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Learning Patterns of Engineering Students in a Singapore Tertiary Education Context and the Implications for Continuing Education in the Field of Engineering

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A Thesis Submitted for the Degree of Doctorate of Education

School of Education

University of Durham

2012

Declaration

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Abstract

In 1997, Singapore implemented radical changes to its education curricula to foster deep, self-directed learning which were thought to be important for lifelong learning. The aim of this study was to establish if there was any evidence that Singapore tertiary students, having been through the revised curricula, had indeed developed desirable learning patterns for continuing education. The samples comprised polytechnic Engineering undergraduates from the Year 1 (N=638), Year 2 (N=616) and Year 3 (N=705) cohorts. The study also included a control sample of working adults (Professionals) (N=140) who had returned for continuing education. A mixed methods design was executed with a cross-sectional study using the 100-item English version of Vermunt's Inventory of Learning Styles, together with semi-structured group interviews.

A flexible learning pattern was reported to be common among undergraduates. Besides that, a prove-yourself directed pattern was reported by first and third year students, while a passive-idealistic pattern was indicated by second year students. The other two patterns reported in each group were variations of the reproduction and undirected patterns. The meaning directed and application directed learning patterns were not clearly distinguishable among the undergraduates. Sub-scale scores related to deep processing and self regulation strategies were not significantly higher in the second and third years, while scores for stepwise (surface) processing and external regulation were not lower. There seemed to be insufficient evidence to indicate that the changes in the curricula by the Singapore Ministry of Education and the polytechnic were effective in fostering the desired learning patterns.

Among the Professionals, the meaning and application directed learning patterns were more clearly distinguishable. Subscale scores related to the use of knowledge and vocation were significantly higher than for the undergraduates. Working adults appear to have a stronger conception that learning was for the useful application of knowledge, and were clearer in their motives to enhance their vocation through their studies compared with the undergraduates. This suggested that learning patterns could be modified if learning conceptions and motives could be changed.

This study has extended the understanding of learning pattern development particularly in a Singapore context, and generally in the wider Asian context. Cultural and educational contexts appear to play a role in influencing students' learning conceptions and motives which, in turn, shape their learning patterns. Interventions that superficially manipulate the learning environment have limited effect in changing learning patterns. To bring about desired changes, all four domains of a learner – learning conceptions, motives, regulation and processing strategies, need to be addressed. This remains a challenge for institutions of higher learning and has implications for educational policy, curricula design and delivery, instructional approaches, assessments and other factors that impact the learner and the learning environment.

Acknowledgements

The completion of this thesis marks the climax of a long but fruitful learning journey for me. This journey would not have been possible without the many who took the time to come alongside with valuable advice and support.

I would first like to thank my two mentors and supervisors, Professor Julian Elliot and Professor Richard Remedios. Your timely, insightful, and critical feedback have been immensely helpful, providing me with the much needed guidance to sharpen my thoughts, and to put this piece of work together. The meetings we had both in Singapore and in Durham certainly went a long way to help me find my direction in this journey.

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This journey certainly does not end here. I look forward to contributing back to the academic community in my institution through the continuation of my work towards the enhancement of teaching and learning, and preparing students with the right motivation and skills for the demands of the 21st Century.

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CHAPTER 1: INTRODUCTION

1.1 Economic Challenges and Skills Development in Singapore

In the face of globalisation and the rapidly changing economic landscape of South East Asia, the island republic of Singapore is probably facing some of its toughest challenges ever in its last 47 years of independence due to intense competition in the region. Being such a small country with very few natural resources, Singapore has little to depend on for its survival other than its people's skills and services.

The latest census done in 2010 reported a total population of 5.1 million, of which 3.8 million are citizens and permanent residents (Department of Statistics Singapore, 2010). With such a relatively small population compared to the competing economies in the region it is of little wonder that human capital development in the form of education and training is of great importance in this country. Singapore may have indeed been the first advanced economy to approximate a 'direct correspondence' between education and production (Brown & Lauder, 2001, p. 118 following Bowles & Gintis, 1976). This has shaped the educational landscape for the last 47 years, influencing even the intakes for the various programmes offered in post-secondary institutions according to the skills required for economic development. It was in this way that the State co-ordinated the inputs of capital and labour to ensure that the economy as a whole moved in the direction of its political objectives (Ashton & Sung, 1999).

This approach to skill formation served the country well in its early industrialisation efforts. However, over the last decade or so, the Singapore government realised that in the face of a rapidly changing economic landscape, extensive globalisation, and the proliferation of knowledge-based industries, the 21st century workforce is required to be highly adaptable, and able to take responsibility to upgrade its own skills to meet the changing needs and, if necessary, re-skill itself for new jobs in order to remain relevant and employable. In other words, *lifelong learning* would be a matter of survival in the new century. This was put forward clearly by Mr Goh Chok Tong, then Prime Minister of Singapore, in a speech at the opening of the 7th International Conference on Thinking in 1997 (Ministry of Education, Speech by Prime Minister Goh Chok Tong, 1997) when he said:

> *Learning goes beyond simply maximising an individual's potential. A nation's culture and its social environment will shape what learning means, and determine its impact. Everyone counts. What grandparents, parents, students and teachers, employees and managers, and leaders in society take to be true about learning will have a profound impact on whether we respond quickly and effectively as a society to change.* ***Our collective tolerance for change, and willingness to invest in learning as a continuous activity, will determine how we cope with an uncertain future. We must make learning a national culture*** (emphasis added*).*

1.2 Lifelong Learning in the Singapore Context

The term lifelong learning has been interpreted in various ways in different contexts, depending on the stakeholders involved. What appears to be common, however, is that it conveys the idea of continuous learning throughout one's lifetime for the acquisition of new knowledge, skills and qualifications through formal, non-formal and informal modes of learning. It also encompasses self-development for the enrichment of life, among other goals.

Singapore’s approach to lifelong learning has been "pragmatic and rational" (Kumar, 2004, p. 559). As mentioned earlier, it has been put forward by the Singapore government as one of the key economic drivers to enhance Singapore’s competitiveness in the increasingly integrated and interdependent global economy, and is viewed as an "antidote against unemployment" (ibid, p. 559).

The Singapore Manpower 21 master plan launched in 1999 enshrines the country's overarching framework for lifelong learning (Ministry of Manpower, Human Capital, 2001). More recently the Singapore Ministry of Manpower introduced its Continuing Education and Training (CET) master plan to offer a comprehensive framework to prepare the Singapore workforce for the future and maintain a competitive advantage for Singapore. The Ministry set aside S$3 billion in 2008 at its launch, and has planned to bring up the investment eventually to $5 billion. These figures are provided to give readers a sense of the extent to which the Singapore government is committed to the cause. The plan defines Singapore's lifelong learning system and aims to fund the training of workers, helping them to seize opportunities in new growth areas and remain relevant and employable (Ministry of Manpower, Masterplan for Continuing Education and Training, 2008).

1.3 Overview of the Singapore Educational Context

In tandem with the Ministry of Manpower's efforts, the Ministry of Education (MOE) has also recently sharpened its Desired Outcomes of Education to offer an education system that would develop every student, by the end of their formal education, to be:

- a *confident person* who has a strong sense of right and wrong, is adaptable and resilient, knows himself, is discerning in judgment, thinks independently and critically, and communicates effectively;
- a *self-directed learner* who takes responsibility for his own learning, who questions, reflects and perseveres in the pursuit of learning;
- an *active contributor* who is able to work effectively in teams, exercises initiative, takes calculated risks, is innovative and strives for excellence; and,
- a *concerned citizen* who is rooted to Singapore, has a strong civic consciousness, is informed, and takes an active role in bettering the lives of others around him.

(Ministry of Education, Desired Outcomes of Education, 2009)

These goals inform the design and implementation of curricula and co-curricula activities (such as leadership development, character-building, social skills infused through sports, arts and cultural clubs, and religious societies and other activities in which students can participate in school).

Students in Singapore begin their education journey at the age of seven, and they undergo six years of compulsory Primary education encompassing a broad-based syllabus with particular emphasis on the English language, Mother tongue, Mathematics and Science. This phase culminates with the Primary School Leaving Examination (PSLE) which is a national examination.

The next phase would be Secondary education. Students may choose to proceed to schools that offer an Integrated Programme (IP) where they can benefit from an enhanced curriculum that caters for academically strong students. The IP is a four- or six-year programme (depending on whether the students join after Secondary 3 or immediately after their PSLE respectively) combining both Secondary and Junior College (JC) education without an intermediate national examination (the General Certificate in Education (GCE) 'Ordinary' Level ('O' Level)). As such, students will take the GCE 'Advanced' Level ('A' Level) examinations at the end of the sixth year. An alternative IP is offered in a few other schools in the form of the International Baccalaureate (IB) where students take the IB diploma.

Besides the IP, PSLE leavers may also choose to take a four-year 'Express' or five-year 'Normal' Secondary programme, or opt for vocational training in a specific skill. The 'Express' programme culminates in the GCE 'O' Level, and the students who take the 'Normal' programme will sit for the 'N' Level examinations.

Following Secondary school education, students may choose to enter a JC and take the GCE 'A' Level examinations, or opt for a three-year Polytechnic education. Alternatively, students may also opt for a higher vocational training at one of the Institutes of Technical Education (ITE). After this phase, students may then proceed into one of the local government-funded or privately funded universities, or join the work force.

The education options described above represent only the mainstream pathways undertaken by the majority of Singapore students. There are many other choices that could cater for individuals depending on their unique talents and educational needs, such as the Singapore Sports School for aspiring athletes (for further details, see Ministry of Education, Ministry of Education Corporate Brochure, 2010).

For each pathway chosen, students are granted places purely based on merit, that is, their academic results and other co-curricular achievements. The competition for options that are perceived to be relatively more prestigious, such as the IP and JC pathways, is extremely intense so the race begins at the PSLE. A near-perfect score in that examination is required to enter into one of the IP schools or the best Secondary schools in the country. It is commonly believed that once a student can get into an IP school or a top Secondary school, their academic careers are secured, and the likelihood of progressing into one of the local government-funded universities would be increased. Students who do not do so well at the PSLE will be left with the other options.

For students who progress through the Secondary school path, they have another chance to prove themselves at the 'O' Level examinations. If they can achieve good results, they may still opt for a JC, otherwise they would have to opt for a Polytechnic education. The latter is often perceived as a second choice, although there is a small percentage of students who do apply out of a real interest in particular courses.

Education is perceived as an important key to socio-economic mobility in Singapore and thus much commitment is made by schools, parents and students in its pursuit. The pressure to excel in the critical national examinations, namely the PSLE, GCE 'O' Levels and 'A' Levels/IB, has led students to place a very high priority on their education. As an indication, a Straits Times newspaper report in September 2010 published that parents in Singapore spent about S$820 million a year on supplementary private tuition (Radha, 2010), and another report in the same newspaper also highlighted a survey that found 97% of students in Singapore have some form of private tuition between Primary to Secondary school, and even Junior College (Toh, 2008). Such tuition classes are usually designed to drill and help students find the most efficient way to acquire the necessary skills and knowledge to do well in examinations.

To further help prepare students for the major examinations, many of the more experienced school teachers in the Primary and Secondary schools have become experts at spotting the right questions, spoon-feeding students with notes and model answers, and drilling them on getting the right answers (Nirmala & Mathi, 1996) for the respective examinations.

It is thus not surprising that after 10 years in such an intensely competitive education environment, many Singapore students can be said to have become rather "exam-smart" (Ong, 1999, p. 111) and syllabus-bound (Smith, 2001) (that is, focussing efforts to study only content that is within a prescribed syllabus) by the time they leave Secondary or JC schooling.

1.4 Preparing Learners for the 21st Century

The call to develop a culture of lifelong learning has impacted many aspects of Singaporean education, work and life . In particular, the MOE in Singapore made a deliberate shift from an ‘efficiency-driven’ education to an ‘ability-driven education’ in 1997 with the ambitious vision of building ‘Thinking Schools’ and a ‘Learning Nation’. It was a paradigm shift which required systemic changes to be put in place. New curricula for Primary and Secondary level education were developed to achieve three objectives. Firstly to build on its already strong foundation in Mathematics and Science (Ministry of Education, Singapore Tops the Trends in International Mathematics and Science Study (TIMSS), 2004). Problem-solving skills that included logical reasoning, critical thinking, strategy development, analytical skills, metacognition, heuristics and other higher order thinking skills were the intended outcomes of the rigorous Singapore Mathematics and Science curricula. Developing these skills would ensure competency in an environment of rapid advancement in science and technology. Secondly, the new curricula aimed to inculcate practical skills to prepare for the knowledge economy; and thirdly to develop lifelong learning skills that will facilitate innovation and entrepreneurship (Ministry of Education, Mathematics

Syllabus Primary, 2006; Ministry of Education, Secondary Mathematics Syllabuses, 2006; Chong-Mok, 2001).

Broad changes to the Primary and Secondary school curricula included the reduction in content of up to 30% so as to free up more time for students to engage in self-directed learning and collaborative group projects. Self-directed learning was encouraged through the introduction of e-learning into the school curricula where students were required to study particular topics on their own. Students were expected to acquire knowledge through their own exploration on the Internet, and take assessments on-line. Project Work, a compulsory subject that students were required to pass in school, was introduced to provide students with the opportunity to synthesise knowledge from various areas of learning, and critically and creatively apply this to real life situations. This was aimed at enabling students to acquire skills like collaboration, communication and independent learning, thus preparing them for lifelong learning and the challenges ahead (Ministry of Education, Project Work, 2011).

Post-secondary institutions, including the local government-funded universities and polytechnics, also developed their own strategies to foster self-directed learning and collaborative project work. At the polytechnic involved in this study, every module that is taught has now an e-learning component where students are expected to explore and study particular topics on their own and attempt on-line assessments. The results from these assessments count as part of their final results for each academic year. Students are also given two hours every alternate week for Self-Study as part of their scheduled time-tables. Besides these, students are required to carry out group projects throughout each semester which are collaborative in nature. There are also compulsory Final-Year Projects and Industrial Attachments for all students. In total, these changes were designed to foster self-directed learning and other characteristics that presumably would prepare students to be lifelong learners.

Efforts to transform education in Singapore have been matched with strong financial commitment from the government to the cause. For a rather small country like Singapore, an annual budget of S$9.7 billion invested into education (Ministry of Education, Ministry of Education Corporate Brochure, 2010) is indeed very high and is second only to the nation's defence budget. An important need now for Singapore is that of measurement - appropriate indicators comprising both qualitative and quantitative measures to gauge the effectiveness of the many programmes that have been implemented (Kumar, 2004). It will not be easy given the complexity of the processes involved, however, this is one area that is rather underdeveloped in Singapore, and in need of appropriate measures and assessment tools.

In line with that, it is timely to ask to what extent have the above three objectives to transform education in Singapore been successful in the context of students who have been through these changes for 10 years of Primary and Secondary school education. Many of them who have progressed through the various levels of education successfully would be in tertiary education at the time of this present study. As the answer to that question would involve a very wide and lengthy study, this present study will focus on only the third point, that is, to investigate if there was any evidence that these tertiary students have adopted learning patterns that are useful for lifelong learning.

This first chapter has thus framed the context for this investigation. Chapter 2 will review relevant literature related to the research fields of cognitive styles, learning styles, student approaches to learning and learning patterns. It is intended for the review to give insight into some of the theoretical models and instruments available for investigating learning behaviour, and the possible factors that may shape these behaviours. The review will then lay the theoretical basis that underpins this current investigation.

Chapter 3 will lay out the considerations and course of decision for the methodology chosen for this study. The choice of samples, instrument, design and data analysis process will be discussed. Chapter 4 will present the results, analysis and brief discussions of the data. Chapter 5 will bring the data together in an attempt to answer the research questions posed for this study, and finally Chapter 6 will summarise the study, crystallise the key findings from the investigations and their respective implications, outline the limitations and end by drawing the final conclusions.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

The notion that different people have different preferences for the way they learn or for that matter, for doing anything, has a strong intuitive appeal simply because everyone can agree that individuals are different in some ways and similar in other ways. These differences account, to a large extent, for the way each person interprets and interacts with his or her environment. Over the decades, research in the role of individual differences in student learning processes has evolved in various directions with the underlying objective to seek ways to help learners improve the effectiveness of their learning and studying (Entwistle & Peterson, 2004). Investigations have also been carried out in the area of learning development to provide the skills needed for lifelong learning (Rayner, 2001). One important direction stemmed from research related to personal styles with influential literature published on *learning styles* emerging mainly in the 1960s and 1970s (such as Dunn, Dunn & Price, 1975; and Kolb, 1976). However, the nature of learning styles research has been fragmented with studies concentrated in specific domains, and apparently little attempt has been made towards cohesive progress (Bonham, 1988). More recent works have, however, shown signs of a reconceptualisation of the theory of learning styles to link learning styles and the self-regulation of learning (Bedford, 2006).

