?	
2M: Yes, especially on rice. Before when eating rice, if there is some leftover, I just throw	48
them away... I didn't seem to really care. But now, after experiencing paddy planting	49
myself, the difficulties of being a farmer, like, if I eat nowadays I wouldn't leave even a	50
single rice on my plate, I finish it all. I now realised how difficult it is to produce rice.	51

Both examples, from Students 2N and 2M above, seem to demonstrate progression at the SOLO Level 5 (extended abstract) where there is evidence of deep understanding beyond school context. They showed us that learning about agriculture can bring a lot of good values to learners, not only in terms of gaining knowledge and skills but also in terms of personal changes/transformation in attitudes and perceptions. These virtues point more towards the meanings behind the experiences for life and self, family and community in terms of personality, well being, socio-economy and environment. The whole experience made students look up more to agriculture as a future endeavour. This positive attribute and attitude transformation, which emanated from agricultural experiences, is admirable and praiseworthy.

Appendix 8.2

A case of an untransformed learner – Student 2A

Student 2A is categorised as an untransformed learner. There was hardly any evidence of attempting to relate or connect her knowledge; even if there is, the connection made was very simple and considered independently (Interview 2, Lines 14-18). Although she knows that there is some connection of agriculture with science, especially the biology parts, she could not explain the relationship (Interview 1, Line 32) to help her agricultural understanding. She also knew that the science knowledge would be useful to visualise her practical activities in plants, but she seemed unable to visualise the connections as it was revealed that she is *not* a practical person, thus creating an imbalance and the missing part that could help her better understanding.

She seemed to be unable to make links between her practical and theoretical knowledge learnt in classrooms, and therefore could not apply her theory to make sense of her practical. So, she prefers theory lessons more than practical (Interview 1, Line 4). It seems that she didn't obtain much understanding during her practical as compared to her theory lessons, as she said there was only 'brief' explanation given for the activities (Interview 1, Lines 4-6); as a result she couldn't understand the purpose of the practical activities she was engaged with. This seems to imply that the teacher's insufficient explanation for activities reduce the chances of this learner connecting to theory. As one says, there is hot water but not enough to make tea.

This resulted in her to like and enjoy best those lessons which she found easiest. For example, between paddy planting and vegetable growing, she would prefer the former since there was not much to do. Between the topics on soils and animals (Interview 1, Line 23), she prefers the latter for reason of ease of understanding, because soil she found to be more complicated.

The untransformed state of Student 2A seems to highlight that there should be a balance between acquisition of knowledge and the application of knowledge, from theory to practice, that learning should always be in context. Similarly, Ashwin (2008) also argued that, in economics, more enforcement should be between the 'acquisition and use of knowledge'. Sfard (1998) also warned that there is a danger between ignoring just one thing between her notion of 'acquisition and participation metaphors', where a mixed metaphor seemed to be most useful. She argued that we need both metaphors, as relative advantages from either of them will offer what the other cannot provide (p. 10).

The worst case scenario in this particular case is that even Student 2A admitted that she hasn't been able to increase her knowledge i.e. not making much progress (Interview 2, Line 24) despite already learning for two years. This could be the carried over from her previous year, when she was only able to make connections in what were isolated chunks of knowledge, where students are expected to actively link more interconnections but which, for her, seemed to have no relevance in her second year. This issue of stagnant progress will cause a lot of concern to us. It would appear that either the student is unable to make links or the teacher has failed to facilitate such connections.

She also remarked on insufficient time and resources (Line 29) for doing the practical activities. This seems an issue of a stuffed curriculum with too much to do within a limited time and the issue of limited resources. Both could limit the efficient function of practicality to reinforce understanding.

This problem could also stem from her being unable to connect her various theory lessons with one another, probably due to an overstuffed curriculum with too much content during a lesson. Alternatively, it might be that she could not organise her thinking logically since she was unable to connect between various concepts, and more so to connect to her practical activities. There is evidence for this conclusion in that she preferred topics to be taught in a compartmentalised way (Interview 2, Line 6) due to her failure in organising her thoughts in a logical structure.

In contrast to paddy lessons, there seems evidence of sufficient learning taking place for students since there were theory lessons, planting activities which were also reinforced via attachments and study trips to bring about effective learning. Thus, having practicality is important for acquiring an understanding of agriculture. It seems that to Student 2A, the paddy component in the course has provided sufficient grounding with theory and practicality as seen from the various contexts of learning in which it took place. Not only was paddy learnt during school lessons, but students experienced the world of work during their attachment; as well as in an overseas study trip to gain insights into, and compare how, other countries are going about doing their rice farming. These contextual experiences seem to give a complete and whole picture in paddy learning and provided vast insights for learners.

The issues with Student 2A seem to point to an inability to connect, and therefore she was unable to make progress, and what more to transform in her discipline. Could this be due to her inability to see deeper into why each practical experience was carried out and to connect to the overall picture of agriculture? It seems that she failed to connect the ideas theoretically as well as practically, and to apply them in real and everyday contexts – which form the basis of agricultural understanding. The evidence also seems to suggest that there is lack of practicality in some parts of the course. Unlike, in paddy, which has more emphasis compared to the others in the course, it seems learning about paddy during lessons and planting it, and then being reinforced via attachments and study trips, could bring effective learning to an untransformed student such as 2A. Thus, having practical experience is important for the understanding of agriculture, so that students could understand better. In the case of Student 2A, numerous exposures to paddy planting experiences brought the desire to venture into paddy production in future, which is a positive effect. Could this be the reason, or one of the reasons, why most students did not turn out to be agriculturists in the past? That is, it seemed that learning was not successful in transforming students to think and practise like agriculturists, such that lack of confidence is impossible for them to become one and do something about Brunei's agriculture. But this is just the tip of an iceberg we are talking about here, since this interpretation is just based on this one particular case.

Evidence of interview extracts of an untransformed learner, Student 2A:

Line

I: Okay, in terms of your intellectual thinking and development, did your thinking expand after doing this research methods?
2A: Hmm... I think I've expanded since I can utilise the calculation. 14

I: How about its application for your future career in agriculture? I mean... what shall I say... I mean what will be its benefit towards agriculture wholly?
2A: For making ... like... [Quiet] like...What do you mean? 15

I: Like... when you research about paddy, like...when you count the stems or the panicles whatever or the stalks, etc., so what can you learnt from that, i.e. the application to it?
2A: Ahm... like if the bunch of paddy stems is bigger, sometimes the grains are much more.. 16
But depends sometimes if the bunch is small but the grains are more. So we can compare. 17

I: So after learning agriculture for two years, is there a difference of what you learnt in this second year from that in your first year?
2A: Yes, different. In the first year, its basic but in this second year it is more detail. 18

I: So is it sufficient to complete your agricultural knowledge?
2A: No, it's not enough. Because the subject in the first and second semester is about 19
diseases in animals. But in this second semester, it is much more detail. If possible, let it be 20
different from the basics in the first semester. 21

I: But what is it to you that are really most important to be learnt in the second year?
2A: Hm... like... [quiet] hm... about...ahm... About types of plants in detail... whole of it... 22
But livestock also needs to be in detail, not similar to the basics. 23

I: So, do you feel that your knowledge has been increasing?
2A: No, not increasing. I feel like, it's more of the same thing. The subjects/topics are 24
almost similar, not much difference. For example in semester one it's about animal, but in 25
the second semester it's about poultry husbandry but the content are about similar, not more. 26

I: Is it not detail, or just different?
2A: Not so detail, just in the middle. Not so much detail. 27

I: I see. Is it because you just learnt it from theory without practical?
2A: Theory only. For the practical, we only have a visit. 28

I: What is the reason for not doing the practical?
2A: Because during learning livestock, we don't have chicken or cattle. 29

Appendix 8.3

A case of a transformed learner – Student 2N

There is remarkable evidence from 2N that she has achieved the relational level and the extended abstract in SOLO levels 4 and 5, when she was able to relate various ideas together in an integrative way. Progression in Student 2N's thinking seemed so evident in that, in order to be successful in the agriculture world one needs to be good in management, which consists mainly of aspects of production and business. She was able to connect her thinking between agricultural production and business; and stressed that agricultural production requires good management, both in agricultural skills and knowledge, to be successful on a commercial scale. This is in contast to a small scale which does not require a lot of specific agricultural knowledge and skills.

Commercially produced food in agriculture needs business to sell or export it. In the interview, Student 2N was able to link agricultural food production with business via food. She said that 'food is the end product of agriculture and people buy food' (Line 62). There is a relationship between production and business through demand in commercial agriculture, as it is not appropriate producing something when there is no demand from people willing to buy it, according to 2N.

On the whole, it all centres on food, for agriculture is the production of food which includes selling it via business. Increase in demand will also increase production in commercial agriculture. And undoubtedly, commercial scale production needs both good knowledge and skills in crop management and production. In summary, consumers' demand for food determines and calls for good management both in production (knowledge and skills) and business, if it is to be successful. This is an extraordinary understanding seen in Student 2N, someone who had been able to think at a higher level of thinking and practising within the agriculture discipline, as well as beyond the context, as in commercial production.

As a case of transformed learner, Student 2N's insight into her learning is a remarkable finding in this study. Student 2N's ways of viewing her learning has displayed an exceptional phenomenon and hence her transformation at this lower level of agriculture is outstanding. Student 2N kept mentioning a 'picture' (Interview 1, Lines 14-15) as a way of viewing learning holistically, and in-context, by relating her learning experiences to real life applications. From her interview data, it seemed that a transformed learner can view things holistically in a whole picture, as opposed to a discreet manner. A picture represents her ways of thinking about something as a result of inter-relating concepts to each other to form one whole bigger piece: a picture is formed as a result of these various concepts linking together to create it. In other words, in a transformed learner like her, the knowledge one learnt in school should be connected to real world application in life, in order to be viewed holistically. Seeing the connection this way can transform a learner to value more of their learning, as they can see the real application of what has been learnt. In progressing, Student 2N is taking a holistic view of learning by linking concepts actively and constructing her thinking based on her acquired knowledge, related to her everyday life and context. A picture represents her whole thinking; that is, the connection and inter-relationship between agricultural production and business – which seems to be the proposed threshold concepts of agriculture in this study – in order to nurture agriculturist ways of thinking and practising. On top of that, she foresees that in learning 'one should be able to think outside the box' (Interview 1, Line 70-72) and to 'relate to real life' (Interview 1, Lines 74 & 80):

Line

I: I am actually doing research to find from students which of the concepts or parts of their learning that are really useful for understanding of agriculture better. So I need to interview you guys to find out so that I could recommend those concepts for teaching to every student because that concepts are the key to their understanding better.