Another important direction of research was in the concept of *approaches to learning* that was pioneered in the 1970s by Marton (1976) and Säljö (1975) in Sweden, and studied at about the same time in Australia (Biggs, 1976) and in England (Entwistle, 1977). These, and other researchers who have extended the field, generally conceptualise learning as a composition of motives and strategies, and a student's approach to learning can change depending on the context.

In the following literature review, I will first provide a brief overview of the complex field of learning styles research and then focus my review on the key concepts of cognitive styles, learning styles, and approaches to learning. These will provide the theoretical foundations upon which my thesis will be built.

2.2 The Complex Field of Learning Styles Research

Difficulties abound in the wide fields of studies in learning style research, and attempting to even define the term learning style has proven to be challenging. Moran (1991) suggested that one of the key difficulties of the field is the over-extension of the notion of learning style and the associated semantic confusion generated through haphazard expansion and dilution of the concept. Presland (1994) described the research on learning style as presenting a "bewildering variety of definitions, conceptualisations and claims of learning behaviour that can be predicted" (p. 179). Others have repeatedly criticized the myriad test instruments; inappropriate measurement, in particular the lack of rigour in psychometric testing, and the lack of independent evaluation (Messick, 1984; Tiedermann, 1989; Curry,1990; Furnham, 1992; Sadler-Smith, 2001; Coffield, Ecclestone, Hall, Meagher, & Moseley, 2004; Entwistle & Peterson, 2004). Still others have taken a broader view and criticised style for its lack of theory and its isolation from mainstream psychology and cognitive science (Kozhevnikov, 2007; Shipman & Shipman, 1985) and even raised the question, "Should we be using learning styles?" (Coffield, Moseley, Hall & Ecclestone, 2004a).

In the light of the above issues, Peterson, Rayner & Armstrong (2009) conducted a survey among style researchers, selected mainly from an international forum called the European Learning Styles Information Network (ELSIN) (now known as The Education, Learning, Styles, Individual Differences Network) encompassing respondents located in a wide range of different countries.

Respondents raised concerns over the level of “uncritical acceptance of the validity of instruments for measuring styles and their pedagogical implications” (p. 521). Another common concern centred on the doubtful categorising of learners, which the researchers thought could have a negative effect on their learning. However, while the respondents indicated that they were aware of the concerns, 93% of the respondents thought it was possible to accurately measure learning and cognitive style differences and over 85% believed that there was enough evidence to accept the existence of cognitive and learning style. Of course, it should be noted that the respondents were not likely to be impartial in their vote as they were already researchers in the field of style research. The researchers concluded with a positive view that understanding style differences had the potential benefit of promoting diversity in teaching and learning and providing opportunities for students with different styles to be nurtured. Ultimately, they envisaged that this would have a positive impact on raising educational outcomes.

2.2.1 An Integrative Model of Learning Styles

Several scholars have attempted to conceptually integrate the various style labels (Curry, 1983, 1987; Miller, 1987; Riding & Cheema, 1991; Grigorenko & Sternberg, 1995; Zhang & Sternberg, 2005; and Sadler-Smith, 2009). One of the most commonly cited integrative models in the learning styles field was developed by Curry (1983) who hypothesised that all the various styles of learning could be generally categorised within a structure comprising three layers like an onion. Each layer represents the extent to which the styles within it could be directly observed and modified as a result of environmental influences. Figure 2.1 illustrates this idea.

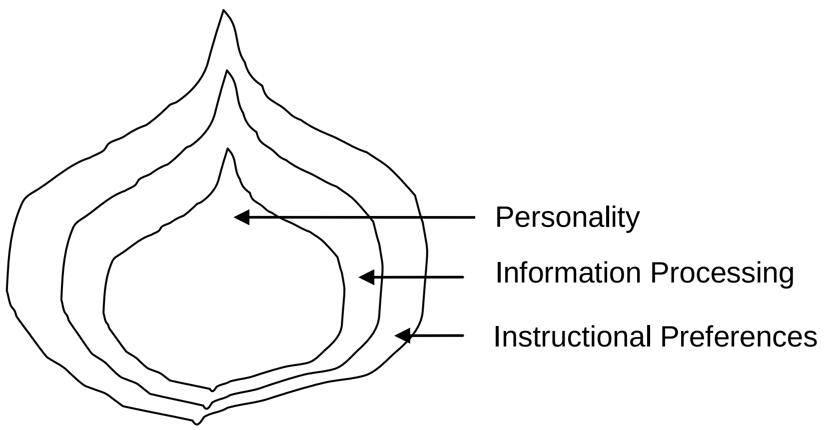


Figure 2.1: Illustration of the “onion” model proposed by Curry (1983)

The innermost layer represents the cognitive *personality* styles which are stable traits of individuals that govern the way they adapt and assimilate information. These can be viewed as the personality dimension of individuals which do not interact directly with the external environment, and can only be observed by the behaviour of the individuals across many learning instances.

In contrast, the outermost layer encompasses styles that represent the individual's *instructional preferences* and are relatively easy to observe. This layer is the most exposed to the learner's environment, learner expectations, instructor's expectations, and other external factors and is the least stable among the three layers. The individual's instructional preferences are thus the most adaptable to contextual influences.

The middle layer of the onion represents the *information processing* styles. These may be considered as learners' intellectual approaches to assimilating information, and are more stable than instructional preferences, but more adaptable than cognitive personality styles.

By organising styles in this way, and drawing from concepts in personality theory, Curry (1983) posited that learning behaviour could be seen as being centrally controlled by the personality dimensions, translated through the middle layer information processing dimensions, and then modified by interaction with environmental factors at the outermost layer. This three-step connection between the personality layer and observed behaviour were thought to explain individual differences in learners.

Marshall (1987) examined the construct validity of Curry's (1983) model with particular focus on the information processing layer and whether the model translated into the learning preference layer. He used Kolb's (1976) experiential learning styles model as a representative of the information processing styles and found evidence that supported Curry's model. However, Marshall (1987) only tested the model using one particular learning style model and there were hardly any other systematic studies carried out since then. Nevertheless, the model does offer a useful framework for classifying learning style models and instruments into a meaningful structure.

2.3 Concept of Styles

The style construct has been extensively studied in a number of academic disciplines such as in psychology where it has been used in many different areas such as personality, perception, motivation, communication, behaviour, cognition, and learning. Of interest to the present literature review would be the concept of cognitive styles and learning styles which will be examined closer.

Studies of individual differences began perhaps nearly a century ago. Gordon Allport and his brother, Floyd Allport, studied 55 male college students in 1921 and attempted to identify central traits among them (Allport & Allport, 1921). The measurements they took were grouped into four categories: intelligence, temperament, self-expression and sociality, and each category had up to five items. This publication has now become an important reference in psychology because it was the first publication that linked traits as a considerable part of personality (Pervin & John, 1997).

Gordon Allport subsequently continued to re-evaluate his own understanding of traits and published a book, *Personality: A Psychological Interpretation* (Allport, 1937), where he discussed his trait theory of personality, suggesting that a trait can be thought of as a relatively stable characteristic that causes individuals to behave in certain ways. Allport suggested the idea of an individual's *style of life* and was probably the first researcher to introduce the *style* construct in association with cognition (Rayner, 2001).

The field of cognitive styles flourished in the middle of the 20th Century influenced by research focussing mainly on four key areas of psychology: perception, cognitive controls and processes, mental imagery, and personality constructs (Rayner, 2001). One of the more influential researchers in cognitive style was an American psychologist, Witkin, who focused on individual differences in perceptual processing (Witkin,1954). He developed the field-dependence/independence cognitive style construct where he, together with his colleagues, showed via laboratory experiments that for individuals who are field-dependent, their perception of what they see is dominated by the overall organisation of the surrounding field, and for those who are field-independent, parts of the field are experienced as discrete from the background. Witkin, Moore, Goodenough & Cox (1977) gathered that:

> "From such evidence it became clear that we were dealing with a broad dimension of individual differences that extends across both perceptual and intellectual activities. Because what is at issue is the characteristic approach the person brings with him to a wide range of

situations - we called it his 'style' - and because the approach encompasses both his perceptual and intellectual activities - we spoke of it as his 'cognitive' style" (p.10).

Riding was another researcher who investigated cognitive styles extensively, and also learning design and personality. He developed a model comprising two independent dimensions, one relating to cognitive organisation (Holist-Analytic) and one relating to mental representation (Verbal-Imagery). According to Riding & Buckle (1990), the Holist-Analytic dimension was derived from Witkin's (1962) field-dependence/independence cognitive style construct. This dimension described the tendency of individuals to process information in wholes, or in smaller parts. The Verbal-Imagery dimension described the inclination of individuals to represent information during thinking either verbally or in mental pictures (Riding, 1997). Based on this model, Riding developed his Cognitive Styles Analysis (CSA) tool, which was a computerised assessment method to measure the two dimensions (Riding, 1998a, 1998b). This was not designed as a self-report measure, but presented cognitive tasks in such a way that it was not evident to the participant exactly what was being measured. The instrument measured the participants' speed of reaction and processing for both dimensions, rather than, for instance, the relative strength of verbal and visual cognitive abilities.

Riding's model, however, has been criticised as being conceptually problematic. Coffield, Moseley, Hall, & Ecclestone (2004b), for instance, pointed out that not many tasks in everyday life made exclusive demands on either verbal or non-verbal processing, which were more often interdependent or integrated aspects of thinking. Independent evaluations of the CSA have also reported a general lack of test-retest reliability (Peterson, Deary & Austin, 2003; Redmond, Mullally & Parkinson, 2002).

Many other researchers extended the style field, such as Kagan, Rosman, Day, Albert & Philips (1964), Oltman (1968), Pascual Leone (1970), Messick (1976), and Goodenough (1976). These researchers have mainly adopted a theoretical orientation in which the concept of cognitive style is defined as a consistent, stable, pervasive, personality-related individual way of organizing and processing information (Messick, 1984). In summarising the origins of the term, Sadler-Smith, Allinson & Hayes (2000) suggested that it represents an in-built and preferred way in which an individual responds to situations and data. In particular they emphasised that an individual's cognitive style is acquired at a young age and is both pervasive and fixed. This supports Escalona & Heider (1959) who concluded from an extensive developmental study of behaviour that:

> "As one notes behavioural alterations from infancy to…later preschool ages, one knows that not a single behaviour remained the same, yet one is struck with the inherent continuity of behavioural style and of the child's pattern of adaption" (p. 9).

It may be necessary at this juncture to point out the possibility of confusing cognitive style and ability. Riding (1997) suggested that style existed independently of ability, and pointed out that some tasks may seem easier for one individual than another, simply because the task may be better suited to one individual's cognitive style.

Various models and instruments have been developed to classify individuals according to their cognitive styles. Witkin's field-dependent/independence was an example of a two dimensional model. Examples of other models developed by researchers are described in Table 2.1.

Table 2.1

Examples with Brief Descriptions of Two-Dimensional Models of Cognitive Styles (extracted from Rayner & Riding, 1997)

Two-Dimensional Models of Cognitive Styles	Description	References
Impulsivity-Reflexivity	One's tendency for a quick response versus a deliberated response under situations of uncertainty	Kagan (1965)
Convergent-Divergent	One's narrow, focused, logical, deductive thinking style, in contrast to one that is open-ended, using associational thinking to solve problems	Hudson (1966, 1968)
Abstract-Concrete	One's preferred level and capacity of abstraction	Harvey, Hunt & Schroder (1961)
Verbaliser-Visualiser	The extent to which verbal or visual strategies are used when processing information	Paivio (1971); Richardson (1977); Riding (1997)

Riding and Cheema (1991), who reviewed a wide range of related literature, proposed that all cognitive styles could be organised into the two fundamental dimensions developed by Riding as discussed earlier. For example, the Impulsivity-Reflexivity and Convergent-Divergent styles could be classified under the Holist-Analytical family; and the Abstract-Concrete and Verbaliser-Visualiser styles could fall under the Verbaliser-Imager family.

While research in cognitive styles expanded, a large variety of terms were accumulated, each attempting to describe distinctive individual styles, and those associated mainly with education came to be known as *learning* *styles* (Entwistle & Peterson, 2004). However, attempts to distinguish learning styles from cognitive styles have not been consistent. Some authors use the term interchangeably (for example, Entwistle, 1981). Others, like Cano-Gracia & Hughes (2000), distinguished the terms more clearly. Cognitive styles, to them, described individual differences in cognitive processing and perception, while learning styles were more activity-centred, describing individual styles in relation to various learning activities, settings, and environments. Thus the learning style construct in educational psychology generally refers to consistent individual differences in the way individuals set about learning something (Adey, Fairbrother, William, Johnson, & Jones, 1999). These individual differences could include a combination of the cognitive, behavioural and affective aspects of a person that define his or her unique learning style (Rayner & Riding, 1997). As such, some authors like Witkin, Goodenough, & Karp (1967), and Schmeck (1983) viewed learning styles as applied cognitive styles that are relatively consistent predispositions to adopt particular learning strategies across specific tasks and domains.

Many educationists and researchers today have embraced the learning styles concept as a way to address individual differences in learning. It appears that most of the learning styles research started from the premise that a relatively direct relationship exists between learning style, teaching style and learner performance. This has come to be known as the *learning-styles hypothesis* which claims that learning outcomes could be optimised if instruction could be individualised to the learners' styles (Pashler, McDaniel, Rowher, & Bjork, 2009). To be specific, Pashler et al. (2009) defined a "meshing hypothesis" (p. 108) that referred particularly to the claim that the presentation of content should match the learners' inclinations to particular forms of information reception (for example, visual or verbal). Researchers who hold this view have attempted to devise instruments to measure and categorise learners according to their preferred mode of learning.

Neil Fleming was an example of one who carried out research based on the preceding concepts and introduced the VARK model (Fleming & Mills, 1992). VARK is an acronym that describes four types of learners: Visual, Aural, Read/Write and Kinaesthetic. Fleming claimed that there exists visual learners who learn best when information is presented pictorially (such as by means of diagrams, charts, and maps), aural/auditory learners who prefer information in a form that can be heard (such as lectures, audio recordings and verbal discussions), while learners who prefer the read/write modality learn best if information was presented in text-based formats (such as written documents, lists and books), and finally kinaesthetic learners who prefer experiential and practical forms of learning (such as role-playing, laboratory experiments and practicum). Studies have shown that a minority of people prefer to use one sensory modality when internalising information (unimodal), whereas the majority of people prefer to use two, three, or all four modalities (multimodal) (for example, Alkhasawneh, Mrayyan, Docherty, Alashram & Yousef, 2008; Baykan & Naçar, 2007; Lujan & DiCarlo, 2006; Murphy, Gray, Straja & Bogert, 2004).

Recent studies such as Leite, Svinicki & Shi (2010), using a Multitrait–Multimethod Confirmatory Factor Analysis Model, have found support for the validity of the VARK instrument. However there appears to be only a few studies that have focused on the possible relation between academic scores with sensory learning modalities. Baykan & Naçar (2007), for example, in their study of first-year medical students at a university in Turkey, found no correlation between their students' scores and their sensory learning modalities. Other studies did find some evidence that certain preferred modalities were associated with lower academic scores, such as Kinaesthetic learners (Dobson, 2009,2010), Aural learners (Foster, Gardner, Kydd, Robinson, & Roshier, 2010), and in general, unimodal students (El Tantawi, 2009).

Other than classifying learners by their preferred sensory modalities, researchers in the Learning Styles field, such as Kolb (1984), have studied how individuals understood their experiences and transformed these into knowledge. Kolb (1984) defined learning styles as distinctive individual differences in the learning process that arise from consistent patterns of transaction between the individual and his or her environment. Kolb's Experiential Learning Theory posits that through their past and present experiences, learners program themselves to grasp reality through a particular degree of emphasis on four modes of learning. The first two are related to how learners gather experiences and Kolb described them as the concrete experience and abstract conceptualization. The other two are related to the way learners transform their experiences into knowledge, and can be described as reflective observation and active experimentation. Kolb (1984) proposed that an ideal learning process should encompass all four modes to be effective, so learners would learn best if they were taught using all four modes. However, individual learners tend to develop strengths that are a combination of two modes - comprising one experience-gathering approach and one experience-transforming approach. So according to Kolb (1984), a person who uses abstract conceptualisation and active experimentation is a Converger; one who uses concrete experience and reflective observation is a Diverger; one who uses abstract conceptualisation and reflective observation is an Assimilator; and finally, one who uses concrete experience and active experimentation is an Accommodator. From this model, Kolb developed his Learning Style Inventory (LSI) as a tool to determine a person's learning style.