2N: O, I see, since you said that, to me overall, any subject although they are related to 67
agriculture, I think we as a student we need to know how you incorporate it into real life – I 68
think that is the main point, like, I feel as a student you just learn and learn, but then you 69
don't think outside the box, you tend 'not' to think outside the box, like asking why should I 70
do this for? What is it for? Like this subject, what is it for? What is the importance when you 71
do practical and all that stuffs? So I think the students need to be briefed about that. 72
Like, they need to be shown [demonstrated] so that they can picture what they are learning 73
and its needs to be used in real life or real situation. 74

I: So you think it is important to relate it to real life situation?

2N: Yes of course it is important because I believe agriculture is more to practicals...more to 75
planting... farming and so on. So, it's not like maths when you have the ... for example, if 76
planting you have the resources like soil and your seeds, but for mathematics your 77
resources is numbers, so it's in front of you already so you can do it in front of you already, 78
but this is different in agriculture. So I think the students need to know what is the 79
usefulness in real life when you are going to do your farming, this is, what your subject is 80
for. I think we tend to forget and not to think about that... 81

Thus on the whole, it can be said that Student 2N has related her experiences to the *wider connections of agricultural relationships* i.e. evidence that she has reached a higher level of understanding. However, Student 2A is oscillating between some *irrelevant responses,* as well as towards *simple structures.* Thus the SOLO hierarchy is useful in diagnosing students' levels of understanding or levels of quality, as a way of seeing integration or connection of knowledge in the students' thinking.

Appendix 10

10.1 Detailed analysis of concepts under content areas at the multicase level

10.2 Detailed analysis of Teacher A's interview and findings

10.3 Detailed analysis of Teacher H's interview and findings

Appendix 10.1

Detailed analysis of concepts under content areas at the multicase level

Content areas in agriculture	Teachers																
	Z	A	H	T	M	R	J	L	N	S	F	K	B	V	*f*	3+	No. of responses
1. Farming and systems		✓	✓		✓	✓	✓	✓				✓	✓		8	*	8
- Farming		✓	✓		✓	✓	✓	✓							6		
- Farming system												✓	✓		2		
2. Farm management						✓						✓			2		2
- Record keeping						✓									1		
- Management in farms												✓			1		
3. Farm machinery, tools and equipment	✓			✓											2		2
- Farm machinery				✓											1		
- Farm machinery, tools & equipment	✓														1		
4. Animals livestock production	✓			✓	✓					✓	✓	✓	✓	✓	8	*	10
- Livestock/ruminants rearing and production	✓			✓						✓	✓				4		
- Livestock pests and diseases												✓	✓		2		
- Genetics and breeding											✓	✓			2		
- Livestock management													✓		1		
- Uses of livestock					✓										1		
5. Poultry											✓			✓	2		2
- Poultry											✓				1		
- Rearing poultry														✓	1		
6. Fish and prawns (aquaculture)														✓	1		1
- Fish and prawn farming														✓	1		
7. Crops and vegetables production	✓		✓	✓	✓					✓		✓	✓	✓	8	*	10
- Planting/growing vegetables and crops	✓		✓	✓									✓	✓	5		
- Hardening										✓					1		
- Plant nutrition										✓					1		
- Plant structure & function												✓			1		
- Pests and diseases													✓		1		
- Uses of plants					✓										1		
8. Fruit trees growing				✓							✓				2		2
- Growing fruit trees				✓											1		
- Plant propagation											✓				1		
9. Paddy planting		✓													1		1
- Paddy growing		✓													1		
10. Ornamental horticulture and landscaping	✓													✓	2		2
- Horticulture & landscaping	✓														1		
- Landscaping														✓	1		
11. Soil	✓			✓					✓	✓	✓	✓	✓		7	*	12
- Soil	✓			✓								✓			3		
- Soil composition and formation											✓		✓		2		
Soil properties:																	
- Soil properties										✓					1		
- Soil fertility										✓					1		
- Soil texture									✓						1		
- Soil nutrients									✓						1		
Soil management:																	
- Soil drainage									✓						1		
- Soil leaching									✓						1		
- Soil erosion									✓						1		
12. Food processing and industry		✓													1		1
- Food industry & processing		✓													1		

13. Business entrepreneurship	✓		✓	✓	✓	✓	5	*	6
- Agribusiness and entrepreneurship	✓		✓	✓	✓	✓	5		
- Agri-industry						✓	1		
14. Technology – old and new	✓			✓	✓	✓	4	*	5
- Technology	✓			✓	✓	✓	4		
- Post-harvest technology					✓		1		
15. Agriculture careers and employment			✓	✓	✓		3	*	3
- Employment and job opportunity			✓	✓	✓		3		
16. Self-sufficiency	✓		✓			✓	3	*	3
- Self-sufficiency	✓		✓			✓	3		
17. Individual research project		✓					1		4
- Plan what to grow		✓							
- Choose the right variety		✓							
- Apply knowledge and carry out activities		✓							
- Report and present		✓							

Appendix 10.2

Detailed analysis of Teacher A's interview and findings

Super-ordinate theme - Sub-ordinate theme	Line	Key words	Line
How arrive at TC? RQ3 Critical episodes in learning, the pickup point where students observed getting motivated in learning Ag as reflected by teacher?			
- visual creates interest: visualising the things in front of them made them interested in learning.		Interested in learning as they saw the thing in front of them	5
		They liked it and that they wanted to learn more	7
		Also when seeing the specimen they get very interested.	25
- gardening: hands-on/practicals made them interested, happy and eager, 'feeling of doing'		Very happy when they heard that they're going to do something hands-on/practicals [students' mood changed into something different]	9
		They get interested, especially if there is practical	25
		They were very hard working, everybody was doing their job. Such as mixing the soils, potting on, etc.	23
RQ1 TC in agriculture subjects **Farming**			
- farming, especially vegetable farming	28	Farming has practicals, becomes real.	28, 37
		Practicals they could see or feel	29
		Avoid boredom, sleepiness if theory only no practicals	30
		Farming describes agriculture the most	39
		Fish rearing, ornamental planting, vegetable growing – are all farming.	40
		Especially vegetable farming – gives the most understanding	42
RQ1 + RQ3 How? **Why vegetable farming:**			
- motivation in terms of money generated from the sales from the harvest and yields.		With vegetable farming on individual, it's much easier for marketing – products sold separately	44-45
- satisfaction from seeing own work, effort and sweat		students see their own effort →satisfaction from result	48-50
- commensurate their effort.		"Whereas if the work was done in groups, students may not know which were as the results of their own work. Because some may not contribute if in group work. If on individual basis, one can see and admit that all was done was from one's own work and sweat."	50-53
		They even requested to do it alone, Teacher A said, students used to say "I want to do it alone, so I could get more money since I have more yield".	47
Why practical activities? Practical helps understanding: - helps theory - engage learners		Yes, yes, definitely [practicals help understanding]	54
		...they learnt about theory... Then ...they applied it to practical	54-56
		[without practical] makes learning difficult, ...	57
- helps visualise students to agriculture and how certain things are done		they cannot visualise how things look like and how things done...especially in vegetable farming	58
		Not similar to reading in books (which is	58

	surreal) "things look like, how these things are done.	57-61
RQ1 **Difficult concepts** to students' understanding:		
- difficulty in learning due to difficulty in language use	Difficult words, difficult terms, explain bilingually	64
- not common to everyday language	Hard to remember the word Even simple word like weeding	65-70
- technical term difficulty - not familiar to everyday words	Technical terms, they find it hard to understand and remember	72
	Because these words are not very familiar in everyday use.	73
	Sometimes, even pests and diseases, they don't know.	74
	They are all new to them these terms like insecticide, rotovating, rotary tiller, all these farming machineries, so they have difficulty	74-76
Overcome by: - memorisation technique	introduce the technical word then give its meaning and then ask them to write in their note book and try to memorise.	77
- practical activities to reinforce meaning	again relate to practical like all the activities, as a way of reinforcement.	78-79
	And then in every teaching, I have re-emphasised the word's meaning.	79
Useful concepts in agriculture: - entrepreneurship 93	in agriculture its more regarding selling and marketing, how they sell their products such as the vegetables. entrepreneurship in agriculture is more towards selling and marketing,they don't have to...like go to government sectors for future work, like for example, they can like concentrate more on business.	95-99
- food processing and industry	Food processing and industry... learn about fruit tree crops, the fruits can be turned into canned fruits, like... jams, etc	100
	Processing like in fish products such as fish balls, fish cakes.	101
	Teachers need to mention these to students, as these are also part of agriculture that is related to agriculture industry.	102
Issue in agriculture education: Gender issue – practical activities (such as farming) more **challenging to girls** due to heavy work involved	Theoretically, the girls are performing better in class compared to the boys.	86-87
	Boys are active, and don't like to sit long. they could be day- dreaming	84
	Girls are okay and they like to ask questions, girls are more curious	85,86
	Boys to help with their work. They're doing their work but the boys must help.	88
	Girls may do their work slow and finish the work late, the end product of their work is usually very good.	89-90
What the country aspires is not equally transcended in the education.	All this while, agriculture is a subject which is neglected, and not given any priority, not listened to. So, now they know that our Majesty has already underscored how important agriculture is, especially regarding paddy. So, I am very happy.	110-112

Farming gives the overall understanding of agriculture

The result of the analysis from Teacher A showed that *farming,* especially vegetables, (similar to her responses in the survey questionnaire) provided students with a good *overall understanding* of agriculture. The reason for this, as reflected by Teacher A, is that, it has a practical component where students can visualise their learning in the real context – allowing them to know how things look and how things are done. She observed her students' mood picked up when informed of upcoming activities. She said they got very interested and motivated (Line 25). They felt excited when learning something they can visualise and feel when doing practicals. Teacher A echoed the importance of learning in reality and in a concrete visual environment in agricultural subjects.

Farming describes agriculture the most

Besides providing an overall understanding of agriculture, Teacher A's results also highlight that 'farming describes agriculture the most' (Line 39), especially in vegetable farming. The reason for this, as reflected by Teacher A, is that 'farming has practicals' (Line 28) where students can visualise (Line 5) their learning in the real context thus allowing them to know how things look like, and how things are done by feeling or doing. She observed that her students' mood picked up when informed of upcoming activities, and that they became very eager, interested and motivated. She mentioned that the students felt excited when learning something they could visualise and feel, especially when come to doing practicals. 'They get interested, especially if there is a practical. Also when seeing the specimens they get very interested' (Line 25-26), mentioned Teacher A.

Concrete-visual learning in agriculture; practical increases participation

Teacher A echoed the importance of learning in reality and in the concrete-visual environment. The practicals provided the avenue for *doing* or hands-on which increase participation, and thus practicals increase participation. Increasing learners' participation means that there is active learning taking place. As seen in Teacher A's interview data, through doing and seeing the real things during practicals, made her students interested and eager to participate. Therefore, doing either through hands-on or by being actively engaged in activity, increases participation. Teacher A's data also showed that the students also learnt best in context (contextual learning). Learning in context allows learning in a less abstract way. As Teacher A resonated, the students' moods in learning plant science changed when they saw real specimens in front of them, ‘they like it and they wanted to learn more’, she said (Line 7). This means that providing learning in a concrete-visual way encourages more learning and interest to take place, since these can stimulate learners’ thinking.

Similarly, practical activities in farming provided *real* experiences for her students (Lines 28 & 37). During practicals, her students could see and feel (Line 29) through engaging in various activities. Teacher A was of the opinion that practical activities will avoid students’ boredom, sleepiness, and day-dreaming during theory lessons. This is because practical hands-on situations are very likely to motivate learning and increase students’ participation, and therefore, lessen the inattentiveness and disengagement. Teacher A said that it all centres on farming, in agricultural learning. She believed this applies not only in the farming of vegetables but also includes other types of farming such as ornamental plants and fish-rearing. Nonetheless, she was of the opinion that *vegetable farming* gives the most understanding in learning agriculture (Line 42). It seemed that to Teacher A, farming is the starting point for making meaning in students’ understanding of agriculture. Similarly, in learning plant structure and function, she believed that the subject could give insight and feeling towards an understanding of agriculture. So, it seems that from this evidence, farming in the form of planting or growing something plus plant science knowledge, could contribute to an overall understanding of agriculture. Similar finding were revealed in the students’ data, where planting and plant science were both viewed to be useful by students for understanding agriculture.

Why practical activities in farming?

‘Practicals help the application of theory’, therefore, this ‘definitely helped students’ understanding’ (Lines 54-56) according to Teacher A. It seems that allowing students to do practical activities helps them to understand and make meaning of their theoretical knowledge. This shows that practicals help to foster an understanding of theoretical knowledge through real application in context. So farming experience is helpful for understanding through *reinforcement of knowledge in the real context*, besides also the *practicals could engage learners to stimulate their thinking*. Not being given any farming experience will dampen students’ motivation and make their learning more difficult. This is because, according to Teacher A, students could not visualise how things look and how things are done, especially in vegetable farming, as it is dissimilar to reading from books. She mentioned the following in relation to the absence of practicality:

> ...that makes their learning difficult, sometimes they cannot visualise how these things look, how these things are done. Especially in vegetable farming, it's not the same as reading from books or doing on your own, touching the materials. So the problem is they cannot visualise, or cannot imagine how to do things. So the more they do it by hands-on the more they can remember. The more they remember, the more they understand. The terms even like pests, say for example, caterpillar of course they know. But, aphids...? What does an aphid look like? Just showing it on books sometimes it is not similar to real ones [Lines 57-63].

The above extract from Teacher A was similar to Student 2N, who also remarked that learning agriculture must be visualised through real-life experiences, and in context, to get a whole picture. This is also the case for Student 2M who declared that doing helped him understand and remember more. This shows the importance for learners of practicality in agricultural subjects. The evidence showed that farming experience helped students to visualise agriculture and how agriculture should be done. Learning without the farming experience would dampen their motivation and made it even more difficult and abstract, due to the fact that they cannot visualise the learning in front of them. Learning by doing, therefore has a powerful effect in such cases. This is dissimilar from learning through books or just by reading. Thus, to the agriculture students, without the farming/gardening experience, understanding would be difficult or troublesome.

Why particularly vegetable farming?

Vegetables usually take a relatively short time to grow compared to other types of crops, which is why they are the most suitable to use in a school garden and for teaching agriculture. When asked the reasons why vegetable farming is the best for teaching students about agriculture, Teacher A mentioned two things: *motivational and satisfaction factors*. The money generated from the sales of the vegetable harvests and yields becomes the motivating factor for the students, she said. Secondly, the satisfaction from seeing their own work, effort and sweat, made them feel happy and rewarded. Most students would usually like to see that their work is commensurate to their efforts. Individual vegetable farming, according to Teacher A, as opposed to working in a group, allowed her to sell her students' produce separately, and provide an ease of marketing, since she knew which vegetables were being produced by each student. Seeing the results of their own efforts and getting the satisfaction from them, thus motivates students, and is also a way of ensuring fairness for the students. She explained, '... whereas if the work was done in groups, students may not know which were as the results of their own work ... because some may not contribute if in group work. If on an individual basis, one can see and admit that all that was done was from one's own work and sweat' (Lines 50-53). She added, '... they even requested to do it alone' so that they could get more money since they have more yields (Line 47) for themselves.

Troublesome knowledge due to language difficulty, uncommon or unfamiliar to everyday language

In reviewing Teacher A's interview data, there was evidence of difficult concepts encountered by her students. Recalling her previous and current experiences, the problems the students encountered came from the difficulty of language use; that is, words which may not be commonly used in everyday language. This finding about language difficulty is similar to what Perkins (1999) termed as one of the root causes for troublesome knowledge. In Teacher A's students' experience, the difficulty was caused by certain technical terms that are hard for them to conceptualise and remember, as these words are not familiar or common in to everyday language (Line 73). Worse still, and making it even make more difficult, is that English is not their first language. She mentioned terms like insecticide, rotovating, rotary tiller, farm machineries, and even simple words like weeding, pests and diseases (Lines 74-76), were hard for students to remember; particularly their meanings. The vocabulary issue left her no choice, but to teach by way of memorisation techniques – repetition and to 're-emphasise the word's meaning in every teaching' (Line 79); as well as reiterating the meaning again when she taught the practicals. The practical activities are thus useful for reinforcing meaning of the difficult technical terms. During theory lessons, she had no choice, but to introduce technical word, give the meaning and then ask her students to write in their note books and encourage them to memorise them (Line 77). This shows that the difficulty of explaining unfamiliar words did not only occur in the students but the teacher too, which forced Teacher A to use bilingual explanations (Line 64) in trying to make her students understand well.

Important useful concepts in agriculture

Entrepreneurship, food processing and industry are important concepts students need to know, according to Teacher A. She viewed entrepreneurship as related to business with emphasis more on selling and marketing, which is useful both in agriculture and for future employment. She chose the three concepts in her previous survey questionnaire because she regarded them important for self-employment in terms of doing business, so that students need not have to rely on the government for their future employment (Lines 95-99). She also viewed processing agricultural products into processed foods as an important part of agriculture which students need to be informed of, because this is related to agriculture industry; for example ‘fish processing into balls and cakes’, ‘fruits into jams’ (Lines 101-101). Clearly, Teacher A viewed agriculture as a potential platform for future self-employment and business, which students could pursue rather than just solely relying on the government. This gives a holistic view of the agriculture industry in learning, and may be a somewhat high level for some students’ thinking to accept.

Issues in agriculture education

A small issue in practical activities emerged, such as farming is more challenging (or difficult) for the girls than the boys, due to the heavy work it involved. This is a gender issue in Teacher A’s classes. She said, the girls were good in theory classes, but in the practicals were not so good due to the heavy work they had to do. But, however, the girls were more careful and meticulous despite being quite slow to finish their work, as compared to the boys. The girls would always complete their work properly. She explained:

> ...theoretically, the girls are performing better in class compared to the boys... Boys are active and don’t like to sit long or they could be day-dreaming... Girls are okay and they like to ask questions ... girls are more curious. Practically, the boys [are better]. The girls will ask the boys to help with their work. They’re doing their work but the boys must help. Although the girls may do their work slowly, and finish the work late, the end product of their work is usually very good [Lines 84-90].

It could be gathered that there seems an *element of team work* exists during practical work in the farm between both genders, where male students help female students. This implies that it is better to have co-ed (mixed) students in the agriculture course in school, because of the role boys play in reducing heavy work during practicals. Although vegetable growing is supposed to be done on an individual basis, the work involving heavy physical effort requires some elements of team work and cooperation among students to deal with the tasks together. Such cooperation can happen and work well in a school’s vegetable growing project, which is why vegetable farming is the most suitable activity to foster team work, aside from of its short-term span to produce a crop yield.

One of the issues revealed from Teacher A’s data is the issue regarding support for the agriculture subjects in the education system. There was an issue about what the country aspires to, is not, in fact, being equally transcended at school education level. She argued that the agriculture subjects in schools are being neglected and not given a priority. There were limited financial funds and voices were not listened to, despite agriculture being rhetorically stressed at the national level, particularly concerning rice self-sufficiency. The campaign to raise rice production to attain a sufficiency level in order to overcome the food security problem was launched country wide by His Majesty. Only then, could she feel very happy with the image of the agriculture subject (Lines 110-112).