Kolb's theory became one of the most influential in the learning style research field, gathering the highest number of citations according to Desmedt & Valcke (2004) in their review of 1,091 papers on learning styles and cognitive styles spanning over about 30 years. However, the reliability and validity of Kolb's ILS was also widely criticised (for example, Lamb & Certo, 1978; Freedman & Stumpf, 1978; West, 1982; Fox, 1985; Rule & Grippin, 1988; and Holman, Pavlice & Thorpe, 1997). Results from some studies indicated that generally test-retest measurements for the LSI did not reliably assess the learning styles of learners (Garner, 2000). A weakness of the LSI was the ipsative measurement method that required respondents to rank order their preferences for given sets of items. This method has been criticised for its inherent artifactual negative interdependence within the scores (Cornwell & Dunlap, 1994) because a response to one item is necessarily dependent on responses to other items in the set. Psychometric problems with regards to construct validity have been attributed to this limitation (Platsidou & Metallidou, 2009). Research utilising the LSI to relate learning styles to academic performance have also shown mixed results. One such study was carried out by Lynch, Woelfl, Steele, & Hanssen (1998). They found that Convergers and Assimilators in their sample of third year medical students performed better on the objective United States Medical Licensing Examinations and National Board of Medical Examiners assesments, but no significant differences in performance in clinical simulations compared with their peers. Perhaps, in view of its limitation in predicting academic performance, Kolb's learning style theory could be applied only to understanding the different learning preferences of students. Designing instruction to match the various styles of learning based on the LSI may not yield significant improvements in academic performance.

Following Kolb's work, Honey & Mumford (1986) adapted Kolb's model in an attempt to address the shortcomings of the LSI. They described four learning styles: Activists, Reflectors, Theorists and Pragmatists using their own instrument called the Learning Styles Questionnaire (LSQ). Various studies carried out in different countries have shown some evidence of reliability and validity for the LSQ, for example Allison & Hayes (1988, 1990) and Hayes & Allison (1988). However, other researchers such as Duff & Duffy (2002) and Zwanenberg & Wilkinson (2000), have cast doubts on the use of the LSQ to develop appropriate instructional methods or categorising individual students, and have also cautioned against the use of the LSQ in predicting academic outcomes.

At about the same time that Kolb published his Experiential Learning Theory, Dunn & Dunn (1978) developed a multidimensional model that extended the understanding of learning styles beyond just individual preferences for particular sensory modalities and experiential learning. Their model comprised five stimuli groups encompassing the environmental, emotional, sociological, physiological, and psychological dimensions of a learner, and contained 21 subcategories, which the Dunns referred to as elements. Each element was thought to impact learners to different degrees and was associated with each of the stimuli as follows:

(i) Environmental stimuli (elements include sound, light, temperature, and furniture/seating designs);

(ii) Emotional stimuli (elements include motivation, persistence, responsibility [conformity vs. nonconformity], and need for either externally imposed structure or the opportunity to do things their own way);

(iii) Sociological stimuli (elements include learning alone, in a pair, in a small group, as part of a team, with an authoritative or collegial adult, and wanting variety as opposed to patterns and routines);

(iv) Physiological stimuli (elements include perceptual strengths, time-of-day energy levels, and need for intake or mobility while learning; and

(v) Psychological stimuli or processing inclinations (elements include global/analytic, right/left hemisphericity, and impulsive/reflective characteristics).

Using this model, Dunn, Dunn & Price (1989) developed their own Learning Style Inventory (LSI) comprising a 100-item self-report questionnaire which became very widely used and highly cited (Dunn, Beaudry, & Klavas, 1989; and Desmedt & Valcke, 2004). Curry (1987), who reviewed 21 different learning/cognitive style models through psychometric analyses, reported that the Dunn & Dunn model had good internal reliability and validity ratings compared with the other models in their study.

Using a meta-analytic technique, Dunn, Griggs, Olsen, Beasley & Gorman (1995) evaluated 42 experimental studies based on the Dunn & Dunn Learning Style Model conducted between 1980-1990 to determine the value of teaching students according to their learning style preferences. Among several results of their study, they found that instructional interventions in classrooms that were congruent with students' learning preferences were effective in facilitating good academic results. The effectiveness of the interventions depended on the duration of exposure experienced by the students.

Several other studies have appeared to support the Dunn & Dunn matching hypothesis such as Nelson, Dunn, Griggs, Primavera, Fitzpatrick, Bacilious & Miller (1993). However, a number of researchers have shown strong evidence that has raised doubts about the reliability and validity of the instrument and hence the results of the studies, including Hughes (1992), Knapp (1998), and Shwery (1998). Coffield et al. (2004b) put forward probably one of the strongest critiques of the Dunn & Dunn model, pointing out the insufficiency of independent evaluations that could support their theory. They went as far as to say that it was the Dunn's inability "to conceive that other professionals have the right to think and act differently from the injunctions of the model that constitutes its most serious weakness. This antiintellectual flaw makes the Dunn & Dunn model unlike any other evaluated in this review" (p. 34).

Only a few of the many models and instruments that claim to measure learning styles have been discussed so far to illustrate some of the theories that have influenced the styles field. Fleming's VARK model and Dunn & Dunn's LSI represented models that focussed on instructional preferences, while Kolb's and Honey & Mumford's LSQ represented models focussed on experiential learning. Having understood the respective claims and possible weaknesses of the learning style models that have been briefly outlined, I shall now discuss some possible implications for pedagogy.

The first implication assumes that learners have fixed traits and abilities (such as Dunn & Griggs, 2003 and Gregorc, 1984) and that there exist instruments that can provide valid and reliable measurements to determine an individual's learning style. Knowledge and understanding of students' learning styles can then help teachers become more sensitive to the differences students bring to the classroom. This can also inform the design of specific interventions to address them, both at the level of individual self-awareness and in the lesson delivery. However, critics of the notion of learning styles and its measurability have been quick to point out that these so-called measurements are derived from the subjective judgments which students make about themselves in response to the test items (Coffield et al., 2004b). In addition, with so many different ideas about learning styles, each creating distinct approaches to identifying the specific attitudes and skills that characterise these styles, and different measures designed to generalise between learning contexts and types of learners, the difficulties are obvious.

Indeed these competing theories and measurements are so varied and contested that simple choices about the most suitable are difficult to substantiate (Coffield et al., 2004b). Many writers have questioned the psychometric quality of many of the learning style instruments in terms of their reliability and validity (examples include Rayner & Riding, 1997; Reynolds, 1997; Sadler-Smith, 2001; Stellwagen, 2001). Coffield et al. (2004b) proposed that observation and interviews may be more likely than self-report instruments to capture some of the broad learning styles that learners adopt. Those who reject the idea of measurable learning styles often consider it more useful to focus on learners' previous experiences and motivation (Coffield et al. 2004b). Translating specific ideas about learning styles into appropriate interventions in teaching and learning is critically dependent on the extent to which these learning styles have been reliably and validly measured, rigorously tested in authentic situations, given accurate labels and integrated into everyday practices of information gathering, understanding, and reflective thinking. Assuming that these steps are possible, the implementation in actual day-to-day classroom situations could be very complex, and "ultimately, the practical question will be whether the benefits of learning-styles interventions exceed other ways of using the time and money needed to incorporate these interventions" (Pashler et al., 2009, p. 116).

The second implication is that the meshing (or matching) hypothesis effectively improves learning outcomes, as briefly mentioned earlier. This hypothesis builds on what is called aptitude-treatment-interaction (ATI) research (Cronbach & Snow, 1977), and advocates that if a teacher matches instruction to the individual learning styles of his or her students, the latter will perform better, or at least they will appreciate the instruction to a higher extent. Several studies, such as Dunn, Griggs, Olsen, Beasley & Gorman (1995) and Nelson, Dunn, Griggs, Primavera, Fitzpatrick, Bacilious & Miller (1993) that were described earlier, have suggested that providing instruction in a manner consistent with the students' preferred style of learning contributes to more effective learning. However, critics such as those already mentioned in the examples discussed, have questioned the reliability and validity of the instruments used, and hence the results of the studies. Pashler et al. (2009), using their own rigorous criteria to validate the use of learning-style assessments in instructional settings, found only a small number of pieces of evidence that supported the hypothesis, but were not convincing enough to advocate the use of learning-style assessments in the classroom. Moreover, several well-designed studies found evidence that contradicted the matching hypothesis (Constantinidou & Baker, 2002; Massa & Mayer, 2006).

Acknowledging the difficulties and shortcomings of attempting to match teaching and learning styles, some theorists would rather promote the idea that learners should develop a repertoire of styles, so that an awareness of their own preferences and abilities should not bar them from working to acquire those styles which they do not yet possess. McCarthy (1990), for example, proposed an eight-step instructional sequence which she called the 4MAT System that was largely derived from Kolb's (1984) work. This system sought to accommodate preferences for using the two hemispheres of the brain in learning, and what she considered to be the four main types of learners: imaginative learners, analytic learners, common-sense learners and dynamic learners. McCarthy proposed that "this cycle appeals to each learner’s most comfortable style in turn, while stretching her or him to function in less comfortable modes. The movement around this circle is a natural learning progression" (McCarthy, 1990, p. 33). Many studies have claimed positive results after the implementation of the system, for example, Wilkerson & White (1988). They developed a new course package for a particular Science subject based on the 4MAT system and introduced it to one group of third grade students. The content to be covered was presented in a variety of ways and through different activities such as group discussions, watching a filmstrip, doing word-matching and so on. Another group was taught using the existing method which mainly required the students to read their textbook and answer worksheets in class. The students then took an assessment that comprised two parts - Part A was an objective achievement test that measured knowledge, comprehension, application, and analysis. Significant differences were found between groups in favour of those taught using the 4MAT system; Part B was a performance test that measured synthesis and evaluation. To the surprise of the researchers, no differences were found between the two groups on this second measure, which they posited could be due to the difficulty level of the test and possible rater errors. They administered the test again after 35 days to evaluate the students' memory retention. Again significant differences were found on Part A in favour of those taught using the 4MAT system, and no differences were found on Part B. While studies such as this may appear to support the claims for the effectiveness of the 4MAT system, it is possible that the students who responded positively did so simply because they were more purposefully engaged through a variety of classroom activities compared to the other students who were taught using just a textbook and accompanying worksheets. The possibility of the novelty effect also cannot be ruled out. Another critique against the use of the 4MAT system could be its linkage to Kolb's model which had inherent reliability and validity limitations as discussed earlier.

In summary, the literature on learning styles is vast and diversified. While a general consensus may be reached for the existence of personal traits that give rise to individual differences in the way people take in and process information as part of learning, the same cannot be said about how these differences can be identified and measured. Many researchers have posited their own theories, models, and instruments to distinguish these differences. One of the main goals of identifying learning styles was to inform instructional design so as to match teaching to the individual styles thereby optimising learning effectiveness based on what has come to be known as the learning styles hypothesis, or more specifically, the matching hypothesis. However, there has not yet been sufficient evidence gathered through research to support this matching hypothesis conclusively. Key challenges faced by researchers include limitations in the models and psychometric instruments that they have devised. Perhaps many of the theories discussed so far may have taken a rather limited, and simplified, view of learners and their learning processes. There could be other factors that need more consideration when understanding learners from their perspective, such as their conceptions of learning and the influence of the educational context. In the following section, I shall review another important branch of research that has attempted to place more focus on these other factors.

2.4 The Student Approaches to Learning Concept

It is interesting to note that the authors cited in the previous sections who favoured the concept of learning styles were for the most part working in the United States and many of the applications of their theories were involved in management education. There appears to be an alternative and distinct school of thought that has emerged from researchers mainly in non-management education contexts in the United Kingdom, Europe and Australia who have moved on from the stable or *flexibly stable* characteristics of learning styles towards a broader understanding of the term and prefer to use terms such as *learning approaches, orientations, or strategies.* Entwistle (1983), Marton (1976) and Biggs (1993) are pivotal authors for this school of thought and they form the phenomenographic tradition (Marton, 1981) in the research into individual differences in learning and focus on understanding the experience of learning from the student's perspective, in naturalistic settings in higher education. Data are collected through interviews and self-reports to analyse individual differences in approaches to learning instead of learning styles. These approaches comprised both motivational and strategy components and were only meaningful in particular contexts. Struyven, Dochy, Janssens, & Gielen (2006) put it this way: "In contrast to learning styles, approaches to learning are not characteristics of learners, they are determined by a 'relation' between a learner and a context" (p. 279). Therefore, they are less static than learning styles or cognitive styles (Biggs, 1993).

The origins of the approaches to learning school of thought can probably be traced to the work of Marton & Säljö (1976a,1976b) who were among the first to use the term. Their research was mainly carried out in higher education settings, and they hypothesised that different learning outcomes could be attributed to various learning intentions, or conceptions of learning of students. Säljö (1979) identified five different conceptions of learning among his sample of Swedish students:

(i) Learning as the increase of knowledge

(ii) Learning as memorising

(iii) Learning as the acquisition of facts, procedures, etc. which can be retained and/or utilised in practice

(iv) Learning as the abstraction of meaning

(v) Learning as an interpretative process aimed at the understanding of reality (p. 19, quoted in Richardson, 2011).

Säljö described the first three conceptions as *reproductive* (Surface) conceptions of learning and the remaining two as *reconstructive* (Deep) conceptions of learning. Thus there could exist students who adopt a Deep Approach with the intention to establish mastery of the material and its integration into the learners' existing knowledge base. There could be other students who adopt a Surface Approach with the intention to achieve short-term memorisation of the material so that it may be reproduced, for example, in an examination.

Further studies by Entwistle & Waterston (1988) and Ramsden (1981) (quoted in Diseth & Martinsen, 2003) have also proposed a Strategic Approach that was adopted by students who have the intention to achieve the best possible grades by adapting their learning approaches according to the assessment demands. Students who use this approach try to manage their time and intellectual resources in line with the perceived criteria for high grades (Diseth & Martinsen, 2003). Therefore these students could mix both Deep and Surface Approaches, motivated by achievement rather than an interest in ideas or gaining understanding, or even the fear of failure. These distinct approaches to learning were identified in several other studies such as those by Christensen, Massey, & Isaacs (1991), Clarke (1986), and Entwistle, Tait & McCune (2000).

In addition, some studies have identified that learning contexts or learning environments could be an important influence on students' approaches to learning (e.g. Entwistle & Tait, 1990; Laurillard, 1997). Prosser and Trigwell (1999) argued that students' prior experiences, especially their experiences of learning and existing understanding of the subject matter, would influence the approach adopted in a particular learning context. Laurillard (1997) posited that a student's learning approach was not a stable characteristic, but was determined by the student's perception of the needs of the task. This idea was seen as particularly important as it underpinned the main thrust of much of the action research reported from the 1990s onwards, mostly carried by practitioners in educational institutions seeking to improve teaching and learning outcomes. For example, Gibbs (1994) suggested that it was possible to improve the quality of learning by changing students' approaches to learning via the manipulation of the learning context or environments and assessment regime.

The key features of the approaches to learning concept thus includes dimensions such as the educational context, conceptions of learning, motivational orientations, and regulation of learning (Heikkilä & Lonka, 2006). Instruments such as the Approaches and Study Skills Inventory for Students (ASSIST) by Entwistle (1997), the Study Process Questionnaire (SPQ) by Biggs (1979), and the Inventory of Learning Styles by Vermunt (1998) attempt to encompass the measurement of some of these dimensions. Vermunt's work will be discussed in greater detail later in this literature review.

The ASSIST instrument was designed to measure the three major constructs of Deep, Surface and Strategic Approaches to studying and learning. There are four subscales included in the Deep Approach: meaning-seeking, relating to ideas, use of evidence and interest in ideas. The Surface Approach is also measured by four subscales: unrelated memorising, lack of purpose, syllabus-boundedness and fear of failure. The Strategic Approach has five subscales included: organised studying, time management, monitoring effectiveness, achievement motivation and alertness to assessment demands. A brief description for each of the subscales can be found in Table 2.2. Altogether there are 52 items (4 items for each subscale) with a five-point response scale.