Appendix 10.3

Detailed analysis of Teacher H's interview and findings

Super-ordinate theme - Sub-ordinate theme	Line	Key words	Line
		Key: I2= interview 2	
Planting embedded in practical activities - RQ1		What to plant	2
		Making the right choice for planting	3
		Applying the knowledge in practical activities, which benefits/importance of agric to Brunei	4
TC! RQ1 Critical episodes in learning, the pickup point where students observed get motivated or gained enthusiasms in learning Ag as reflected by teacher?			
- Planting! Planting is the most enjoyable part.		... when it comes to planting i.e. gardening	6
		So excited to go there	43
		Made them enthusiastic, very anxious, eager	7
		Very excited, extremely eager	8
		Especially if it coincides with planting time	12
		... they liked it	13
		They really enjoyed it, made them enjoying it	15
		That's how they become enthusiastic	17
		They really enjoyed their plants	43
		...theory lesson, they're getting very bored.	10, 11
		To theory lesson, they would wish that it soon get over, so that they could go to their garden	44
How arrive at TC? RQ3 - ***'Business injected some enthusiasm'***	22	Business side of agriculture has actually injected some enthusiasm	22
		Selling the chicken after slaughter...they were all very excited	21
		Asking for seeds from me	25
		Wanted to plant myself at home	26
		Sells the produce himself, loved agriculture so much	27
		Money – makes him happy and pleases parents	28
		...yield, made them industrious (yield motivates them)	I2:18
Practical activity is a must have for understanding agriculture:		"They really enjoyed the practicals...that's why for agriculture, it should not be far away from practical... if no practical activities, they will easily get bored."	I2:98-100
- **Project-based learning** is enjoyed by students. Such as vegetable growing, poultry rearing, and paddy planting.	I2:36	Poultry and vegetable growing, both they really enjoyed	I2:36
Poultry, vege growing, paddy – are well liked by them due to practical components in the project.		Paddy project also they liked	I2:37
- Chicken rearing project		When they started raising chickens, they began to love agriculture	20
		They need to have the 'real' experience.	104
		Really important to give them the experience since this is what most of them going to do if they really wanted to venture into farming.	105
		The lack of practicality is not thrill for	103

	students [Students even admit that they love to do the gardening, but not so much on the theory.] They felt it's rather boring.	106
	Will it not affect their practical if they don't understand their theory? True, but that's why we shouldn't give too much theory, there needs to have more practicality.	108
With practicals, students... ***- understand more***	Through doing it, they understand more and why it has to be done. Just by doing they could understand the concept	I2:65 I2:67
	'This means that they will understand through their actions rather than just I described to them what it is' If they themselves carried out the task, they know what's the term means They don't know what it actually means until they do it	I2:60-61 I2:61-62 I2:63-64
Doing makes learning more. (i.e. Learning by doing promotes deeper understanding)	If they did the practical they could understand what it means	I2:68
- remember more Practical – helps gain more and remember more knowledge.	Already know what to do [by doing they remember more, so no need to inform them again and again].	I2:72
- become better student and do better as well in practical activities	Even my worse students, they can do better in the practical	I2:73
- know the reasons why certain cultural practices in Agriculture is carried out	[By doing] ... they know what that pruning is and what tools to use, how to do it, the reasons behind it – due to the practical activity Carrying out certain tasks/practices in agriculture ... they know the reasons why they do it. And why it has to be done.	I2:69 I2:58-59 I2:65
- can apply their theory	Can apply what they learnt in theory	I2:48
- can predict what steps to do	Upon seeing the situation and conditions of their plants, they can predict what to do, and what steps to be done such as time for fertilizing [Know what to do] just by seeing the conditions on their bed... no need to tell them anymore what to do [after first time experience].	I2:49-50 I2:55-56
- get motivated	Students become motivated if they do the practicals ... when they're doing the practicals starting from sowing, land preparation, plant maintenance, all these they enjoyed doing - the point when they become motivated and interested in agriculture I see the difference in their motivation They really wanted to do something during the	I2:1 I2:2-4 I2:5 I2:30

	practical, 'they wanted to know what they're capable they can do'.	
- they even get motivated by teacher	Competition for best project: most healthy and most yields, most industrious – get presents from teacher besides money from sales of produce.	I2:195
	So they loved it.	I2:199
- praise from parents further motivate them	Brought home some yields to be tasted personally and enjoyed by the family (freshly picked – tastier)	I2:200
	Eager to show their parents (share with parents what they've done in school)	I2:203
	Home where their parents are also motivated about their children's learning of agriculture	I2:218
No practical - means ***low in motivation***, less in understanding. 'no practical, less understanding' i.e. learning becomes difficult and understanding becomes insufficient.	Lack of motivation	I2:46
	No practical, less understanding	I2:47
	There is insufficient understanding	I2:47
	Without the practical, I don't think they can understand how and why these cultural practices being carried out in agriculture.	I2:58-59
	No practical, they wouldn't know and cannot visualise how to do certain tasks.	I2:31
- Without it, they get ***bored***.	Stay inside the classroom, they get bored	6
	They are very reluctant and said its boring, so they wanted to do gardening.	8
	If no practical activities, they will easily get bored.	I2:99
	Showed lack of interest	7
	They feel it bored if there is no project going on.	I2:27
	No project work, learning will be more on the theoretical, which made them feel bored.	I2:28-29
Why practical experiences? ***- provides better understanding***	So, activities provide a much better understanding to	I2:70
- engage their thinking (curious), ***increase participation***	They asked me everything, they were so curious.	I2:21
	Always asking me all sorts of these questions, due to their curiosity, especially during projects	I2:26
- promotes thinking and decision making, encourage participation, and enhance motivation.	They become curious and raised more questions	30
	They become excited and curious, wanted to know why	32
	There were so many questions they raised and asked me	34
- ***encourage and motivate*** them, and ***promote further learning*** by them becoming curious (raised more questions, become more ***inquisitive*** minds), similar finding in Teacher A	Sometimes, I don't have to tell them what to do, they already know what to do and when	37
	Amazing, after sometimes they are even faster at noticing things and even doing it better than I would expected.	39
- builds confidence	Upon seeing the situation and conditions of their plants, they can predict what to do, and	I2:49-50

		what steps to be done such as time for fertilizing	
		NB: Students can make decision on what to do and take some steps after some times, without being told – an evidence that they've learnt and understood what was expected of them.	
- made them ***responsible and committed*** - practicals ***promote enthusiasms***		During school holidays no body taking care, so it's a bit difficult. The plants died. They worried about their plants and they came to the school.	I2: 37-39
- ***encourage team work and cooperation***		Doing it together... there is cooperation, they do it together	14, 16
		Challenging parts such as soil cultivation (soil preparation for vegetable beds) - they became very cooperative, helping each other like brothers and sisters in family, not selfish, they do it in team work, foster closer relationship between classmates	I2:130-2
		Motivate and push each other to do the work, scolded lazy friends	I2:137
		The good ones even challenge to teach the lazy ones	I2:141
		So by helping and motivating each other they learnt better. So from there they gain more knowledge and remember more by doing	I2:142-3

RQ1 Troublesome: **1. Soil is troublesome** (not everything of soil)	75		
		Soil concepts must be taught to students, but difficult, they cannot avoid it.	78
		Soils, to them this is difficult to understand.	I2:32
		They're quite slow in grasping soils	49
		When it comes to soil, for them it's hard, difficult for them to accept because it's more like based on facts [factual, too abstract, can't be seen].	51-52
Soil (chemical & **physical properties**, see below Line 75):		They told me, soil topics are difficult and they requested me to give revisions on it, again and again [memorisation for students as a way of overcoming difficulty].	53-55
- ***too factual, too complicated***	51	Chemical and physical, they found it hard to understand. They always complain to me that it is difficult to understand the soil	I2:33-34
		Too complicated (soil physical properties)	I2:223
		How to improve soil like liming, pH – soil chemical properties are okay	I2:224
- ***cannot be seen, too abstract*** e.g. soil pore spaces and drainage		Because they cannot see these things	76
		Difficult ones are like soil pore spaces and drainage in soil.	I2:225
difficult to imagine/visualise unlike in ruminants.	76	Practically they know how to apply drainage to avoid water-logging in the farm	I2:226
		Couldn't understand the pore spaces concept in lab practical difficult for them to visualise or relate to.	I2:227-9
"Soil topics are difficult" but must be taught (the earliest) and cannot be avoided (see Line78). i.e. difficult but necessary.		It should be the earliest, by common sense as it should.	78
		To me for a start, we need to teach the basics of soil not too complicated at the start.	I2:222

- Soil difficulty is link to language difficulty	80	When come to answering examination question they have problems they couldn't understand the questions, and also could easily get confused.	86
		I think it's due to the difficulty of English, difficult for them to understand	88,89
		Have trouble with written, in answering and explaining in English	90
		Brings performance down	91
Difficult due to problem of difficulty of understanding English language		They couldn't explain in words (English problem) to describe the answers though actually they do understand. This is the only hurdle which makes them finding it the difficulty.	I2:145-7
		Forget the right words, to explain using the right words	I2:148-9
Very wordy = so much to remember		But they have no choice, they have to master both, the theory and the practicals and they have to know how to explain in words. Because we are so exam-oriented.	I2:149-51
2. Plant propagation (marcotting, grafting, cutting) Difficult but interesting		... it's difficult for students but interesting.	I2:96
Interesting: ***- enjoyable to students***		They really enjoyed the practicals...that's why for agriculture, it should not be far away from practical... if no practical activities, they will easily get bored.	I2:98-100
- easier to do during practical		Much easier for them to do it during practical.	I2:230
It is difficult: ***- too much theoretically***		It's too much theoretically	I2:230
- a lot to explain		It seems a lot... and all have to be explained	I2:95
- difficult to get plant sources for practicals.		It's difficult to get the plant sources for the practicals.	I2:97
- difficult terminology and confusing		Sexual v asexual propagation – the only difference is the letter 'a'	I2:233
		Students complained to me most of the times. They get confused	I2:234
Concrete learners (for soils difficulty)		Students they come along learning with pictures having to see themselves the things... ...to visualise [visual learning].	58-59
- "students learnt by picturing" from visuals, so as to remember from experience. Even the teacher found it hard if without having past experience.		**"If learning based on theory only, I don't think they can understand**. Even for myself, I found it difficult to understand unless we see the things for real. However, I myself, have the previous experience when I learnt the diploma agriculture, so I can visualise myself and can still remember. For them, they don't have the prior experience."	59-63, 63
		From here only they can visualise, just based on theory, they wouldn't be able to understand	66-67
How to overcome troublesomeness: 1. Lab practical helps understanding of soil concepts.		Having practicals on soils in the lab helps their understanding	76
2. Teach simple contents first		We should be careful not to put too difficult content at the start, just give the basics first,	81-82

	like the functions of soil, make it simple so as not to alienate students So we have to be cautious with which part of the soil topic to teach first so as not to intimidate (them) as this will have repercussion on their motivation.	 83-85
3. Teacher has no choice, have to use bilingually to make students understand.	Have to use bilingual – teach in Malay language, so that my students understand. I had to, to make them understand I feel pity for them I have to, I had no choice. English is very difficult for them, not only for my subject, other subjects as well	68 69 71 72
4. To overcome language difficulty:	Practice more writing, practice more question papers I think. Have more revisions... Drawing to illustrate the points help Answer by points to avoid constructing long sentences. So that they can remember That is, avoid unnecessary words in order to remember Memorise the concepts. The spellings also difficult So this is how, more on remembering strategy... use mnemonics Have to relate to something remember ... there must be something to relate to remember... only then they enjoyed the learning. Because agriculture has so much to remember. Actually, a lot to remember and confusing in terms of technical terms. But once they get the technique, it's okay. After such lengthy explanation, they admitted it is much easier to understand once it makes sense to them	I2:152 I2:154 I2:238 I2:239 I2:166 I2:157 I2:160 I2:168-70 I2:244
Agriculture helps understanding of other subjects as well.	Students often said, "it's interesting this agriculture, it's so complete, it has everything.	I2:113
Agriculture is ***a package*** subject. Real = living, can be seen, felt, eaten. Why it helps science?	"In science, although there are many practicals, but the practicals are not real, non living. Because in science students have difficulty visualising, whereas in agriculture the things are real and can be seen. They can see the plants and animals in front of their eyes. In agriculture when they learnt about chicken digestive system, they can visualise, however in science the human digestive system is difficult to observe from their everyday life. And that in chicken the parts can be eaten, but in human it's not consumable... which means in agriculture, they can visualise, feel, and eat. Everything is possible. So, agriculture is fun... complete... it's a package! A package subject!"	I2:187-94
- Science, mathematics,	Agriculture helps them a lot in terms of their understanding of other subject as well Through this subject students can learn in concrete, they can apply their knowledge because of the practical activities. It benefits other subject as well not just agriculture	93-94 95-96 98

- agriculture is everything in! So complete. Multifunctionality (see Line 180).	In my opinion agriculture has everything, everything is there in agriculture	I2:106
	Agriculture has everything...all subjects included. Multifunctionality but really fun for students	I2:180
	So everything in! Most subjects can integrate with agriculture	I2:110
Agriculture **overlaps** with other subjects: - Science	Science and agriculture go along, because in science there is also agriculture. In agriculture there is also a bit of science. E.g. plants in plants science	I2:117-8
	They know science and agriculture go together, easier for them to understand	I2:122-3
- Maths	Students those poor in maths, could learn maths in agric... using real data to calculate... [so it makes sense to them]	I2:108
- English		
- Geography	For example, soil and geography, ... ain't this seems like geography	I2:109-10
- Accounting	In poultry project, we counted expanses and sales account	I2:112
	In agriculture, its encompassing...everything exists within this subject. "It has geography, accounting, a bit of maths, in short everything. Even a bit of chemistry as well such as in photosynthesis."	I2:113-6
Values of agriculture - Build confidence in thinking and acting/behaving like farmers	Practiced planting at home Practiced what was learnt from school at home Seemed successful	I2:206 I2:214 I2:217
- Provides living skills, self-reliance, and overcoming unemployment	Self-reliant Aware if couldn't find any job, would support himself by farming	I2:215 I2:216
Issues in agriculture education: Less support (lack of support for facilities)	Teachers felt there is less support for agriculture in school (unlike other more important subjects)	102
	Eager to plant paddy in school, but no land (given/allocated) for this	100
...and not enough resources for teaching practicals activities	...suppose I have to carry from home, it's too much to carry... heavy, lots of preparation.	I2:105
Issue of not enough agriculture teachers	Not enough teacher and teaching loads too heavy for me NB: students were willing to commute far just to study agriculture	I2:85
Issue of parents' low perception towards agriculture	Some parents were discouraging their children from taking agriculture due to the low perception they have towards agriculture (i.e. wrong perceptions towards blue collar job)	I2:219

Planting embedded in practical activities

The finding from Teacher H's data analysis showed that the planting concept is well embedded in practical activities. Her previous survey questionnaire's responses identifying agricultural threshold concepts, also showed similar concepts being embedded in an individual project. From the beginning, she already mentioned the planting concept as implemented in the planning and applying knowledge in practical activities, and to relate the importance of such activities to the economic benefits of the country. She seemed to have already identified planting as the key threshold concept. Perhaps, that was the reason why her responses to the questionnaire were so different from the rest of the teachers. In thinking ahead, she just focussed on *planting as the key in the agriculture practical activities*; and seemed to show at the outset that she already knew which of the concepts is primarily responsible to motivate, enthuse and transform students; unlike Teacher A who only declared this upon interview probing.

In similar tone to her questionnaire responses, during and throughout in-depth interviewing, Teacher H kept coming back to this same idea. Her interview analysis gave a picture of agriculture learning as difficult, but enjoyable in the planting or farming components of the practical activities. From the beginning of the interview, she reflected on the importance of practicality as the trigger for students' motivation and enthusiasms in planting activities. Results of her interview analysis illustrated that students did not show much interest until the time they were about to do practical activities, especially planting in the school garden. Teacher H observed that students became more active and inquisitive once they started doing practical activities in the farm. She noted that farming, especially planting, is the most enjoyable learning experience for her students. To her, this seemed to be the starting point when students were getting motivated and enthusiastic. This boost in motivation similarly occurred in Teacher A's findings and was noted in the evidence from Students 2C and 2F.

Teacher H admitted that she enjoyed and felt satisfied in her teaching if students were more enthusiastic, inquisitive (eager to know by asking lots of questions), and actively interacting with each other (making lots of discussions and negotiation with her and among their friends, see Interview 2: Lines 182-186). To her, practical activities are 'must-haves' in agriculture learning. Her dialogue showed compassion in her interaction with students, adhering closely to their empathy, and in exhibiting a display of enthusiasm and indication of deep satisfaction in her teaching experiences and students' interactions.

Threshold concept in agriculture: Planting is the most enjoyable part (critical episode) in agricultural learning

When asked about a critical episode in which she witnessed her students starting to get motivated or gain enthusiasm in learning, Teacher H reflected ‘when it comes to planting’ (i.e. gardening, I1:6) and ‘especially if it coincides with planting time’ (I1:12). She noted her students would become very excited (I1:8&43), enthusiastic (I1:7), anxious (I1:7), extremely eager (I1:7&8) and they liked it (I1:13) and ‘really enjoyed their plants’ (I1:15&43). This shows that planting experience is phenomenal to them. Her students enjoyed tending their plants and indicated they were engaged in learning about planting. This could also be attributed to the pleasure of the freshest taste, when they consumed their own harvest and the money generated from selling, and even the satisfaction from seeing yields or their healthy plants. All these matters could form the critical episodes, in both cognitive and emotional culminating in the learners. This indicated planting is the most enjoyable episode for her students. In contrast, her students would get bored (I1:10&11) if the lesson was just on theory, forcing them to sit inside their classroom, and how they ‘wished it soon to be over so that they could go out to their garden’ (I1:44). There is something about the agricultural planting and practical activities which have caused students to become infatuated. In terms of the threshold concepts framework, this suggests that planting is transformative since it engages learners deeply. It seems that the students appeared to have found a way or ability to relate and fortify their theoretical/cognitive thinking with their emotional experiences, through the practical experiences and activities provided by the act of planting.

How do students arrive at their threshold concept in planting? Seeing yields and selling (the business side) injected enthusiasm and further sparked the impetus

The ‘business side of agriculture has actually injected some enthusiasms’, Teacher H asserted (I1:22). The real contextual learning, via practical activities, triggers the love and enthusiasm for agriculture, especially if it shows in the students’ eyes that there are extra benefits such as yields and generated income. The motivating factor is the business side, or *selling* to be exact, as Teacher H emphasised that students could see the monetary value of agriculture. Besides money, yield had firstly made her students industrious, and they wanted to work even harder. She explained, ‘seeing this yield, made them industrious...’ (I2:18). She also added:

> In my previous students, when doing project in chicken or poultry, they also liked it. Because when they started raising chickens, they began to love agriculture. And then, until selling the chicken after slaughtering at the abattoir...they were all very

excited. That’s why in my point of view, the business side of agriculture has actually injected some enthusiasms for agriculture [Interview 1: Lines 19-22].

Due to enjoyable school experiences, some students were further motivated, and they wanted to try out planting on their own time at home. Some students even requested some seeds from Teacher H, so they could try out planting them at home (see Interview 1: Lines 25-27). This is a similar finding in Student 2C, who was also motivated to plant something at home due the influence by her school experience. This evidence shows a strong liking for agriculture, which had been developed from the school contextual experience. Specifically, the experience had a great impact on the students; so much so that they brought these experiences home out of their strong interests and the desire for wanting to do more. In addition, being able to sell the produce made them feel happy (I1:28) and successful. The emotional feelings adhered to planting and the success emanating from their efforts are motivating factors. The fact that this success pleases the parents would further add ‘oil to the fire’ (I1:28).

Practical activity is a necessity in agriculture, especially a project-based activity

Agriculture is enjoyable to students because it involves practical activities. Data from Teacher H showed that practical activity is a must have for understanding agriculture. Agriculture learning must have practical activity components to be enjoyable for students. Project-based activities such as vegetable growing, poultry rearing (I1:20 & I2:36) and paddy planting (I2:37), are rich with practical components, well-liked and enjoyed by learners. As Teacher H argued, ‘they really enjoyed the practicals... that’s why for agriculture, it should not be far away from practical... if no practical activities, they will easily get bored’ (I2:98-100). She stressed the importance for the need to have real experience for students, and said that it is ‘really important to give them the experience since this is what most of them going to do if they really wanted to venture into farming’ (I1:104-105) in the future.

However, a lack of practicality is no thrill for her students (I1:103). She admitted that her students loved to do gardening, but not so much on theory lessons in the classrooms where they feel bored (I1:106). Feeling bored could be a sign of students who were unable to understand their learning as they could not visualise the relevant context. She has the opinion that teachers should not give too much theory, but there needs to be more practicals in learning agriculture (I1:108). This implies that, for students to find agriculture both interesting and understandable, there should be more emphasis on practical activities.

What are the benefits of practical activities?