Tait, Entwistle, & McCune (1998) tested the reliability of the instrument with a sample of 1231 university students across six UK institutions and from 16 disciplines, most of which came from the Arts and Social Sciences or Science and Engineering courses. They obtained alphas from 0.8 to 0.87 on

Table 2.2

Description of Sub-scales of the Approaches and Study Skills Inventory for Students (ASSIST)

Approaches to Studying	Sub-scales	Descriptions
Deep Approach	Meaning seeking	Seeking to reflect and understand for oneself the meaning of what needs to be learned
	Relating ideas	Exploring and relating concepts and ideas from various sources
	Use of evidence	Examining details and evidence to draw conclusions
	Interest in ideas	Engaging with new ideas out of strong interest
Strategic Approach	Organised studying	Planning and systematically approaching learning tasks
	Time management	Organising a schedule to fit in the required learning tasks and staying with it
	Alertness to assessment demands	Seeking to understand what is expected to achieve good results in assignments and examinations
	Achievement motivation	Maintaining a high level of effort in learning tasks that is motivated by a sense of achievement
	Monitoring effectiveness	Thinking through the requirements of a learning task, and checking through when finished to ensure objectives are met
Surface Approach	Lack of purpose	Having doubts about one's choice of study path due to lack of interest
	Unrelated memorising	Memorising content in an unsystematic way, with no clear purpose
	Syllabus-boundedness	Confining learning of content or learning tasks to meet minimum requirements to pass examinations and assignments
	Fear of failure	Doubting one's own ability to cope with learning tasks

the main scales (Deep, Surface and Strategic), and the subscales had alphas ranging from 0.54 to 0.76, with a median value of 0.62. Factor analysis using maximum-likelihood extraction (rotated matrices) revealed a three-factor-pattern which corresponded to the Deep, Surface and Strategic Approaches. In a different study by the Centre for Research into Learning and Instruction

(CRLI) under the University of Edinburgh, 817 first-year students from 10 contrasting departments from six British universities were studied.

The alphas for the three approaches to studying were reported as follows: Deep Approach (0.84); Strategic Approach (0.80) and Surface Approach (0.87) (CRLI, 1997, quoted in Coffield et al., 2004b). It was noted that while Entwistle and his team provided extensive research evidence to support the reliability and validity of their model, verifications carried out by independent studies were scarce (Coffield et al., 2004b).

The approaches to learning concept has been applied to various educational contexts, and the relationship between the study approaches and academic performance of students have been found in several studies, for example Newstead (1992), Sadler-Smith (1997), and Diseth & Martinsen (2003). Newstead (1992) found a modest, but positive correlation between the academic performance of a sample of Psychology students with the Deep Approach ($r=0.22$, $p<0.05$) and Strategic Approach ($r=0.32$, $p<0.01$) scales. In a later study, Sadler-Smith (1997) also found correlations between performance and the Deep Approach ($r=0.26$, $p<0.01$) and, to a smaller extent, the Strategic Approach ($r=0.14$, $p<0.05$) for their sample of Business students. Diseth & Martinsen (2003), however, found, to their initial surprise, that their sample of undergraduate students at a Norwegian university responded in a different way. They found that the Deep Approach did not significantly predict academic achievement while the Surface and Strategic Approaches did. On further investigation, they found that the course that the students were studying included a fixed curriculum that had a well-defined assessment that did not invite nor reward exploration of learning materials and ideas that were beyond the curriculum. Moreover, the majority of the students were eager to continue with graduate studies and had to achieve high grades for their undergraduate course to secure a place. Diseth & Martinsen (2003) proposed that these factors could have been important enough to cause students to resort to the Surface and Strategic Approaches to succeed in the course. This response was also found by Newble & Hejka (1991) when they studied a sample of medical undergraduates. It may be concluded that the learning environment and the perceived examination expectations were likely to have an impact on students' approaches to learning. In fact, in a more recent study, Diseth, Pallesen, Brunborg, & Larsen (2010) found that it was "more important to discourage a surface approach than to encourage a deep approach if the goal is to improve performance" (p. 348) by using assessment methods and teaching practices that aim at fostering deep learning and conceptual understanding.

The understanding that the learning context plays a key role in shaping students' approaches to learning has led a number of researchers to propose models that attempt to describe this relationship. One example was Biggs (2003) who described three stages in the process of learning which he termed Presage, Process and Product, otherwise known as the 3P-Model. Presage factors referred to existing factors that are brought to a learning situation. These include two sets of key factors, the first being student factors, for example, prior knowledge, interest in the topics, and abilities. The second set includes the teaching context (or situational) factors, for example, the nature of the course content, instructional method, assessment method, and even the institutional climate and procedures. According to Biggs (2003), these Presage factors interact at the Process stage to influence the way students carry out their learning-focused activities, that is, their particular approaches to learning (deep, surface or strategic). These approaches to learning in turn influenced the students' learning outcomes, which is the Product stage. While this was the general learning process flow, Biggs (2003) also proposed that each stage interacted with every other stage forming a complex system. Figure 2.2 illustrates the 3P model described by Biggs. The bolder arrows indicate the general process flow and the lighter arrows indicate other possible interactions between each stage.

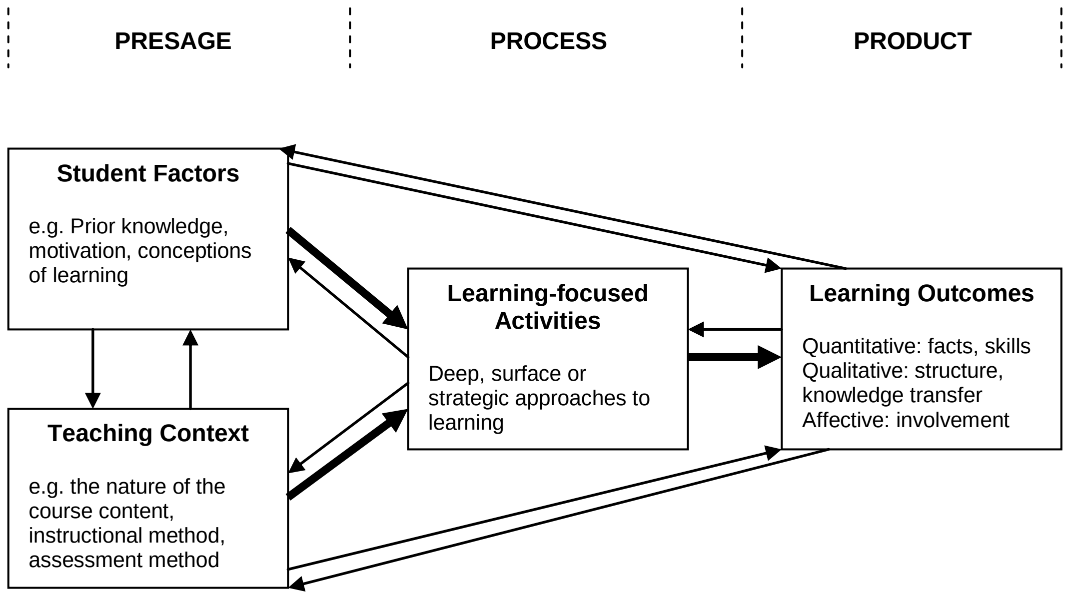


Figure 2.2. Diagrammatic illustration of the 3P Model for teaching and learning (Biggs, 2003, p. 19)

Models such as the one described by Biggs (2003) seemed to imply that learning environments could be intentionally manipulated to foster Deep Approaches and hence increase the quality of learning and enhance academic outcomes.

Balasooriya, Toohey, & Hughes (2009) carried out a study utilising the Revised Two-Factor Study Process Questionnaire (SPQ-R-2F), developed by Biggs, Kember, & Leung (2001). The questionnaire was administered to students before and after exposure to three different course units in medical education, each designed to encourage deep approaches to learning. They found, as anticipated, that there were students who had a preference for Surface Approaches at the start of their respective courses who eventually changed towards Deep Approaches. Interestingly, they also found that there were students who were *Persistent Deep* and others who *were Persistent Surface* - that is, the students did not change their approach to studying regardless of the learning context. Moreover, they identified some students who went through the respective courses that had started out preferring Deep Approaches but eventually changed towards Surface Approaches. In total, Balasooriya et al. (2009) found eight possible combinations of interaction between the student and context presage factors, of which four of these combinations gave rise to the anticipated deep or surface approaches. The other four combinations gave rise to approaches that were contrary to their hypotheses. Balasooriya et al. (2009) cautioned that there could be a substantial proportion of students who could respond in such an unintended manner, underscoring the effect of complex interactions between the student factors and teaching context factors. Other studies such as Gibbs (1992), Kember, Charlesworth, Davies, McKay, & Scott (1997) and Hambleton, Foster & Richardson (1998), have also found that interventions aimed at fostering desirable approaches to studying appear to be less effective than expected. These findings have highlighted the fact that the process to achieve the intended outcomes may not be so simplistic. This resonates with Cuthbert's (2005) criticism where he pointed out that the approaches to learning concept often places too much attention on manipulating the context without giving sufficient focus to the student presage factors.

While the 3P model suggested that students' learning approaches were due to the interaction between the student factors and the context, it was not able to adequately explain the variations in the results of the above studies. Richardson (2006) suggested that the way students perceived their academic environment had an important role in influencing the interaction between students and their context. More specifically, through path analysis, he found that a bi-directional relationship existed between variations in students' perceptions of their educational context (such as appropriateness of assessments and workload) and variations in their study approaches (deep, strategic and surface). More recently, Richardson (2011) reiterated the importance of students' conceptions of learning, an idea introduced earlier by Säljö (1979), as an influence on *both* their perception of their context *and* their approaches to learning. Richardson (2011) examined empirical evidence (such as Vermetten, Vermunt, & Lodewijks, 1999; Edmunds & Richardson, 2009), and argued that students' conceptions of learning were relatively stable across various contexts and could thus fit the traditional notion of learning styles as "relatively consistent preferences for adopting learning processes, irrespective of the task or problem presented" (Entwistle & Peterson, 2004, p. 537). Richardson (2011) therefore proposed the possibility for the rapprochement of the two important research fields of styles and approaches to learning. This concept merits further study because it could pave the way towards a more unified and holistic understanding of learners and learning processes within various contexts.

Interestingly, this close interplay between conceptions of learning and other dimensions of learning had been studied by Jan Vermunt upon which he developed his model describing the regulation of constructive learning processes (Vermunt, 1996, 1998).

2.5 Vermunt's Model of the Regulation of Constructive Learning Processes

Vermunt (1996) investigated a sample of 34 first year students at an Open University in the Netherlands. Using phenomenographical analysis, he identified four qualitatively different styles of learning which he named: meaning directed, application directed, reproduction directed and undirected. The styles differed from each other in five areas: the way in which students cognitively processed learning content, the way in which students prefer their learning to be regulated (self-regulated or externally regulated), the affective processes that occur during studying, the students' mental models of learning (or conceptions of learning) and their learning orientations (or motives). Vermunt (1996) noted that each student in his sample showed one of the four learning styles as a dominant style, although some possessed features of other styles. He argued that the term *learning style* here encompassed "a coherent whole of learning activities that students usually employ, their learning orientation and their mental model of learning" (p. 29). He also considered learning styles as the result of the interplay between personal and contextual influences, and were therefore not unchangeable personality attributes.

After that study was published, Vermunt appeared to have refined the five areas that influenced the learning styles of students and reorganised them into four domains of learning which he reported in Vermunt (1998). He called these domains: processing strategies, regulation strategies, learning orientations and mental models of learning.

Processing strategies refer to the thinking activities that students use to process content that they need to learn, and to attain their learning goals by doing so. These activities lead to learning outcomes that include understanding, knowledge, and skill. Examples of processing strategies include relating elements of particular subject matter to each other and to prior knowledge, drawing one's own conclusions from subject matter, memorising learning contents, thinking of one's own examples related to subject matter, and selecting main points from text while reading (Geisler-Brenstein, Schmeck & Hetherington, 1996; Janssen, 1996; Schellings, Van Hout-Wolters & Vermunt, 1996).

Regulation strategies can be described as metacognitive activities that are directed at regulating cognitive activities and therefore lead to learning outcomes indirectly. Examples of metacognitive regulation activities include planning and monitoring one's own learning progress, and diagnosing the cause of one's own difficulties in learning a particular subject matter (Brown, 1987; Volet, 1991).

The learning orientations (or motives) of students generally encompasses students' personal goals, intentions, attitudes, expectations, anxieties and doubts. Researchers (e.g. Biggs,1987; Entwistle, 1988; and Gibbs, Morgan & Taylor, 1984) have found that the learning motives of students in a course of studies, can have significant influence upon their learning process. For example, Biggs (1987) reported that intrinsic study motives characterised by the desire to actualise interest and competence in particular academic subjects, had a strong correlation to the adoption of deep strategies.

Finally, mental models of learning include conceptions of learning and studying in general, conceptions of themselves as learners, conceptions of learning objectives and learning tasks and conceptions of the task division between themselves and others in the learning process (Flavell, 1987; Lonka, Joram & Bryson, 1996; Marton, Dall'Alba & Beaty, 1993; Prosser, Trigwell & Taylor, 1994).

Vermunt (1998) further developed his original theory into a model that explicitly attempted to provide a comprehensive and integrated account of learning by bringing together the four different domains of learning. He postulated that students' mental models of learning and their learning orientations have direct influence on their regulation strategies, and also indirect influence on their processing strategies. In turn, students' processing strategies (approaches to learning) are mainly determined by the regulation strategies they employ. His model of the regulation of constructive learning processes is illustrated in Figure 2.3.

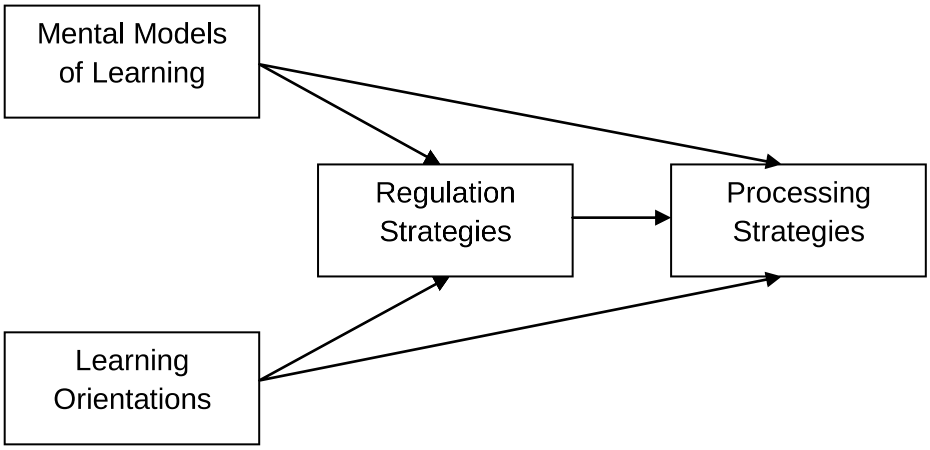


Figure 2.3. Vermunt's (1998) Model of the Regulation of Constructive Learning Processes (p. 153)

Interestingly, Richardson (2000), quoted in Richardson (2011), compared Vermunt's model with Curry's (1983) "onion" model and suggested some conceptual similarities. Regulation strategies and processing strategies could be viewed as being more susceptible to influences from environmental factors and so they could belong to the first or second layer of the "onion" which represented instructional preference and information-processing style. In contrast, learning orientations and conceptions or mental models of learning could be considered as relatively stable, personal characteristics, and so could belong to the innermost layer of the "onion" that represented cognitive personality style. Vermetten et al. (1999) referred to processing and regulation strategies as the contextual domain of a learner, while mental models of learning and learning orientations were described as the personological domain. This suggests that Vermunt's model could be viewed as an integrative model that includes concepts from both the learning styles (considered as more stable or flexibly stable) and approaches to learning (considered as more susceptible to contextual influences) schools of thought (Coffield et al., 2004b).

Also arising from the qualitative data derived from his earlier phenomenographic study (Vermunt, 1996), he constructed a diagnostic instrument he called the Inventory of Learning Styles (ILS). The instrument was organised into two parts, Part A was consolidated as Study Activities, and comprised two learning components, namely Processing Strategies and Regulation Strategies. Part B was consolidated as Study Motives and Study Views, and comprised the other two components, namely Learning Orientations and Mental Models of Learning.

Each of the four domains included five subscales containing between four to nine items, with a total of 241 items. Each item comprised a statement for which the participant had to indicate on a 5-point Likert scale to what extent the statement applied to them. A score of 1 means ‘I do this seldom or never’ and 5 means ‘I do this almost always’ for items in Part A. For items in Part B, a 1 means ‘disagree entirely’ and 5 means ‘agree entirely’.

Table 2.3 summarises the parts, domains, subscales of the Inventory of Learning Styles (ILS), and the corresponding descriptions of the subscales and sample statements of the items.