Practical activities allow students to: (1) understand better, (2) remember more, (3) know the reasons why certain cultural practices are carried out, (4) apply their theoretical knowledge into practice, and (5) get motivated.

- Practical activities help to understand agriculture better, thus remember more

Besides enjoyable lessons, obtaining satisfying yields, money and hard work from their learning, there are other benefits of having practical activities in agriculture. One of the most important findings revealed from Teacher H's interview is that students can understand agriculture better through doing practical activities. When they understand, obviously this will allow them to remember more. By doing, students are encouraged to remember more, as most often we tend to remember what we had done rather than by what other people have said. This evidence shows that practical activities are able to better inform the students' understanding, since they embark on the doing the practical activities themselves. This supports that there is a relationship between what is happening between their hands and the cognitive thinking in their minds. The activities the students experienced put them into active thinking, since it could be visualised, so they could feel and understand better. Also, visualisation has helped them to remember more from the image they hold in their head. From this evidence, it can be seen that there were interplays of *physical* experience (practical activities), *emotional* experiences (enjoyment and happiness), *context* visualisation (real context learning) and *cognitive* thinking. It can be argued that all these behaviours have taken place to consequently provide better understanding and remembering.

Teacher H argued that 'through doing it, they understand more and why it has to be done' (I2:L65). She expressed, 'just by doing they could understand the concept' (I2:L67). This shows that learning by doing promotes a deeper understanding of knowledge in agriculture. She emphasised that 'this means that they will understand through their actions rather than if I just describe to them what it is' (I2:61). She added that 'they don't know what it actually means until they do it' (I2:L63), and 'if they did the practical they could understand what it means' (I2:68). This means that by performing through their actions has helped the understanding of certain concepts better, because doing makes learning concrete and promotes visual understanding. Thus, hands-on activities are particularly important for subjects like agriculture, which emphasise practical and living skills. Although it must also be learnt theoretically, it may not be as effective as learning through practicality, as some concepts have to be learnt tacitly. When students understand and remember, it saves teachers' time to repetitiously explain the process and/or concepts, as they would know what to do the next time they had to do the tasks again (I2:72). She said that even her worse students can do better in the practicals compared to how they perform in theory lessons (I2:73). This suggested that students will not feel alienated by their learning, and could improve their performance by relating well to their practicals and theory over time, thus helping the weak students to become better in the learning process.

- Practical activities allow students to know the reasons why certain cultural practices are carried out

Through doing certain practical activities, students are allowed to understand why certain cultural activities were carried out. Obviously, it is much easier to explain in the practicals through doing and demonstration, rather than a lengthy explanation in the theory why certain things have to be done. It may not make sense to students if the context of the learning is not real, which may be hard for students to imagine without having to visualise the real contexts. Teacher H emphasised that by doing (i.e. through having practical activities), 'they know what pruning is, what tools to use, how to do it, and the reasons for carrying out (I2:58-69). This means that learning via practical activities has informed them the real practices in context.

- Practical activities allow students to apply their theory into practice

By experiencing the activities themselves, it allows them to apply what they have learnt in classrooms to real practice. And thus, they can understand far better by connecting to their theoretical learning. These students cannot remember too many concepts at one time during theory lessons. So by doing practicals, they will remember more through hands-on activities and experiencing the steps necessary in any particular procedure. Also, most concepts in agriculture are unfamiliar to students' daily lives, as they may not come from an agriculture background family; therefore farming experiences will be quite remote from their everyday surroundings.

- Practical activities allow them to predict what steps to take next

Because they remember and understand more through doing the practical activities, they could predict the next step to take if they encountered the same problems or circumstances again, by judging the situational conditions they are confronted with. This is because their previous experiences were based on the real context, not just imaginary like in certain subjects that are based on theory lessons. For example, in science, where according to Teacher H, students have had a hard time imaging the knowledge, as she was also teaching science subjects (see I2:187). Teacher H narrated, 'upon seeing the situation and conditions of their plants, they can predict what to do, and what steps need to be done, such as time for fertilizing. Just by seeing the conditions of their beds... no need to tell them anymore what to do' (I2:49-56).

- Practical activities allow them to get motivated by themselves, in addition to the teachers' reinforcement and parents support

The potential of practical activities in motivating students is enormous, as indicated from Teacher H's interview analysis. Not only were those practical activities were extremely exciting for her students, they were also considered as the catalyst where Teacher H has seen the students' motivation began to shoot up. She could 'see the difference in their motivation' (I2:5) when they became 'interested and enthusiastic' (I2:2-4). They also at times 'wanted to know what they are capable of, what they can do' during practical activities (I2:30), and it appeared that this builds the students' confidence and self-esteem.

Besides students' own intrinsic motivation, Teacher H also gave reinforcement by motivating them extrinsically through organising a competition among her students. She would give out presents for the best project with the most healthy crops and heaviest yields, as well as for the most industrious student. These rewards were in addition to the money they will get from the sale of their harvested crops (I2:195). According to Teacher H, they loved the competition (I2:199) as a recognition of their success, over and above the money they gained.

Not only this, some students even brought home some harvests to be tasted personally and shared with their family members (I2:200). They were so eager to show their parents what they have done in school (I2:203). They felt very proud, particularly students of those parents who were also enthusiastic about their children's learning of agriculture (I2:218). This further motivated the students, as this causes their parents to praise them so much that they felt very proud of their efforts. The support from parents is therefore crucial in motivating students to study agriculture; unlike with some parents who don't see the positive features of the subject, and may disapprove of their children taking agriculture in school.

Disadvantages of not having practical lessons

- Lack of motivation and insufficient understanding

Teacher H agreed that not having practicals in her lessons means that there is low in motivation (I2:46), as such an omission causes insufficient understanding (I2:47) so that the learning may become difficult for students. She postulated, ‘without the practical, I don’t think they can understand how and why these cultural practices are being carried out in agriculture’ (I2:58-59). As she mentioned before (see I2:69), it would be hard for the students to imagine or visualise concepts and procedures without the practical activities; what, how and why certain activities are done in agriculture (I2:31).

- Students get bored

On the other hand, students tend to get bored (I1:6) without practical activities to engage and challenge them. They became easily bored and showed their lack of interest (I1:7) and reluctance (I1:8), if they had to stay inside classrooms, learning theory only. This happened especially ‘when there is no project going on’, explained Teacher H (I2:27). She explained, ‘if no project, learning will be more on theoretical. That made them feel bored’ (I2:28). This shows how important it is that students have practical lessons for making them enthusiastic and motivated about the subject.

These contrasting benefits and disadvantages, of the presence or absence of practical activities in learning agriculture, revealed that the practical parts have facilitated students’ better understanding of agriculture, without which they won’t be properly informed of what agriculture is all about. This is partly due to the fact that agriculture is no longer the people’s way of life in the community. Farming activities have been detached from their daily activities due to urbanisation. The only way most children could learn about agriculture is thus perhaps from schools. Hence, it is just a matter of providing an agriculture curriculum with the appropriate school facilities to allow conducive learning to take place. Such facilities would include labs, classrooms and farm tools, resources and equipment, to encourage practical application in the real context, for a better understanding of what agriculture involves.

So what causes the practical activities in agriculture to be so important?

There are a lot of benefits of practical activities, as shown in Teacher H’s interview data. There was something about physical experiences in agriculture, and why it benefited her students’ learning so much. Some of these as discovered in her interview analysis are the following:

1. The physical experience and the practical activities provide the platforms for better understanding.
2. They promote and engage students' thinking and decision making.
3. They increase and encourage participation.
4. They enhance and encourage motivation.
5. They also promote enthusiasm.
6. They then promote further learning to become curious and inquisitive.
7. They build confidence and students' self-esteem.
8. They foster responsible and committed individuals.
9. They encourage team work and cooperation among students.

The activities *provided the platform for understanding better* (I2:70) because students could become *engaged in their thinking* and *increase their participation*. The experiences made them industrious, curious (I2:21) and excited/motivated (I1:32). As students could relate their learning to their thinking through their physical experiences, their minds become *inquisitive* and would always like to know the reasons why something has occurred. They were always 'asking me all sorts of questions, due to their curiosity, especially during projects' (I2:26). This implies that practical activities put students' mind into gear; that is, they cause and promote thinking and allow students to actively engage in their construction of meaning. Outdoor practical activities promote deeper thinking and relate learners' cognitive processes to their classroom's theoretical knowledge.

Once involved in practical activities, students became curious (I1:30) and wanted to know why a certain something has happened (I1:32). This shows that they were actively constructing knowledge and trying to make sense of their learning. There were so many questions raised and being asked to the teacher (I1:34); evidence that students were trying to make connections on what has been learnt.

In other words, practical activities *promote and engage students' thinking* and as well enhance *decision making*. Teacher H explained that when students have experienced the activity once, she didn't have to tell them what to do the next time they had to do it again (I1:37), and students were 'even faster at noticing things and doing better than I expected' (I1:39). This shows that students were able to *build their confidence* through doing and visualising the circumstances of their learning. 'Upon seeing the situation and condition of their plants, they can predict what to do, and what steps to be done such as time for fertilizing', Teacher H said (I2:49-50). This is amazing as students can make decision on what to do and take the necessary steps needed without being told; evidence that they have learnt and understood what was expected of them. This also shows that being guided by their previous experiences, they gain some sort of autonomy for using that particular knowledge and thus build up their confidence as a result.

The practical activities also *motivated them further* by being *responsible and committed* to their project work. They even came to school during off days to look after their plants, as 'they worried about their plants' (I2:37-39). When they do something involving practical activities, students would *become enthusiastic* and willing to put extra efforts to come even during school breaks just to tend to their plants.

Another positive aspect about practical activities is that they *encourage team work and cooperation* among students, thus fostering closer relationships. Heavy work and tiring tasks, such as soil cultivation in vegetable bed preparation, was lessened through cooperating and working closely together which they enjoyed and felt *enthusiastic* about. Teacher H was pleased to note that students became very cooperative towards each other, like brothers and sisters, unselfishly (I2:130-132). She said, they even motivated each other, and helped the lazy ones to meet up to the standard (I2:137-141).