Table 2.3

Parts, domains, subscales of the Inventory of Learning Styles (ILS), and the corresponding descriptions of the subscales and sample statements of items

Parts and Scales of the ILS	**Description of Content & Sample Statements**
Part A: STUDY ACTIVITIES	
Processing Strategies	
Deep Processing – Relating & Structuring	Relating elements of the subject matter to each other and prior knowledge; structuring these elements into a whole. Sample statements: *"I try to combine the subjects that are dealt with separately in a course into a whole"* *"I try to see the connection between the topics discussed in different chapters of a textbook"*
Deep Processing - Critical Processing	Forming one's own view on the subjects that are dealt with, drawing one's own conclusions, and being critical of the conclusions drawn by text-book authors and teachers. Sample statements: *"I compare my view of a course topic with the views of the authors of the textbook used in the course"* *"I draw my own conclusions on the basis of the data that are presented in a course"*
Stepwise Processing – Memorising & Rehearsing	Learning facts, definitions, lists of characteristics and the like by heart by rehearsing them. Sample statements: *"I repeat the main parts of the subject matter until I know them by heart"* *"I memorise definitions as literally as possible"*
Stepwise Processing - Analysing	Going through the subject matter in a stepwise fashion and studying the separate elements thoroughly, in detail and one by one. Sample statement: *"I work through a chapter in a textbook item by item and I study each part separately"* *"I study details thoroughly"*
Concrete Processing	Concretising and applying subject matter by connecting it to one's own experiences and by using what one learns in a course in practice. Sample statements: *"I try to interprete events in everyday reality with the help of the knowledge I have acquired in a course"* *"I pay particular attention to hose parts of a course that have practical utility"*
Regulation Strategies	
Self-Regulation – Learning Process & Results	Regulating one's own learning processes through regulation activities like planning learning activities, monitoring progress, diagnosing problems, testing one's results, adjusting, and reflecting. Sample statements: *"To test my learning progress when I have studied a textbook, I try to formulate the main points in my own words"* *"When I am studying, I also pursue learning goals that have not been set by the teacher but by myself"*
Self-Regulation – Learning Content	Consulting literature and sources outside the syllabus. Sample statements: *"In addition to the syllabus, I study other literature related to the content of the course"* *"If I do not understand a study text well, I try to find other literature about the subject concerned"*
External Regulation – Learning Process	Letting one's own learning processes be regulated by external sources, such as introductions, learning objectives, directions, questions or assignments of teachers or textbook authors.

Parts and Scales of the ILS	Description of Content & Sample Statements
	Sample statements: *"I learn everything exactly as I find in the textbooks"* *"I study according to the instructions given in the study materials or provided by the teacher"*
External Regulation – Learning Results	Testing one's learning results by external means, such as the tests, assignments, and questions provided. Sample statements: *"I test my learning progress solely by completing the questions, tasks and exercises provided by the teacher or the text book"* *"If I am able to complete all the assignments given in the study materials or by the teacher, I decide that I have a good command of the subject matter"*
Lack of Regulation	Having difficulty monitoring one's own learning processes. Sample statement: *"I realise that it is not clear to me what I have to remember and what I do not have to remember"* *"I realise I miss someone to fall back on in case of difficulties"*
Part B: STUDY MOTIVES and STUDY VIEWS	
Learning Orientations	
Personally Interested	Studying out of interest in the course subjects and to develop oneself as a person. Sample statements: "*I do these studies out of sheer interest in the topics that are dealt with"* *"When I have a choice, I opt for courses that suit my personal interests"*
Certificate Oriented	Striving for high study achievements; studying to pass examinations and to obtain certificates, credit points, and a degree. Sample statements: *"What I want in these studies is to earn credits for a diploma"* *"To me, written proof of having passed an exam represents something of value in itself"*
Self-Test Oriented	Studying to test one's own capabilities and to prove to oneself and others that one is able to cope with the demands of higher education. Sample statement: *"I want to show others that I am capable of successfully doing a higher education programme"* *"I want to prove to myself that I am capable of doing studies in higher education"*
Vocation Oriented	Studying to acquire professional skill and to obtain a(nother) job. Sample statements: *"When I have a choice, I opt for courses that seem useful for my present or future profession"* *"The main goal I pursue in my studies is to prepare myself for a profession"*
Ambivalent	A doubtful, uncertain attitude toward the studies, one's own capabilities, the chosen academic discipline, the type of education etc. Sample statements: *"I doubt whether this is the right subject area for me"* *"I wonder whether these studies are worth all the effort"*
Mental Models of Learning (or Conceptions of Learning)	
Construction of Knowledge	Learning viewed as constructing one's own knowledge and insights. Most learning activities are seen as tasks of students. Sample statements: *"To me, learning means trying to approach a problem from many different angles, including aspects that were previously unknown to me"* *"I should try to think up examples with the study materials of my own accord"*
Intake of Knowledge	Learning viewed as taking in knowledge provided by education through memorizing and reproduction; other learning activities are tasks of teachers.

Parts and Scales of the ILS	Description of Content & Sample Statements
	Sample statements: *"I like to be given precise instructions as to how to go about solving a task or doing an assignment"* *"Good teaching includes giving a lot of questions and exercises to test whether I have mastered the subject matter"*
Use of knowledge	Learning viewed as acquiring knowledge that can be used by means of concretising and applying. These activities are seen as tasks of both students and teachers. Sample statements: *"The things I learn have to be useful for solving practical problems"* *"To me, learning means acquiring knowledge that I can use in everyday life"*
Stimulating Education	Learning activities are viewed as tasks of students, but teachers, and textbook authors should continuously stimulate students to use these activities. Sample statements: *"The teacher should encourage me to check myself whether I have mastered the subject matter"* *"The teacher should encourage me to reflect on the way I study and how to develop my way of studying"*
Cooperative Learning	Attaching a lot of value to learning in cooperation with fellow students and sharing the tasks of learning them. Sample statements: *"When I prepare for an exam, I prefer to do so with other students"* *"I consider it important to be advised by other students as to how to approach my studies"*

Vermunt (1998) went on to conduct a larger scale study with a total sample of 1512 students to verify the results of his phenomenographic study using the ILS he had developed. He included two groups of students for his study, one group comprised students studying in an open university (OU) (N=717) programme, and the other were students studying in a regular university (RU) (N=795) programme. The former were students who worked with self-instructional materials with limited face to face contact with a tutor; the latter were students who attended regular lectures, tutorials and independent study sessions. Through several iterations as part of this study, the ILS instrument was refined using factor, reliability, item, and test-retest analyses. The number of items was thus reduced from the original 241 items to a more useable 120. The results for the alphas, and the factors obtained from factor analysis with oblique rotation, are summarised in Table 2.4.

Table 2.4

Cronbach alphas (α) of the ILS scales for open university (OU) students (N=654) and regular university (RU) students (N=795), and the four respective factor loadings (pattern matrices) in a four-factor oblique solution (F1 to F4); loadings > -.25 and <.25 omitted (summarised from Vermunt (1998))

ILS Scale	**α**		**F1**		**F2**		**F3**		**F4**	
	OU	**RU**	**OU**	**RU**	**OU**	**RU**	**OU**	**RU**	**OU**	**RU**
Domain I: Processing Strategies										
Relating and structuring	.80	.83	.71	.72						
Critical Processing	.72	.72	.75	.70						
Memorising and rehearsing	.79	.79			.65	.73				
Analysing	.67	.63	.27		.69	.76				
Concrete processing	.74	.71	.58	.65					.43	-.39
Domain II: Regulation Strategies										
Self-regulation of learning processes & results	.75	.73	.78	.74						
Self-regulation of learning content	.78	.73	.69	.72						
External regulation of learning processes	.67	.48			.82	.73				
External regulation of learning results	.71	.65			.67	.54				
Lack of regulation	.68	.72					.75	.74		
Domain III: Learning Orientations										
Personally interested	.74	.57		.54					-.70	.25
Certificate directed	.81	.76		-.41	.40	.40			.59	-.33
Self-test directed	.86	.84			.34		.32	.29		
Vocation directed	.85	.69							.84	-.80
Ambivalent	.75	.82					.73	.65		
Domain IV: Mental models of learning										
Construction of knowledge	.77	.78	.72	.75						
Intake of knowledge	.78	.77		-.36	.67	.54	.35	.33		
Use of knowledge	.76	.70							.67	-.74
Stimulating education	.90	.88					.59	.73		
Co-operation	.93	.89					.67	.61		

Vermunt (1998) found "strong interrelations among the four learning components, so strong that one may indeed speak of learning styles" (p.166). The first factor corresponded well to a Meaning Directed learning style, with high loadings of relating and structuring, critical processing, concrete processing, self-regulation of learning processes and learning contents, personal interest as a learning orientation, and construction of knowledge as a mental model of learning. It was noted that for the OU students personal interest was found to have a lower association with this dimension than for RU students. The second factor corresponded to a Reproduction Directed learning style with high loadings of memorising and rehearsing, analysing, external regulation of learning processes and learning results, certificate and self-test directed as learning orientations and intake of knowledge as a mental model of learning. The third factor corresponded to an Undirected learning style with high loadings of lack of regulation, an ambivalent learning orientation, and cooperation and stimulating education as mental models of learning. The fourth factor corresponded to an Application Directed learning style with high loadings of concrete processing, vocational and certificate oriented learning orientations, and use of knowledge as a mental model of learning. Table 2.3 may be referred to for the meaning of the various subscales if needed.

The four learning styles could thus be understood as follows: *Meaning directed* learners could be described as those that take an active role in knowledge construction through relating and structuring information and processing it critically. Such learners would be self-regulated and motivated by personal interest in the learning content. In contrast, *reproduction directed* learners would be more dependent on external regulation, expecting their instructors to guide their learning processes. They would also tend to rely on memorisation and studying material in a piecewise manner without attempting to link or construct knowledge. *Application directed* learners could be described as more vocation oriented, and their view of learning would be for the use of knowledge in their current or future jobs. They try to concretise new subject matter by linking these to past knowledge and personal experience. *Undirected* learners would be those that have difficulty grasping learning contents and thus struggle to process the information. They are least able to regulate their own learning compared with other learners, and expect their instructors to guide them, but the assistance received is often perceived as insufficient. These learners could have a somewhat ambivalent, insecure attitude towards their studies. The relationship between the four domains and the four learning styles can be illustrated in Table 2.5.

Table 2.5

Vermunt's learning styles with illustrations of their components (summarised from Vermunt (1998) and Coffield et al. (2004b)

Learning Styles / Domains Of Learning	**Meaning-directed**	**Reproduction-directed**	**Application-directed**	**Undirected**
Processing Strategies	Look for relationships between key concepts/theories: build an overview Subscales include: - Deep processing - Critical processing	Select main points to retain Subscales include: Memorising & rehearsing Analysing	Relate topics to everyday experience : looks for concrete examples and uses Subscales include: Concrete processing	Find study difficult; read and re-read Little or no processing strategies
Regulation Strategies	Self-guided by interest and their own questions; diagnose and correct poor understanding Subscales include: - Self-regulation of learning processes & results - Self-regulation of learning content	Use objectives to check understanding; self-test; rehearse Subscales include: External regulation of learning processes External regulation of learning results	Think of problems and examples to test understanding, especially of abstract concepts Subscales include: Combination of both self and external regulation strategies	Not adaptive Subscale includes: - Lack of regulation
Learning orientation (Study Motives)	Self-improvement and enrichment Subscale includes: - Personally interested	Prove competence by getting good marks Subscales include: Self-test directed Certificate directed	Vocational or 'real world' outcomes Subscales include: Certificate and vocation directed	Ambivalent; insecure Subscale includes: Ambivalent
Mental model of learning (Study Views)	Dialogue with experts stimulates thinking and engagement with subject through exchange of views Subscale includes: - Construction of knowledge	Look for structure in teaching and texts to help take in knowledge and pass examinations. Do not value critical processing or peer discussion Subscale includes: Intake of knowledge	Learn in order to use knowledge Subscales include: Use of knowledge	Want teachers to do more; seek peer support Subscales include: Stimulating education Cooperation

Vermunt’s integrated model of learning was very influential within the higher education community in Holland when it was published, and several independent studies in different contexts followed after (e.g. Prins, Busato, Hamaker & Visser, 1996; Prins, Busato, Elshout, & Hamaker, 1997, quoted in Busato, Prins, Elshout & Hamker, 1998). These studies verified that the four distinct learning styles could be clearly identified.

Vermunt (1998) also studied the stability of the learning styles of the OU students using a test-retest approach. Some three months after the first administration of the ILS, Vermunt invited the same students to retake the ILS. He found that there was a rather high stability of the students' learning styles, yet not so high such that one might conclude that styles were unchangeable. Interestingly, he also found that this stability was higher for mental models of learning and learning orientations than for processing and regulation strategies. This suggested that strategies could be more susceptible to environmental influences than mental models of learning and learning orientations. This supports Richardson's (2000) view that was discussed earlier where he likened Vermunt's (1998) model to that of Curry's (1983) onion model.

Busato et al. (1998) carried out an independent study to examine the development of learning styles using the ILS, combining two research methods. One was a cross-sectional design involving student participants from the first-, second-, third-, fourth-, and fifth-year psychology course at the University of Amsterdam. They found no systematic relationships between the year of study and learning styles, and contrary to their expectations, the meaning directed and application directed learning style scores were not higher in later years, nor were the undirected and reproduction learning style scores lower in the later years. For their second design, Busato et al. (1998) carried out a longitudinal study involving a subset of students from the first study who did the ILS twice with an interval of slightly more than 1 year. This time, they found that the means of the meaning directed and application directed learning style scores increased over time, while the means of the Reproduction and Undirected learning style scores decreased. This was more in line with what they had anticipated.

Following Busato et al.'s (1998) study, Vermetten, Vermunt & Lodewijks (1999) sought to expand their understanding of students' development in academic learning by means of a longitudinal study involving 276 full-time students from four different academic departments at Tilburg University. The ILS was administered after the first and third semester of an academic year. Across this interval, Vermetten et al. (1999) found a significant increase in the use of learning strategies related to the meaning directed learning style. Strategies indicative of a reproduction learning style, however, did not decrease as they expected but remained at the same level. Vermetten et al. (1999) argued that this relative stability of the reproduction directed style "might be explained by the idea that this kind of learning has been crystallised" (p. 234) from past learning experiences. This idea agrees with Schmeck (1988) who posited that styles practiced by learners in past learning experiences could become more ingrained, or crystallised, in the learner with increasing use, making it more resistant to change. Vermetten et al. (1999) suggested that reproduction directed learning could have evolved during the students' early education and continued to be used frequently in later learning contexts. This could have made it a rather permanent part of the students' learning pattern by the time they entered higher education. The meaning directed learning, on the contrary, was still being developed in the later years of the student's education.

From their own, and other studies using the ILS, Vermetten et. al (1999) formulated two seemingly opposing hypotheses to explain the inconsistencies in results that they found. They called them the *development hypothesis* and the *context hypothesis*. The *development hypothesis* proposes that as students progress in education, the factor structure underlying their learning strategies, mental models of learning, and learning orientations will become more focussed and will reveal stronger interrelations. An example could be seen in Alexander, Murphy, Woods, Duhon & Parker (1997) where the factor underlying learning strategies was observed to become an increasingly more consolidated construct at successive stages of education. They suggested that this could be related to the students' increasing interest and competency in the subject matter.

The *context hypothesis* suggests that it is not structural development that explains the variations in the results, but rather the educational context. An example could be found in Severiens (1997) (quoted in Vermetten et al. (1999)) and Severiens & Ten Dam (1997) where she found that her sample of adult secondary education students did not show significantly stronger interrelations between the ILS domains despite their age being 26 years on average. In fact, she found somewhat different factor patterns that did not indicate an application directed style. Her findings showed a variation of it and she called it a *prove-yourself directed* style. She proposed that the difference in results compared with Vermunt's studies could be due to the differences in the learning environment for her sample which comprised adult learners seeking second-chance education.

A study by Boyle, Duffy & Dunleavy (2003) provides another example. They sought to test the generalisability of Vermunt's ILS on a sample of 273 students from a department of Social Science in a British university. The students were from the second, third and fourth year of their study programme, but in their data analyses Boyle et al. (2003) did not attempt to distinguish the cohorts. They carried out a confirmatory factor analysis to test Vermunt's four-factor model of learning styles, and also regression analyses to examine the interrelationships between the components of the ILS. Their results corroborated with Vermunt's (1998) findings and they concluded that Vermunt's model could be generalised across different countries and educational contexts. However, while there were similarities, Boyle et al. (2003) also found some variations within the structure of the factors when compared with the studies done in the Netherlands.

The first two factors that Boyle et al. (2003) identified matched well with Vermunt's (1998) factor loadings for regular university students and corresponded with his meaning directed and reproduction directed learning styles. The third factor that was found corresponded to the undirected learning style but the factor loadings showed less integration across components than the first two factors. The fourth factor corresponded to the application directed learning style and was specified mainly by learning orientations and conceptions of learning, and not integrated across components in the way that Vermunt (1998) described it. Boyle et al. (2003)

noted that the concrete processing strategy had stronger links to the meaning directed learning style rather than the application directed learning style as found by Vermunt. They proposed that this difference could be due to the fact that their sample was from a Social Science department where there was a strong emphasis on the application of theoretical knowledge. This emphasis could have changed the focus of the meaning directed learning style and led to the dissociation of the strategies components from the learning orientations and conceptions of learning components of the application directed learning style in this context. Boyle et al. (2003) thus concluded that while the ILS did identify Vermunt's four learning styles, different learning environments could influence the precise characteristics of each learning style.

In recent years, other studies using the ILS have been carried out beyond the Netherlands and England by researchers in countries such as Belgium, Turkey, Portugal, USA, Australia, Hong Kong, Indonesia, Sri Lanka and Thailand, (for example, Baeten, Kyndt, Struyven & Dochy (2010); Kalaça & Gulpinar (2011); Rocha (2011); Lloyd (2007); Smith, Krass, Sainsbury & Grenville (2010); Law & Meyer (2008); Ajisuksmo & Vermunt (1999); Marambe, Athuraliya, Vermunt & Boshuizen (2007) and Eaves (2009) respectively). In these studies, variations in the underlying structure of the ILS have been found that could arguably support the context hypothesis. The studies done in Hong Kong, Indonesia, Sri Lanka, and Thailand merit a closer look as they are Asian countries and are culturally closer to Singapore, and might provide some references with which my current investigation can be compared.

The Hong Kong study by Law & Meyer (2008) was mainly focussed on testing Vermunt's (1998) model in a Chinese-speaking Hong Kong university context. A Chinese version of Vermunt's ILS was developed, validated and used as the instrument for their investigation. The findings indicated that Vermunt's model could be empirically reconstituted in the Hong Kong post-secondary education response context. The study thus supported the use of Vermunt's ILS in an Asian context, but unfortunately it did not report the learning styles of Hong Kong students.

In the Indonesian study, Ajisuksmo & Vermunt (1999) explored the learning styles and self-regulation of students from a cross-cultural perspective. They devised a version of the ILS that was translated into the Indonesian language and entitled it the Inventarisasi Cara Belajar (ICB). They administered this measure to 888 first-year students from various discipline areas (Management, Accountancy, Law, business Administration, Electrical Engineering and Mechanical Engineering) at a university in Jakarta. Ajisuksmo et al. (1999) did not attempt to distinguish the students from the various disciplines in their data gathering and analyses, otherwise the findings for their Engineering students could have provided a more direct reference for comparison with my investigations. The Cronbach alphas and factor pattern from a principal component analysis with Varimax rotation are shown in Table 2.6.

Ajisuksmo & Vermunt (1999) found that the first factor had high loadings from all five processing strategies and two self-regulation strategies, together with moderate loadings of the two external regulation strategies and the learning conception in which construction of knowledge was emphasised.

No loading from the learning orientations dimension was found. Ajisuksmo & Vermunt (1999) labelled this factor an Active Meaning Directed learning style, although it also contained loadings from memorising and rehearsing, and external regulation. The second factor had high loadings of external regulation of learning processes, intake of knowledge as a conception of learning, and certificate-oriented learning orientation.

Table 2.6

Cronbach alpha (α) coefficients of the ICB scales for Indonesian students (N=888), and the four respective factor loadings in a four-factor oblique solution (F1 to F4); loadings >-.25 and <.25 omitted (summarised from Ajisuksmo & Vermunt (1999))

ILS Scale	Respective Codes	α	F1	F2	F3	F4
Domain I: Processing Strategies						
Relating and structuring	SSDEEP1	.76	*.82*			
Critical Processing	SSDEEP2	.69	*.72*			
Memorising and rehearsing	SSTEP1	.58	.58	.41		
Analysing	SSTEP2	.62	.78			
Concrete processing	CONCRETE	.64	.74			
Domain II: Regulation Strategies						
Self-regulation of learning processes & results	SSELFR1	.74	.77			
Self-regulation of learning content	SSELFR2	.68	.68			
External regulation of learning processes	SSEXTER1	.68	.47	.59		
External regulation of learning results	SSEXTER2	.59	.61	.36		
Lack of regulation	LACKREG	.61				-.69
Domain III: Learning Orientations						
Personally interested	INTEREST	.22		.45		.35
Certificate directed	CERTIFIC	.62		.67		
Self-test directed	SELFTEST	.55		.47	.35	
Vocation directed	VOCATION	.46		.37	.29	.46
Ambivalent	AMBIVALE	.64				-.67
Domain IV: Mental models of learning						
Construction of knowledge	CONSTRUCT	.74			.55	.32
Intake of knowledge	INTAKE	.53		.54	.52	
Use of knowledge	USEKNOW	.66			.59	.28
Stimulating education	STIMED	.82			.62	-.31
Co-operation	COOPER	.67			.69	

Ajisuksmo & Vermunt (1999) found that the first factor had high loadings from all five processing strategies and two self-regulation strategies, together with moderate loadings of the two external regulation strategies and the learning conception in which construction of knowledge was emphasised. No loading from the learning orientations dimension was found. Ajisuksmo & Vermunt (1999) labelled this factor an Active Meaning Directed learning style, although it also contained loadings from memorising and rehearsing, and external regulation. The second factor had high loadings of external regulation of learning processes, intake of knowledge as a conception of learning, and certificate-oriented learning orientation. Moderate loadings were found for memorising and rehearsing, external regulation of learning results, and the self-test-directed, personally interested and vocation-directed learning orientations. This factor was labelled an Active Reproduction Directed learning style. The third factor had all high and moderate loadings from the conceptions of learning scales. There were no loadings from processing and regulation strategies on this factor. Ajisuksmo & Vermunt (1999) labelled this a "Passive-Idealistic learning style" (p. 53). The last factor had high negative loadings of lack of regulation and an ambivalent learning orientation, and a moderate positive loading of vocational-directed learning orientation. This factor was called a Passive Undirected learning style.

Comparing the pattern of factor loadings of the Indonesian study and Vermunt's (1998) study on first-year regular Dutch university students, two differences were noted (ref. Tables 2.4 and 2.6). First, it was observed that in the Dutch study, all factors were defined by loadings from at least three learning domains showing a relationship between the learning strategies used by the students to their conceptions of learning and learning orientations. In the Indonesian study there was less coherence found. Secondly, it was observed that there was some clustering of loadings from particular domains on to particular factors. All five processing strategies showed their highest loading on the first factor. This seemed to indicate that the Indonesian students used both deep and stepwise processing where relating, critical processing, memorising, analysing and concrete processing work well together. Both self-regulation and external regulation elements could also be found on the first factor. The second factor had a cluster of items from the learning orientations domain, and conceptions of learning all load highly on the third factor.

Ajisuksmo & Vermunt (1999) pointed out that the difference in contexts, such as culture and learning experiences, when Indonesian were compared to Dutch students could have influenced the differences observed in the factor structures. They drew attention to the first factor which represented an Active Meaning Directed learning style but also had a mix of memorising and rehearsing and external regulation. This observation was in line with research by authors such as Marton, Watkins & Tang (1997) who studied the learning conception of Chinese students and found that memorisation and understanding were not experienced as opposites and could be closely related as part of the learning process. According to Marton et al. (1997) this view was contrary to what most Western students would hold.

Ajisuksmo & Vermunt (1999) also proposed that the traditional respect of a teacher's status upheld by the students could be another influence on the differences observed. In Indonesia, a teacher is typically viewed as an authority, and held up as "a reliable person who should be listened to and who has to be followed or obeyed" (p. 57). Thus the instructional mode in the classrooms is mostly teacher-led explanations and the students' role was to listen and follow instructions. Students are not expected to think independently and critically, and question what is taught, instead, teachers often expect their students to reproduce in the examinations the information and knowledge presented in the classroom. The results of the examinations are viewed more importantly than the learning process.

According to Manikutty, Anuradha and Hansen (2007), this perception of teachers as figures of authority could be typical of societies with high *power distance* and is more predominant in Asian countries. The concept of power distance describes the extent to which people that are lower in a social hierarchical structure accept and expect unequal distribution of power (Hofstede, 1980). This cultural influence could be reflected in the teacher-student relationship in a classroom setting. Manikutty et al. (2007) hypothesised that the higher the power distance is experienced in a society, the more likely it is that students' learning approaches would tend to be surface rather than deep. This could explain the higher scores for the memorising and rehearsing scale compared to the Dutch students and the association of this scale with the Active Meaning Directed learning style.

Another interesting group of students reported a Passive-Idealistic learning style. Ajisuksmo & Vermunt (1999) described these students as being "occupied with exploring their conceptions of what learning is and attach great value to cooperation with fellow students" (p. 56), however, they did not offer any direct explanation for this pattern.

In the Sri Lankan study, Marambe, et al. (2007) studied first-year medical students at the University of Peradeniya using a validated Sri Lankan version of the ILS called the Adyayana Rata Prakasha Malawa (ARPM) written in Sinhalese. The Faculty of Medicine had implemented a new curriculum at that time using what they called Student Generated Learning, with greater focus on group work and independent study. Marambe et al. (2007) were interested to study the impact of these changes on their students' learning strategies, conceptions and orientations compared with students who took the traditional curriculum. Thus for their data analysis, they opted to focus only on these three key learning domains, measuring the differences between their two samples using independent sample t-tests. They did not apply factor analysis to investigate the learning styles of the students as was done in the Indonesian study. Thus it was not possible to make a comparison of learning styles between the two studies.

The results of their study showed significantly higher scores for two deep processing strategies - critical processing and concrete processing, compared with the traditional curriculum group of students. Interestingly, this same group also scored higher for memorising and rehearsing - a result that the researchers found to be "disturbing" (p. 753) because it was contrary to what they had anticipated. As for regulation strategies, students following the new curriculum reported higher scores for both self-regulation and external regulation. For learning orientations, higher scores were reported for personal interest, and lower on the ambivalent scale. No significant differences were found for the learning conception scales.

As in the Indonesian investigation, students in the Sri Lankan study also utilised mixed processing and regulation strategies in their studies. This supported the conclusions of earlier studies such as Vermunt & Vermetten (2004) and Verschillen (2005) (quoted in Marambe et. al (2007)), where Asian students were found to mix learning strategies that might not work well for Western students, but worked well in the Asian context. Marambe et al. (2007), however, chose to explain this deviation from Vermunt's original learning styles by pointing to the fact that the Sri Lankan students in their study could be experiencing a mismatch between instructional design and assessment strategies that had yet to be aligned with the new curriculum.

In addressing the "disturbing" increase in memorisation and rehearsing despite the focus on more deep processing activities in the new curriculum, Marambe et al. (2007) proposed, firstly, that at the first-year level, the students were not yet proficient in the English language which was the medium of instruction. Secondly, the new curriculum brought forward the foundational knowledge of all the systems of the human body into the first-year level and students had to struggle with learning many new terms for the first time.

In another study involving Asian students, Eaves (2009) focussed mainly on investigating the differences in learning styles of Thai students in England compared to local students in England and Thailand. Her samples included three sets of postgraduate Business students: Thai students in England (N=26), European students in England (N=16) and Thai students in

Thailand (N=122). A mixed methods design was carried out including a psychometric approach where Vermunt's (1998) ILS was administered to the three sets of samples; and a qualitative approach using focus group interviews for a sample of Thai students in England (N=44). For all the students in England, the English version of the ILS was used, while the students in Thailand were administered a version that was translated into the Thai language.

The small and unequal sample sizes were a major limitation for this study. Nevertheless, it could still provide some useful insights into the influence that culture and learning contexts might have on learning pattern development. Focus group interviews revealed that Thai students perceived clear differences between the mode of teaching in England and Thailand thus requiring them to adapt in behaviour and values relating to respect and social roles. For instance, students reported that teaching styles were more instructor-centred in Thailand but more student-centred in England. Learning was strongly directed by Thai tutors, and students were provided all the information they needed, whereas learning in England required more self-directed searching for information to prepare for classes. As for assessments, the students reported that they were expected to reproduce information in closed-book examinations, but in England assessments were mostly formative and assignment-based. Finally, the Thai students also reported difficulties in adapting to cultural differences in the new roles and behaviour expected of them in class discussions and asking questions. They perceived that it was inappropriate to raise questions in class, or debate information with their tutors because it was impolite and disrespectful to them as authorities in the classroom, and such behaviour was contrary to their Asian upbringing.

Quantitative results indicated lower scores for the meaning directed dimensions for Thai students compared to their European peers in England, but higher than Thai students in Thailand. This was an interesting observation because it seemed to suggest that Thai students immersed in an English educational context for a period of time could change their learning behaviour to some extent. However, this change was not without challenges as could be understood from the qualitative findings above.

While the meaning directed dimension scores for Thai students in England were higher than their counterparts in Thailand, their reproduction directed dimension scores were also higher than the students back home, and higher than the European students. Eaves (2009) suggested that this phenomenon could be due to the struggles the Thai students had with the English language, grasping information with a looser structure than they were accustomed to, and adapting to unfamiliar teaching methods. Under these circumstances, the students could have chosen a more reproduction-directed learning as a safer option rather than trying but failing a meaning oriented style.

The four studies carried out with an Asian context have validated the ILS in their respective contexts. The Indonesian, Sri Lankan and Thai studies have indicated some similarities in findings including a tendency for Asian students to mix both deep and stepwise (surface) processing strategies, and also self- and external regulation. Asian values of respect for, and obedience to, elders and authorities in society have been inculcated in students as part of their upbringing. Generally, this would imply that high power distance exists in many Asian societies, and this has been reported by students who expect their teachers to be the source of knowledge, and being a good student would mean listening and obeying them without questioning. This becomes an issue when students with that mindset are placed in a learning environment where their roles are changed and they are expected to be self-directed in sourcing for information and constructing knowledge, and to critically engage with their teachers and subject matter that they read. It seems evident that in such an environment, some would be able to adapt and become more meaning directed in their learning, but others who are unable to cope may respond in the opposite way by becoming more reproduction oriented.

It may be concluded from the discussions so far that learning pattern[1] formation is influenced by the interaction of multiple factors. Vermunt (2005) held that other than the cultural and environmental context, the personological aspects of a student also affected how he or she interacted with the environment (see also Geisler-Brenstein, Schmeck and Hetherington, 1996). In a study involving a sample of 1279 students across six academic disciplines at a university in the Netherlands, Vermunt (2005) drew several conclusions:

(i) Age was an important predictor of meaning directed learning, with older students showing more characteristics of this pattern (such as being self-

[1] After the year 2000, Vermunt deliberately replaced the term 'learning styles' in his literature because he opined that the term 'style' was too much associated the unchangeable personality attributes of students. He advocated the use of the more inclusive term 'learning patterns' instead (Vermunt, 2005; Vermunt & Minnaert, 2003 and Vermunt & Vermetten, 2004). However, he did not rename his instrument which remains today as the Inventory of Learning Styles.

directed, critically processing information and constructing knowledge) and were also less certificate directed (one aspect of reproduction directed learning).

(ii) Female students attached more value to cooperative learning than did their male counterparts. In all other respects,, there were no consistent relationships between students' gender and their learning patterns.

(iii) Students with higher levels of education at the point of entry into university showed less characteristics of reproduction directed learning compared with students who entered straight after secondary school. Those with lower levels of education also showed relatively more characteristics of lack of regulation.

(iv) Arts and Psychology students showed the most characteristics of meaning directed learning, while Econometrics and Economics students showed the least, they being the most Undirected. Econometrics and Law students showed the most characteristics of reproduction directed learning, while Psychology and Arts students showed the least. Law students showed the most features of application directed Learning, while Arts students showed the least. It appeared that academic discipline was an important predictor for all four learning patterns. Vermunt (2005) posited that these interesting relationships could be firstly due to the varying demands of the different subject domains that influenced the way students chose to study them. Secondly, it could also be possible that a self-selection phenomenon was being observed where students with particular learning patterns chose courses that appealed to them.

Vermunt (2005) thus concluded that students' learning patterns were "not only the result of instructional measures, but were apparently also embedded in a complex whole of personal and general contextual factors" (p. 229) and were subject to change.