Cooperation and team work, when doing heavy activities during practicals, help build closer relationships between students. This has also become a motivating factor, since they also reminded each other of their own responsibilities in learning. Team work thus creates motivation and support for learning cooperatively, when students become helpful towards each other, and have acted in a less selfish manner. This ensures group success and positive group dynamics. Classmate relationships became closer, and they learnt better through cooperation, Teacher H noted. She felt that this helps a lot when they try to remember and understand their theory and in passing the exams. Practical activities are thus an important avenue to allow time and opportunities for students and the teacher to interact/mingle in a less formal way, in order to foster closer ties and team-building, as well to maintain their class's good reputation and relationship between students and the teacher.

Troublesome knowledge found in Teacher H's data

The two most troublesome concepts seen from the analysis of Teacher H's data were on soil and plant propagation.

1. Soil

Soil is troublesome for students, although not everything about soil is troublesome (Line 75). Teacher H admitted, soil is indispensable and must be known. Despite its difficulty as a concept and topic, she argued students could not avoid it (I1:78), and that they have to learn it. However, this does not mean that soil is the key threshold concept, as it may seem not necessarily giving a complete understanding of agriculture to students.

Teacher H noted, students found soil more difficult than ruminants and poultry (I2:35), because it is much easier for them to visualise/imagine the ruminants and poultry. She observed, they were 'quite slow in grasping soils' (I1:49). 'When it comes to soil, for them it's hard, difficult for them to accept' (I1:52). Her students complained (I2:34) that the topics are difficult and requested a repeat revision session on the topic (I1:53-55).

So what could make soil so troublesome to the students? Among the reasons why, as seen the Teacher H's interview data, are it is hard to understand and unacceptable. The evidence to support this perception is: (1) the topic of soil is too factual (I1:51-52), therefore too complicated (I2:223), (2) too abstract – cannot be seen (I1:76), and (3) students having language difficulty (I1:88). Students found the soil topic to be too factual (based on facts – I1:51-52) causing it to be hard to accept. Particularly troublesome were topics on the chemical and physical properties of soil. They found soil physical properties as too complicated (I2:223); the soil pore spaces and drainage are too abstract (I2:225) as they found them difficult to imagine/visualise, unlike in ruminants (I1:76), which can be seen clearly. The students 'couldn't understand the pore spaces concept in lab practical, difficult for them to visualise or relate to' (I2:227-229), she elaborated.

Despite the difficulty students had, the topic of soil is still necessary. Teacher H opined that soil must be taught the *earliest* (I1:78) to give students the foundation to planting. She said, 'to me for a start, we need to teach the basics of soil, not too complicated at the beginning' (I2:222), especially with regards to 'how to improve soil like liming, pH for the soil chemical properties' (I2:224). This evidence shows that soil should not be too difficult at the beginning of the course in order to familiarise students with its properties, particularly useful are those that are directly relevant to agriculture such as liming and pH according to this teacher. It seems that there is a tendency in learning the soil topic for it to be too scientific, where students could not see its application during planting. This may seem appropriate for higher level, but not for this lower level agriculture. As Teacher H stated, ‘practically, they know how to apply drainage to avoid water-logging in the farm’ (I2:226) but theoretically, they don’t understand the relationship to the pore spaces theory.

Another issue about the soil topic is its problem of language difficulty due to English being a foreign language. English is a second language for the students. Their everyday spoken language is Malay or Bahasa Melayu. English is widely used in the country as a means of communication and knowledge transfer in schools, but often students at a younger age tend to have a problem. In keeping with the international arena, Brunei has been adopting a bilingual education system in some subjects as the medium of instruction, and the subject of agriculture is one of them. Agriculture tends to be wordy, with lots of words needed to describe the knowledge which is unfamiliar in everyday terms. Not only is it the unfamiliarity of the terms that is problematic, but also agricultural activities nowadays are getting remote from the people’s usual daily life styles, so that students seldom see them around.

Students found the English language for soil topic was quite challenging, with a high level of difficulty. This brings a problem of being unable to express themselves well when answering examination questions. As Teacher H explained, ‘when it comes to answering examination question they have problems, they couldn’t understand the questions, and also could easily get confused... I think it’s due to the difficulty of English, difficult for them to understand... have trouble with written, in answering and explaining in English... this brings their performance down’ (I1:86-91). Teacher H further explained that the students’ English problem was that they could not explain using the proper English words, especially to describe the answers although they may actually know what the answer is (I2:145-147). They ‘forgot the right words and how to explain using the right words’ (I2:148-149). But as Teacher H said, ‘...they have no choice, they have to master both theory and the practicals, and they have to know how to explain in words. Because we are so exam-oriented’ (I2:149-151).

The English medium of instruction in the agriculture subject makes it difficult for students to describe their actions in words, although they may perfectly well know what to say in their own Malay language. This could be the reason why they struggle and get low results. This does not mean that they don’t know the answers in written examination. It is just that they don’t know how to express properly in the written word especially in English. This shows that there is a problem describing their physical experience with foreign words, and this could, and almost certainly does,,hamper their progress in the subject.

This could also point to why the agriculture subject is double trouble for teachers who teach it. Teachers often have to use a bilingual vocabulary in order to make their students understand, not only for the sake of their theory lessons but especially for facilitating their practical activities. Teachers have to work very hard in trying to make their students understand the knowledge, and its content, both theoretically and practically. Due to the nature of agriculture, where students had to master both theory and practicals, as well its wordy attribute of possessing lots of technical terms, and it being taught in a foreign language on top of that, makes the subject rather alien to students to describe and explain in English, which is not their first language. This difficulty, and remembering what they have learnt, often encourages the use of rote memorisation to pass their examination.

2. Plant propagation

The second topic that is troublesome, as suggested by Teacher H's data, is plant propagation: marcotting, grafting, and cutting. Another teacher, Teacher F, in his questionnaire responses, has also chosen plant propagation as his first rank problem choice. Unfortunately, the reason for his choice was not very clearly stated. However interesting and enjoyable it may be, it is still difficult for students (I2:96). Teacher H said, therefore it is 'much easier for them to do during practical' (I2:230). This shows that there are problems in the theory part of plant propagation, but not in the practical parts where students could visualise the various steps involved in the process.

Teacher H further explained, the difficulty arose from too much content theoretical content (I2:230), a lot to explain (I2:95), difficult terminology and confusing for the students (e.g. the concepts of sexual and asexual – I2:233). Also, there were difficulties in getting plant resources for carrying out the practical activities (I2:97). Specifically, Teacher H narrated:

> In case of plant propagation, it's too much theoretically... much easier for them to do it during practical. Another thing is that they have to differentiate between sexual and asexual propagation. The terms (sexual and asexual) are difficult for them to comprehend. The wordings are almost similar to them – sexual versus asexual – the only difference is the letter 'a' in front... [giggle]. Students complained to me most of the times. They got confused by these words. So, I remind them that the word 'sex' which means that there has to be a male and a female. So, this works well,

> since they remember the word sex. So, asexual means no sex. If sexual, there has to be fertilisation and pollination processes. So, if asexual, means nothing. That's why when they answer written questions they will only answer in point forms to avoid constructing long sentences so that they can remember. That is, to avoid unnecessary words in order to remember. So, I told them, if there is a point, it's already sufficient. Similarly, they also had difficulties with the advantages and disadvantages between sexual and asexual. So, I told them if asexual its fast growing since the parts being used is the plants, whereas in sexual, it is from seeds so it'll take time to grow. So if from parts of plants, it is much easier to grow. Then after such lengthy explanation, they admitted it is much easier to understand once it makes sense to them [Interview 2: Lines 230-244].

The difficulty the students faced above in explaining or describing the theory of plant propagation requires practicals to overcome their lack of understanding. However, for teachers, there may be problems when sourcing plant materials for use in the practical activities. Despite the limited resources available in school, Teacher H still managed to run the practical activities by taking some plants from home, because she knew the importance of the practicality to reinforce her students' understanding.

From the above evidence, it can be deduced that plant propagation seems to possess this characteristic: difficult for the theory part, but interesting for the practical part. This means that the practical bits were interesting and enjoyable to students but not the theoretical parts, where there is a problems in language difficulty as students need to describe and explain in English (foreign language), and also to use difficult terminology for describing the knowledge content.

What types of learners are in the agriculture learning?

From the data, there is evidence students learning in agriculture at lower levels are concrete learners. The difficulty for the learners of the concepts of soils and plant propagation found in Teacher H data, shows that students will have trouble if they cannot visualise their learning. This is similar to the findings in Student 2N's data, which also emphasised the importance of having to visualise her learning. Teacher H argued that 'students come along to their learning with pictures having to see themselves the things ...to visualise' (I1:58). She added, 'if learning is based on theory only, I don't think they can understand' (I1:59-63) and 'just based on theory, they wouldn't be able to understand' (I1:66). This shows the importance of providing practical experiences to students in order to remove abstraction from their learning and hence create deeper understanding. Even Teacher H herself admitted that she will not understand the knowledge without having to reflect on her previous experiences, when she was an agriculture student. She expressed, 'even for myself, I found it difficult to understand unless we see the things for real. However, I myself have the previous experience when I learnt the agriculture diploma, so I can visualise myself, and can still remember. For them [her students], they don't have the prior experience' (I1:63).

So, how to overcome troublesomeness in agriculture learning?

1. Lab practical

Teacher H tackled troublesomeness in agriculture learning by giving her students practical activities, both in the lab and in the school garden. Lab practicals enhance students' understanding of the soil concepts. To overcome the concept difficulty regarding soil chemical and physical properties, provisions of laboratory practicals become helpful for students' visualisation. 'Having practicals on soils in the lab helps their understanding' (I1:76), she said.

2. Teach simple contents first

To overcome the soil difficulty issue, Teacher H suggested that at the start of the course, only basic content of soil curriculum should be taught. Teachers must avoid complicated idea at the beginning, she stressed. The difficult concept of pore spaces should be taught when an increased understanding has developed in students that will permit them further development of ideas. As Teacher H argued:

> We should be careful not to put too difficult content at the start, just give the basics first, like the functions of soil, make it simple, so as not to alienate students [Interview 1: Lines 81-82].
>
> So, we have to be cautious with which part of the soil topics to teach first, so as not to intimidate (them) as this will have repercussions on their subsequent motivation [Interview 1: Lines 83-85].

3. Teach bilingually to overcome learning difficulties in a foreign language in order to make students understand the concepts well.