Donche, Coertjens & van Petegem (2010) sought to understand how learning patterns might change over time. They designed a longitudinal study that stretched over the entire life-cycle of a sample of students at a Flemish University College in Belgium across eight study programmes. This was over a longer period than any other studies done up to that time (e.g. Busato et al., 1998; Severiens, Ten Dam, & van Hout Wolters, 2001; Vermetten et al., 1999; and Vermunt & Minnaert, 2003). Their findings supported, to some extent, those of previous studies where first-year students were reported to be more Undirected compared to the third year students, who exhibited more meaning directed or deep learning. However, they also found that reproduction directed strategies remained fairly constant even among the third year students. That is, while the third year students increased the use of meaning directed strategies, they also continued to rely on a moderate use of reproduction directed strategies. Donche et al. (2010), proposed that the senior students "may have advanced in their capacity to judge which strategies are more suited to the demands of particular tasks which can also refer to the concept of 'strategic learning'" (p. 259) - a concept that was first introduced in reports by Entwistle & Waterston (1988) and Entwistle (1998). Donche et al. (2010) called this a "flexible learning pattern" (p. 258). Combining both meaning directed and reproduction directed strategies could be perceived as an effective approach for students to cope with their studies to achieve the results they wanted.

The study also revealed that the change in learning patterns among students was related to the patterns that they had acquired prior to the start of their study programme. The meaning directed learning pattern seemed to be more stable in comparison to the reproductive and undirected patterns, whereas students who started with the latter two learning patterns underwent a more significant level of change in their second and third years towards the more meaning oriented learning pattern.

Summarising the works related to Vermunt's ILS, it may be seen that the four distinct learning patterns posited by Vermunt (1996,1998) - meaning directed, reproduction directed, application directed and undirected, may be modified to varying degrees when exposed to different developmental and contextual influences. The personal aspects of a student could also contribute to variations in learning patterns. Vermunt & Minnaert (2003) called this the "dissonance phenomenon" (p. 60). They observed that learners go through varying lengths of time to adjust to new learning contexts, often adapting their conceptions of learning and learning orientations as they deem necessary. These changes in the learning components may also change at different moments and at different rates throughout a student’s' life-cycle within a particular programme, and should be considered as "normal, adaptive, and necessary" (p. 60). Vermunt & Minnaert (2003) postulated that this phenomenon of dissonance could thus be temporal phases that are part of the students' adaptation process when faced with new learning environments, and after a period of time, their learning patterns would become clearly differentiated again.

2.5.1 Limitations of Vermunt's Model and the ILS

Vermunt's (1996, 1998) model and the ILS have been widely evaluated across various cultures and learning environments and found to have reasonable validity and reliability (Coffield et al., 2004b). Nevertheless, there are limitations that should be noted.

The ILS has been shown to be rather contextually sensitive, as can be observed in the preceding review, resulting in dissonant learning patterns in some cases. Vermunt & Minnaert (2003) has offered a possible explanation for this phenomenon as discussed earlier. However, their hypothesis that such dissonance in learning patterns would eventually be resolved as students become more adapted to a new learning environment has yet to be proven.

There could be another view on this phenomenon. In the development of his theories, model, and the ILS, Vermunt (1996, 1998) relied mainly on samples of students in a regular university and an open university in the Netherlands. Thus his conceptualisation of learning would have been mainly based on observations in the context of higher education in northern Europe. Cases where dissonant patterns were reported include situations where new curricula or new programmes were introduced to foster changes in learning behaviour (for example, Vermunt & Minnaert, 2003); or when first-year students began a new course of study (for example, Vermunt & Verloop, 2000). However, there have been studies conducted outside of northern Europe, such as in Turkey (Kalaça & Gulpinar, 2011) where no particular changes were made to curricula and yet dissonant patterns were found. This could highlight a cultural influence on learning patterns, or it could also be due a limitation of the ILS because it was developed in a different cultural context. As the ILS becomes increasingly used in different contexts and cultures, it may be anticipated that dissonant patterns would emerge, making it potentially problematic to interpret learning patterns that are not directly comparable with Vermunt's original results. The dissonant learning patterns of Indonesian students in Ajisuksmo and Vermunt (1999) could have been influenced by both the cultural context, and the fact that the students in their sample were in the first year of studies. Further study on dissonant patterns is much needed.

In his phenomenographical analysis, Vermunt (1996) identified five themes or components: cognitive processing, regulation of learning, affective processes, mental models of learning, and learning orientations. Vermunt described the various learning patterns according to the variations of these components. He did not report why he eventually reduced the number of components to only four by excluding affective processes (Vermunt, 1998) in his model and in the construction of his ILS. However, it does appear that he had selected some items related to affective processing and subsumed them under the learning orientations component. As such, there are no items in the ILS relating to affective aspects that were present in his original analysis in Vermunt (1996), such as low self-esteem, failure expectation, disappointment in oneself, fear of failure, fear of forgetting and intrinsic interest leading to selective learning. The lack of consideration for affective processes seems to be a drawback that might limit the power of the instrument to distinguish learning patterns more clearly. For example, if there was an item describing intrinsic interest that leads to selective learning where deep learning could be applied to topics that are of interest, while other topics of lesser interest would be memorised to meet assessment requirements, a meaning directed student might indicate a high score for that item. With the existing construction, the same student would likely indicate high scores for items under the memorising & rehearsing subscale, and also high scores for items under the deep processing subscales. The result could indicate a mixed learning pattern that is unclear.

Finally, the ILS has not been sufficiently proven as a strong predictor of academic outcomes (Coffield et al., 2004b). For example, Busato et al. (1998) investigated the correlations between the learning patterns and academic success of five year-groups and found only significant negative correlations for the undirected learning pattern for their Year 2 (r=-.49), Year 3 (r=-.39) and Year 4 (r=-.37) groups. The lack of a negative correlation for Year 1 students was contrary to earlier research (Busato, Prins, Hamaker & Visser, 1995, quoted in Busato et al., 1998), and the correlation for Year 5 students was negative, but not significant. For the other learning patterns, no significant correlations with academic success were found. Another example was reported in Boyle et al. (2003) where only small to moderate negative correlations were found between the undirected learning pattern and students' overall grade point average (GPA) (r=-.26), examination GPA (r=-.17) and coursework GPA (r=-.21). In addition, small to moderate significant positive correlations were found between the meaning directed pattern and overall GPA (r=.23) and examination GPA (r=.13). No significant correlations with academic performance were found for the reproduction nor application directed learning patterns. These examples highlight the rather limited role that the ILS can play in predicting academic outcomes. Nevertheless, Boyle et al. (2003) did suggest that the ILS might be useful as a diagnostic tool for the early detection of learners with inappropriate learning conceptions and orientations, and fail to adopt systematic and regulation processing strategies, thus being in danger of faltering in their academic journey.

2.6 Learning Patterns Useful for Lifelong Learning

The development of appropriate learning skills in primary to tertiary institutions that are transferable into lifelong learning has become one of the important objectives for education in Singapore, and many countries around the world. Evidence gathered over the last decade or so has indicated that adequate preparation for the career and life of graduates requires more than the acquisition of a specified body of knowledge (Brown, 2000; Sterns & Dorsett, 1994). While human resources for the new globalised and interconnected economy context will require a good deal of formal education, it also demands continuous learning, flexibility, excellent literacy, numeracy and problem solving skills and the ability to acquire and apply new ideas and use knowledge creatively (Tuijnman, 2003). Among the various learning skills, self-directed learning has been said to be the most important that formal education can foster in students (Bolhuis, 2003; Meichenbaum & Biemiller, 1998; Grow, 1991). This skill enables students to self-direct and self-regulate independent learning processes (Francom, 2010). However other researchers have also asserted the importance of the personal factors that could drive self-directed learning. McCune & Entwistle (2011) advocated the need to cultivate in students a "disposition to understand for oneself" (p. 309). This refers to an intrinsic intention to understand, which is an important attribute related to a deep learning approach that students should develop during tertiary education. Essentially teachers must somehow ignite within their students a will to learn (Barnett, 2007). Boyle, et al. (2003) argued that deep cognitive processing, self-regulated learning, intrinsic motivation and a constructivist conception of learning should be regarded as preferable to surface learning, teacher-centred learning, extrinsic motivation and an objectivist conception of learning.

Several models describing students' learning styles and approaches to learning have been discussed in the preceding literature review. Each model and instrument has its inherent strengths and weaknesses which have been discussed. Despite its limitations, in my opinion, Vermunt's (1996, 1998) model offers one of the more comprehensive descriptions of the regulation of students' learning processes among the rest. The meaning directed learning pattern reported by Vermunt (1996, 1998) appears to encapsulate most of the attributes required of lifelong learners and is thus desirable to cultivate among students. In fact, Vermunt (2007) summarised his research conducted over more than a decade and found that the meaning directed and application directed learning patterns were more desirable than others, and should be fostered especially at higher education.

2.7 This Present Study

At the time of this present study, the cohort of students who entered Primary school in 1997 when the new curricula was implemented would have completed their Secondary education. Those who chose to embark on post-secondary education at a Polytechnic would be in their final year of their 3-year undergraduate programme. The majority of students in the Polytechnic in this study would thus have been exposed to the new curricula as described in Chapter 1 in the past 10 years of their education before entering the institution.

The literature review has revealed that the effectiveness of interventions involving the manipulation of various aspects of the learning contexts to develop desirable approaches to learning in students have yielded inconsistent results. Other studies have suggested that students' perceptions of their context and their approaches to studying were closely related. In addition, it may be possible that other variables exist, such as students' conceptions of learning, that could influence both students' perceptions and their approaches to learning.

In addition to the contextual influences of the educational environment, literature has also shown that the cultural context could have a role in shaping the learning patterns of students. Four studies conducted in Asia, namely Hong Kong, Thailand, Sri Lanka and Indonesia, that used the ILS were reviewed and some indication of similarities in findings were observed that suggested the influence of culture on student learning. However, the student samples in each of these studies were only from one year group, where both the Indonesian and Sri Lankan studies were limited to only first year students (the Hong Kong study did not collect the particulars of the students). The samples thus may not be representative of their respective populations. The number of studies is also rather small to allow firm conclusions to be drawn, so this present investigation in Singapore could potentially extend understanding of learning pattern development in the Asian context in general.

This current research aims to determine if there is any evidence that the undergraduate students had developed patterns that were relevant for lifelong learning by establishing the learning patterns of an opportunistic sample of Engineering students in the School of Engineering (Electronics) at a Polytechnic in Singapore, with particular focus on the possible factors that might influence the development of such patterns. While Vermunt (2007) proposed that the meaning directed and application directed patterns were the most suitable based on his own research, there have not been any reported independent studies to verify that as far as I know. To throw some light on this, professional Engineers will be sampled from among those who enrolled in continuing education at the Polytechnic leading to formal certification and thus they could be considered as 'role models' of lifelong learners in this study. It is acknowledged that these working adults could be very different from the undergraduates with varied life and learning experiences, academic abilities, and personalities. However, I thought it might be interesting to investigate their learning patterns and compare with those of the undergraduates as a reference.

Based on the objectives of this study, the following research questions will be investigated:

(i) What learning patterns do Engineering students within the context of a Polytechnic in Singapore adopt? What, if any, do these students think were the factors that influenced their patterns?

(ii) What learning patterns do Engineering professionals who actively pursue continuing education for self-development in the Engineering field adopt? What, if any, do these professionals think were the factors that influenced their patterns?

(iii) Are there any similarities or differences between the learning patterns of Engineering students and those of professional Engineers who are actively engaged in continuing education in their field?

(iv) How far has the existing learning environment at the Institution in this study shown to have fostered in the students the necessary learning patterns that are useful for lifelong learning?

On the basis of Vermunt and Vermetten's (2004) development hypothesis, in addition to the implementation of interventions by the MOE and self-directed learning programme at the Polytechnic in this study, it may be hypothesised that the senior undergraduate students' learning patterns should show more use of the meaning directed and application directed patterns compared to the younger ones. The Professionals group should show the strongest characteristics for both of these patterns, having the advantage of maturity and being more experienced learners. However, based on the literature review, learning pattern development is sensitive to contextual and cultural influences and how these factors might be manifested in students' learning patterns is unclear. It is envisaged that this study could illuminate this, even if it is to a small extent. As the literature on learning pattern development in Singapore, and in Asia in general, is rather scarce, it is anticipated that the findings of this study could contribute to knowledge in this respect.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

The aim of this study was to determine if there was evidence that the undergraduate students at the institution have developed learning patterns that were relevant for lifelong learning. Another aim of this study was to establish the learning patterns of Singapore students in an institution of higher learning with particular focus on possible factors that might influence the development of such patterns. The following chapter sets out the arguments for the research methodology needed to answer my research questions and thus accomplish the objectives of this study.

In deciding the approach to this study, the potential contributions of both quantitative and qualitative methods were considered. Quantitative research is useful for studying particular characteristics of a large number of people and can sometimes be used to make generalisations if the data are based on random samples of sufficient size. However, quantitative research is typically less useful for documenting participants' internal perspectives and personal meanings about phenomena in their lives (Johnson & Christensen, 2004). In contrast, qualitative research can sometimes provide more holistic insights into educational processes that exist within a specific setting and detailed information about why a phenomenon occurs. However, qualitative research is often based on small, non-random samples and is more typically employed for exploratory or discovery purposes rather than hypothesis testing and validation purposes (ibid).

A mixed methods approach can potentially leverage the strengths of both quantitative and qualitative approaches and minimise the weaknesses inherent in single method designs (Johnson & Onwuegbuzie, 2004). It can sometimes provide a better understanding of research problems than either method alone (Creswell & Clark, 2007). As an approach, it focuses on collecting, analyzing, and mixing both quantitative and qualitative data in a single study or series of studies and provides the researcher with the opportunity to capture both the trends and the details of a situation and to add depth and context to quantitative results (ibid.). However, there have been researchers who objected to the approach, claiming that both quantitative and qualitative methods were rooted in very different philosophical foundations, making the combination logically impossible (Bazeley, 2004). Their main concern arose as a reaction to the earlier dominance of the "positivist" world view that put objective observation and precise measurement above interpretation of subjective experience and constructed social realities. Rossman and Wilson (1985) described this as a purist stance, but this view has increasingly been overruled by a more pragmatic one. The latter view focuses on the research problem and allows multiple methods to address research problems where appropriate (Miles & Huberman, 1994).

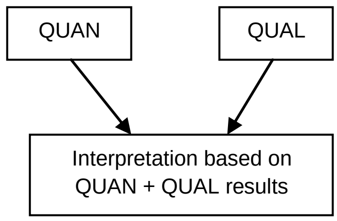
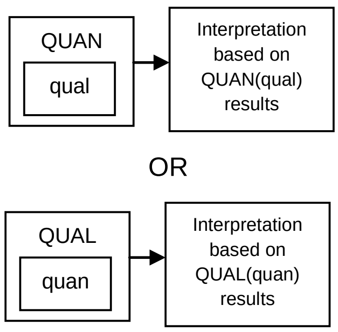
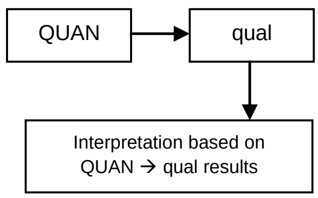
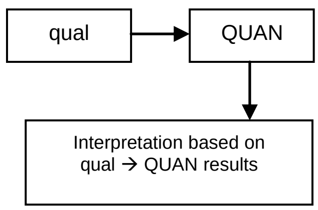
Many mixed method designs have appeared in research literature in fields such as education, social science and health care. Several researchers have attempted to consolidate and classify the various designs, for example, Greene, Caracelli and Graham (1989), and Tashakkori and Teddlie (2003). More recently, Creswell & Clark (2007) found that different authors may have emphasised different features and used different names for their designs but there were more similarities than differences. Based on their own criteria, they proposed that the many methods could be reduced to four major types of mixed methods designs: the triangulation design, the embedded design, the explanatory design, and the exploratory design with variants within each type. The four methods are summarised in Table 3.1.

Considering the intent of this study as articulated earlier and the potential benefits offered by a mixed method approach, the design of my investigation was largely a quantitative study, and a qualitative study serving to illuminate the interpretation of the data, and answering the questions that the numerical data could not achieve on its own. It was anticipated that such a design would provide greater depth and richer interpretation of the results from the questionnaire regarding students' learning patterns, and serve to extend the understanding of the factors that influence the development of these patterns. Based on the classification by Creswell and Clark (2007) as summarised in Table 3.1, an *embedded design*, rather than a triangulation design, was the most suitable for this purpose where my qualitative study was embedded into the larger quantitative investigation.

The quantitative study involved the use of a self-report questionnaire to investigate the learning patterns used by the undergraduate students and the professional engineers, and also to evaluate any differences in the various learning components and scales between the respective groups in this investigation. The qualitative study was conducted through group interviews mainly to illumine the quantitative findings where possible, and to gain a better understanding of the contextual and developmental factors, if any, that could have influenced their self-reported learning patterns.

Table 3.1

Summary of four Mixed Method Design approaches classified by Creswell & Clark (2007), together with their respective descriptions and diagrammatic representations.