As a way of overcoming the difficulty, Teacher H had to teach bilingually, employing both English and Malay languages, so her students could understand (I1:68). She used Malay translations for the difficult English words/concepts to make learning understandable (I1:69). Teacher H said, she has no choice (I1:72) but felt sorry (I1:71) for her students, forcing her to use Malay in some parts of her teaching. She argued, 'English language is very difficult for them, not only for my subject, but also other subjects as well' (I1:72).

4. Practise answering examination questions

Another way of overcoming language difficulties is by practising more writing on answering examination question papers, and to do more revision by practising using less words, according to Teacher H. These strategies include:

- use drawing to illustrate the point in the answers (I2:154) instead of describing in words.

- answer in point forms, avoid constructing long sentences (I2:238), so they could remember. Avoid unnecessary words in order to remember (I2:239).

- use of mnemonics (I2:157) to remember points especially confusing parts/terms, which is essentially a memorisation technique.

- encourage students to make sense of their learning.

- try to relate (I2:160) to something in order to remember.

> ... there must be something to relate in order to remember... only then they enjoyed the learning. Because agriculture has so much to remember. Actually, a lot to remember and confusing in terms of technical terms. But once they get the technique, it's okay [Interview 2: Lines 168-170].

Agriculture helps understanding of other subjects as well

- Agriculture is a package subject

Agriculture helps the understanding of other subjects as well. 'It benefits other subjects as well, not just agriculture' (I1:98) 'because agriculture is a package subject' (I2:194), 'it is real' (living, can be seen, felt and eaten – I2:189), 'it's so complete' (I2:113), 'it has everything' (I2:113), 'everything is there in agriculture' (I2:106).

When Teacher H mentioned, *everything in* she meant that 'most subjects can integrate with agriculture' (I2:110). And, when she said it has everything, she meant that all other subjects could be included in agriculture and are compatible with it; in other words its 'multifunctionality and real fun for students' (I2:180). These views suggest that agriculture could integrate with other subjects well. Agriculture therefore helps the understanding of other subjects, such as maths, English, geography, accounting, even chemistry on top the obvious ones such as biology in plants, which of course is directly related to agriculture. She argued since she was also teaching a science class:

> In science, although there are many practicals, but the practicals are not real, non-living. Because in science students have difficulty visualising, where as in agriculture the things are real and can be seen. They can see the plants and animals in front of their eyes. In agriculture when they learnt about the chicken's digestive system, they can visualise; however in science, the human digestive system is difficult to observe from their everyday life. And that in chicken the parts can be eaten, but in human it's not consumable... which means in agriculture, they can

> visualise, feel, and eat. Everything is possible. So, agriculture is fun... complete... it's a package! A package subject! [Interview 2: Lines 187-194].

- Agriculture overlaps with other subjects:

There was evidence in Teacher H interview data that students were able to improve their learning and understanding as they could see knowledge overlapping from what they studied in agriculture with other subjects, such as science, maths, geography and accounting. Teacher H mentioned, 'in agriculture, its encompassing...everything exists within this subject... It has geography, accounting, a bit of maths, in short, everything! Even a bit of chemistry as well such as in photosynthesis' (I2:114-116).

Teacher H found that her students tended to do better as well in their *science* subjects, as they could apply their agricultural knowledge to science. This finding seems to show that agriculture helps an understanding of science much better as students could see the application of science knowledge in agriculture, and to connect the two together. It seems that agriculture enhances students' science understanding or vice versa. She said:

> Some of my students are really good in other subjects such as science and mathematics. I think agriculture helps them a lot in terms of their understanding of other subject as well. Agriculture students can learn better because through this subject students can learn in concrete, they can apply their knowledge because of the practical activities. Similarly the scientific knowledge in the agriculture subjects makes it all easier for them to grasp their science subjects as well. Agriculture is such a multifunctional subject. It benefits other subjects as well, not just agriculture. [Interview 1: Lines 92-98].

So often she heard them saying, 'we have learnt this before in science' (I2:121), or sometimes, her students said during agriculture lessons that they studied about plants again in science. This shows that there is some knowledge overlap in both subjects, thus helping the understanding of both their science and agriculture knowledge. She expressed:

> Actually science and agriculture go along, because in science there is also agriculture. In agriculture there is also a bit of science. For example on plants in agriculture, there is also about plants in science. So they go along together. Even students when they learnt about plant structure in agriculture, immediately they recognise that they have already learnt this stuff in science. So, this makes them more aware. Then they exclaimed, 'oh this, we have learnt before...' this means that they know science and agriculture go together. This makes it easier for them to understand, and I don't have to explain repetitiously due to that they've already understood from other subject. So in a way, it could be they learnt in agriculture first or if not, they may learnt in science first, one way or the other. Most often and at one time, they admitted that yesterday they've learnt about plants in science, but since they've already learnt it in agriculture, it made it easier for them, which means this overlap helped [Interview 2: Lines 117-127].

This all seems to show that parallel understanding is reinforced between related knowledge in agriculture and science. Learning about plants exists in science, as it does in agriculture. So students could integrate or relate the two subjects due to overlapping of knowledge, thereby making them understand the importance of the concepts better. They seemed to be able to think that science knowledge is also useful in agriculture and vice-versa. In science, they just learnt the science part. But the useful applications of what they learnt in science are applied in agriculture. So these subjects' compatibly help support each other, side by side.

So how could it help science learning? Since practicals in science classes are not real, compared to those in agriculture, the students unfamiliarity with everyday phenomena could be applied and tested in agriculture lessons, because through their hands-on activities in agriculture, their understanding of science ideas could help as well. The practicality of real learning experiences in agriculture both assisted and facilitated their thinking. This is something which most other subjects are lacking, unlike in agriculture. Agriculture seems to fortify these connections, between real and factual/theoretical. This seems to show that there is a dynamic reciprocal thinking exists in the students' learning of everyday sciences, due to their agriculture classes.

Similarly in *mathematics,* agricultural experiences could be reinforced through knowledge that they have used and applied in agriculture, by using real situations, where they could visualise via applications in real circumstances. For example, students could use real figures and the data gathered from their projects for doing calculation on profits and expenses. 'Students, those poor in maths, could learn maths in agriculture... using real data to calculate' (I2:108) so it made sense to them. Similarly, it could also help their *accounting* knowledge when doing their poultry project, where they counted the expenses and sales account (I2:112). In geography, students were astonished to find out that they also learnt about soil in agriculture, 'this seems like geography' they exclaimed (I2:109-110).

All these examples showed that the overlapping of knowledge between agriculture and other subjects, particularly those mentioned above, made it easier for students to understand these other subjects as well, since they could see their applicability in agriculture. In other words, due to the practical nature of the agriculture subject, students could understand better not only in terms of their agricultural knowledge but also other subjects as well; through agriculture they have utilised inter-relationships between some concepts and applied their knowledge to experiences in order to ease understanding. This is why may be a genius student, as mentioned in the beginning of this thesis, who scored 22 A's, could master all his subjects, as he was able to link them up integratively.

Values of agriculture

- Agriculture provides students the chance to think like a real person, as seen in them having the confidence to try out at home in their own time

There is evidence in the data where students *act and think like farmers (agriculturists)* as they were *motivated/influenced* by the planting experience. Once experiencing the practical projects in school, students were even motivated to practise planting on their own at home. This evidence shows that students tend to think and behave like real farmers/agriculturists following their school experiences. This is similar to the findings with Student 2C who was also enthusiastic about her planting experiences from school. This shows that their school experiences have possessed them – they are enthused and addicted to those experiences, causing them to be passionate about planting and farming – a manifestation of transformational learning. As Teacher H, reflected:

> Last year, I had one student who practiced planting sweet corn at home. He planted tomatoes at school but he wanted to try sweet corn, too. He approached me on how to plant sweet corns. Since he already knew how to do soil preparation in tomato, he just wanted to know whether sweet corn is indirectly sown. He asked me lots of questions such as fertilizer application rate, weed control, etc. Do you know what? He managed to get yields from his planting. He informed me he sold sweet corns. He surprised me, I thought he was joking. I never imagined that he wanted to grow sweet corn on his own. I never expected that until he told me he is selling sweet corn, and according to him he made some money from them. So he really practised what he learnt from school at home [Interview 2: Lines 206-214].

This is an amazing story because students were actively thinking about what they learnt they thoroughly enjoyed, as a result of successful learning in school (I2:217) that was brought about by physical experiences. They were encouraged into thinking and behaving like farmers. The joy of learning emanated from their school experiences, causing learners to actively engage in thinking about it. The feeling and experiences became lodged in their minds. That is, they got hooked and fell in love with it. So, they wanted to do more in their own free time, trying to emulate what they had learned and yearning to do it, especially if there was also favourable support from parents.

Rewarding experiences bring confidence to the students. Feelings of success encourage motivation and further uptakes: success breeds success. The sign is that, if they are not impacted by it, they won't seek to try to do it all again at their own time at home. This whole thing shows that practical-physical activities in schools had a strong influence on agricultural students, since they had so much enthusiasm and motivation which triggered them to want to practice and explore more during their own time. They seemed to have actively thought about their school experiences and yearned for these at home too. This shows that the experience was exciting, enjoyable and stuck in their heads. They became addicted and obsessed by it. Taking home the experience to practise it again is a sign of passionate interest in the students following their school experience. This simply shows that they still can't get enough of it. Yearning to do it again at home is a testimony that students enjoyed their learning so much, and the school-based practical experiences have remained successfully anchored in their thoughts.

- Agriculture provides the living skills needed for self-reliance, and in overcoming unemployment

Another piece of evidence as to why students seemed to have confidence in their learning of agriculture is the realisation and awareness that agriculture could provide future employment. This includes provision of living skills that allows them to foresee the development of self-reliance (I2:215) in terms of overcoming unemployment, if supposed they couldn't get proper jobs in the future. They were consciously aware agriculture could create self-employment through farming or setting up a business enterprise. Teacher H noted her students were keen about future farming, which could be triggered by the potential of gardening and production experiences they had while in school. She elaborated:

> I think the intention is this student wanted to become self-reliant. It seems that he is aware that if he couldn't get any job, he could support himself. So, that's why he practiced it at home. It's seemed successful. I think it's because agriculture provides students with living skills. Students that do get motivated are usually coming from a home where their parents are also motivated about their children's learning the subject [Interview 2: Lines 215-219].

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