Mixed Method Design	Description	Diagrammatic Representation
Triangulation Design	Typically a one-phase design where quantitative and qualitative methods are implemented during the same time frame and with equal weight (QUAN & QUAL). Quantitative and qualitative data are collected concurrently, but separately, then analysed and merged by bringing the separate results together in the interpretation, or transforming data to facilitate integrating the two data types during the analysis.	 Creswell & Clark (2007, p. 63)
Embedded Design	This is a design approach in which one data set provides a supportive, secondary role in a study based primarily on the other data type. It premises on the fact that a single data set is not sufficient, that different questions need to be answered, and that each type of question requires different types of data. This design is useful when a researcher needs to embed a qualitative component (qual) within a largely quantitative (QUAL) study, or vice versa.	 Creswell & Clark (2007, p. 68)
Explanatory Design	This is a two-phased design where qualitative (qual) data builds upon the initial quantitative (QUAN) results, thus helping to explain it. This is useful when qualitative data is needed to explain, for example, significant (or non-significant) results, outlier results, or unexpected results.	 Creswell & Clark (2007, p. 73)
Exploratory Design	This is also a two-phase design, but in this design the results of the qualitative (qual) method can help develop or inform the quantitative method. This design is particularly useful if measures or instruments are not available, if variables are unknown, or there is no guiding framework or theory. As such it is best suited for exploring a phenomenon.	 Creswell & Clark (2007, p. 76)

3.2 Participants

The participants that represented the undergraduates in this study were an opportunistic sample from the School of Engineering (Electronics) (SEG(E)) at the Polytechnic where I work. The Polytechnic is one of five in Singapore offering diploma programmes across a wide range of disciplines, such as business management, health science, information technology, multimedia, design, and engineering. The majority of the students enter their study programme after the successful completion of their GCE 'O' Levels, having usually studied in Singapore. A small percentage enter with other qualifications either from local or foreign institutions.

As no other study utilising Vermunt's ILS or his theoretical framework, as far as I know from the literature review, focused its investigation on Engineering undergraduates, the resulting findings related to this discipline could possibly extend knowledge in this area. The Electronics course is a three-year programme with about 700-800 students in each year, with ages ranging from 17 to about 25. The ratio of male to female students is typically 3:2 in this context, although it may be rather unusual in other similar programmes in Western higher education. The student population is multi-racial comprising Chinese, Malays, Indians and others. The majority of students are Singaporeans or children of Permanent Residents[2] and have lived most of their lives here with at least ten years in the Singapore education system. About 15-20% of the total student population are international students mainly from Malaysia, China, India, Indonesia,

[2] Singapore Permanent Residents (PR) are foreigners who have been granted a permanent visa that permits them to stay in Singapore legally without any visa restrictions. Singapore PRs will have the privilege to freely move in and out of Singapore and do not have to re-apply for a work visa for each new work assignment. PRs can also invest freely, secure admission into subsidized government educational institution and gain financial benefits in the form of employer's contributions to their pension funds.

Vietnam, and Myanmar. These students have been granted student visas to study in Singapore. For the purpose of this study, the student population in the School of Engineering (Electronics) was taken as a whole and it is not intended to distinguish the learning patterns by reference to differences of gender, ethnic group, or country of origin. I am cognisant of the fact that each of these factors could influence the development of one's learning pattern, but a closer study of these individual factors would be beyond the scope of this present study.

The professional engineers considered for this study were working adults holding either degrees or diplomas from this, or other institutes of higher education. The number of these engineers who come to the Polytechnic for professional courses in Engineering related subjects is typically between 200 to 300 per year. Of these, 50-80 typically enrol in courses that will lead to formal certification such as a Specialist Diploma or Advanced Diploma. These would usually be people who want to enhance their competency in specific areas, upgrade their qualifications, or acquire new competencies in preparation for a career switch. The courses would typically require between 280 to 300 hours of coursework in a modular format with classes held in the evenings, and would include assignments and individual and/or group projects that are assessed. At the end of each module, students will also have to undertake formal written assessments. The rest of the professional engineers usually come to the Polytechnic to attend short courses (typically between 1 to 5 days) that serve to enhance their knowledge in specific areas of their field of interest with typically no assessments required. For the present study, the sample of Engineering professionals was selected from those who were enrolled in courses that will lead to formal certification as these are likely to provide a closer comparison with the undergraduates.

The study involved a sample comprising four groups (three undergraduate and one postgraduate) which I labelled as: Year 1 (N=638), Year 2 (N=616), Year 3 (705) and Professionals (N=140) respectively.

3.3 Instrumentation

Vermunt’s (1998) ILS offers a psychometric measure comprising two parts. Part A, Study Activities, including questions on two domains: processing strategies and regulation strategies. Part B, Study Motives and Views on Studying, is divided into B1, Study Motives, which addresses learning orientations, and B2, Study Views, which addresses mental models of learning. Each of the four domains includes five sub-scales containing from four to six items. Each item consists of a statement for which participants indicate, on a five-point Likert scale, the extent to which the statement applies to them. Details of the ILS were discussed in the literature review (Chapter 2). The 100-item English version of the ILS was used in this study.

Coffield et al. (2004b), in their critical review of 13 of what they deemed as the most influential learning styles out of 71 in their study, found that Vermunt's ILS was one, among only three instruments that could demonstrate both internal consistency and test–retest reliability, and construct and predictive validity. They also supported the use of the ILS on the grounds of robustness and ecological validity to be adopted for general use in post-16 learning rather than any other instrument. Rigour in the development process, its reliability, validity, and extensive use of this instrument in various independent studies across various contexts (several examples were discussed in the literature review) were all important considerations in the selection of the instrument. However, as the ILS had never been used in any context similar to the present study, it needed to be tested for internal consistency.

Permission was duly sought in writing from Professor Jan Vermunt for the use of the ILS in this study and he responded positively by sending a soft copy of the questionnaire, together with the accompanying scoring key. A copy of Professor Vermunt's email is attached in Appendix D.

3.4 Quantitative Study Procedure

3.4.1 Pilot for Quantitative Study

I was concerned that since this was the first time the ILS was to be used in Singapore, some of the terminology and contexts used in the statements for each item was liable to be misinterpreted by the students. For this reason, a pilot study was undertaken to assess the clarity of the questionnaire and ascertain whether the statements could be understood by the respondents. About fifty copies of the English version of the ILS questionnaire were distributed to students in various classes. They were allowed to attempt the questionnaire during their free timeslots and to return them within a week. A total of 28 questionnaires were returned. The students were asked to feedback verbally any ambiguities and difficulties faced in understanding when they read the statements and made their choices. No difficulties were reported and generally the language level used in the statements were considered easy to understand.

The ILS was also administered to 43 of my own colleagues who volunteered to assess the instrument, motivated by the opportunity to ascertain their own learning patterns. Verbal feedback was sought from them at the end of their attempt of the ILS and again no particular ambiguities or difficulties were reported. The language level used in the instrument was assessed to be within the language ability of the students. Some did raise a concern that a 100-item survey would take too long to be completed during a normal class period and may cause disruption to lesson plans.

Considering the positive verbal feedback provided, it was decided that the ILS could be used without any modifications. The data from the pilot were compiled and analysed for reliability by determining the coefficient alpha (Cronbach's α) for each domain and their respective subscales.

3.4.2 Main Quantitative Study

The ILS questionnaires were distributed to all full-time students in Year 1, Year 2 and Year 3. Ideally I would have liked to have administered the questionnaires myself so that I could ensure that the objectives of the study and instructions to the students were uniformly communicated to the students. This would have allowed any doubts faced by the students to be clarified immediately. However, time and schedule restrictions made this impossible. The administration was therefore undertaken with the help of colleagues teaching in the various year programmes. The distribution of questionnaires was carried out over two different class periods in case some students were absent during one period. This was to ensure sufficient number of responses could be collected. Each copy of the questionnaire was attached with a consent form as approved by Durham University's Ethics Advisory Committee, and a Participant Information Sheet explaining the purpose of the study (a copy is provided in Appendix C). Self-explanatory instructions were provided within the questionnaire as to how it should be completed. This minimised the need for my colleagues to explain to their students when they distributed the questionnaire for me. Students were assured that their participation was voluntary and they were allowed to withdraw at any time without giving any reasons and without any prejudice. All questions were to be directed to me. My office room number, telephone contact number and email address were provided in the Information Sheet to facilitate communication should any clarifications be required.

To minimize any possible disruption to lessons, the students were asked to attempt the questionnaire outside of class time. This minimised any time pressure on the students and ensured that they did not need to rush through and compromise the accuracy of their responses. The majority of the completed questionnaires were collected by my colleagues who were assisting in the study according to the classes they taught, and the rest were returned directly to my office by the students.

The class sizes for the Professionals' group were smaller for each course of study compared with the full-time students. The ILS was administered to these students from four courses from two different batches with the help of my colleagues. As with the full-time students, each ILS questionnaire was accompanied by a consent form and Participant Information Sheet with the same self-explanatory instructions. The students were also allowed to attempt the questionnaire outside of their class time and the completed questionnaires were collected by my colleagues.

All the responses were keyed into a Microsoft Excel spreadsheet and subsequently imported into SPSS (Release 11) for analysis. The following analyses were performed:

(i) Internal Consistency Reliability - Coefficient Alpha

This analysis was included to test the internal consistency of the data (Cronbach, 1951). Cronbach's alpha provides a reliability estimate that is suitable for multi-item scales that have a range of responses (from '1' to '5' such as in the case of the ILS questionnaire). This was repeated for the main study, although it was done for the pilot, to confirm the results with a larger sample.

(ii) Comparison of Means

As this study required the comparison of means for four different groups, a one-way ANOVA was chosen for this part of the analysis to minimize possible Type 1 errors that may arise from multi-group analyses, assuming equal variances and means for the groups, The Welch and Brown-Forsythe tests were also performed. These are robust tests that do not require equal variances and means for the groups. Post-hoc analysis was done using Tukey’s (equal variances assumed) and Tamhane’s (equal variance not assumed) tests for statistical significance in the differences between the group means.

(iii) Factor Analysis

Vermunt conducted a factor analysis on his ILS data , using principal component analysis with oblique rotation, and consistently found four learning patterns: Meaning Directed, Reproduction Directed, Application Directed and Undirected. I attempted to replicate the factor analysis for this present study to determine the learning patterns for each of the four groups (Year 1, Year 2, Year 3 and Professionals) so that I could compare the respective patterns between groups to see if there were any similarities or differences. Comparisons were done with reference to the learning patterns found by Vermunt, and by other researchers in other studies done elsewhere that used the ILS.

3.5 Qualitative Study Procedure

The benefits and limitations of both individual interviews and group interviews were considered for the qualitative study. Individual interviews provide a means to access a respondent’s subjective interpretation of a topic using either a structured, loosely structured or unstructured interview guide. Generally, respondents are asked open-ended questions and given considerable liberty in their responses without being influenced by the interviewer With a well thought through line of questioning, one-to-one interviews can give researchers a way to explore and uncover deep-seated emotions, thoughts, knowledge, beliefs, motivations, reasoning, feelings and attitudes about a particular topic. They are mostly employed when dealing with sensitive matters (Tonkiss, 2004). However, in the context of this present study, the interviewer (a lecturer) may be perceived as an authority figure in the Institution by the respondents, and also perceived to have the ability to affect their grades. This, coupled with the fact that the respondents were much younger, the presence of peers in a group setting may be more reassuring for the respondents and hence provide a more relaxed atmosphere for them to respond to questions with more ease (Krueger, 1994). Generally, group techniques are popular approaches for qualitative research involving young people for a variety of reasons, key among them the quality and type of data generated through the interactions of members of a group (Denscombe,1995; Wilson,1997). When such interactions are allowed, it is more likely that participants will have the opportunity to challenge responses by others in the group and so clarify or extend an individual's response and stimulate new ideas (Hedges, 1985; Powney & Watts, 1987; Watts & Ebbutt, 1987; Breakwell, 1990). Moreover, participation in a group interview could demand relatively less effort or cognition and stimulates self-confidence (Dijk van, 1990).

Further support for group interviews come from Denzin & Lincoln (1998) who argued that group interviewing could offer a different dimension to the data gathering process that may not be accessible through individual interviewing. Other researchers, such as Vaughn, Schumm, & Sinagub

(1996), have put forward that group interviewing can help increase a study's validity by raising the number of participants. From a more pragmatic view, group interview methods have the potential to cost less and involve less time to obtain more information relative to individual interviews (Hedges, 1985).

However, group interviews are not without their challenges. MacPhail (2001) cautions that a number of key concerns have been raised with group methods centring on opportunities for all participants to contribute equally and the concomitant accuracy of data generated in groups that may be dominated by a few individuals. Hedges (1985) similarly argued that biased or constrained participant responses due to social pressure by other group members could distort data. Some participants may feel they cannot give their true opinions due to the psychological pressure on them arising from their concern as to what other members of the group may think. From my own observation, Asian students tend to behave this way and thus prefer to keep their opinions to themselves (Townsend & Fu, 1998). Some may be tempted to give opinions that they feel will be respected by the group, rather than their real thoughts. The presence of one or two 'dominant' participants may repress the opinions of others (Denscombe,1995 and Watts & Ebbutt, 1987), causing the less vocal of the members to feel less confident about expressing an opinion. Some may even resort to submitting to the opinions of others to avoid possible conflict, or perhaps pressurised into believing that their own perceptions were incorrect (the Asch Effect (Asch, 1951)).

Other considerations would include the group size and the number of groups required. When more than one group interviews are being conducted, comparisons of the results between groups can be hindered if the setting, mix of participants, or if different interviewers are involved. Each interviewer may vary in the way they ask questions and change the order of questions in response to the answers being given. Differences in the settings of different groups may produce variability in the quality of results (Dillon, Madden & Firtle, 1994; Welch, 1985).

Bearing these concerns in mind, I decided that the group interview approach had benefits that outweighed that of individual interviews and determined that it was more suitable for this study considering the dynamics between me as the lecturer and the students as participants.

3.5.1 Pilot for Qualitative Study

In preparation for the qualitative study, I tested the questions that I had drafted with five of my own students after one of their tutorial periods. There were ambiguities encountered where the students had difficulties understanding what my questions were actually asking. For example, I initially phrased one of my first questions as, "Can you describe what is learning and understanding?" I noticed that the students were hesitant in their answers so I broke the question into smaller parts and asked them, "What comes to your mind when you think of the term, 'learning' - what does learning mean to you?" and then, "What about the term 'understanding' - what does understanding mean to you? Are 'learning' and 'understanding' the same or different to you?". I reviewed the feedback and refined the questions in my Interview Guide after that (a copy is attached in Appendix B).

3.5.2 Main Qualitative Study

Invitations via email were sent to students from Year 1, Year 2, Year 3, and Professionals who had participated in the ILS questionnaire. The selection of the students took into consideration that each group should have a mix of male and female students from different ethnic backgrounds, and a few international students where possible. It was anticipated that such a group mix might provide for a wider variety of responses. Two interview groups for each level (Year 1, Year 2 and Year 3) and the Professionals were formed, each comprising five to six students. The size of the groups was chosen such that they were not too large so that each student would have ample opportunities to discuss his or her views about their learning experiences without leaving anyone out (Morgan, 1992). This is within the limits of the usual recommended number of participants per group which can range between four to twelve (Krueger & Casey, 2009; Kitzinger, 1995; Bender & Ewbank, 1994; Stewart, Shamdasani & Rook, 2007). A total of eight interview groups were organised and scheduled according to the available time slots for both interviewer and students. Most of the interviews with the full-time students were scheduled during their break times or after classes. The interview sessions for the Professional groups had to be scheduled outside of their work schedules, and the ideal time was found to be on Saturdays when they were on campus for classes. One group was interviewed before class started, and the other group was interviewed after class. Venues chosen were tutorial rooms familiar to the students. These rooms provided a relaxed environment with no external distractions and noise.

I personally conducted all the interviews to avoid possible across-group variations that can arise when interviews are conducted by different interviewers (Dillon, Madden & Firtle, 1994; Welch, 1985) . In the process of conducting the interviews, I was also keenly aware of researcher bias and realised that I could be in danger of imposing preconceived perceptions on my interpretations. A key strategy that is often used to understand researcher bias is reflexivity, which means that a researcher engages in critical self-reflection about his or her potential biases and predispositions in the interview process (Johnson & Christensen, 2004). To minimise researcher bias in my situation, I constantly checked and reminded myself to be as objective as possible in my data collection. In addition to that, I was also cognisant that behaviour and wording are culturally inflected, that is, they could be subject to various interpretations by students of different cultures. This could give rise to the interviewees' misunderstanding of the context and meaning of questions I asked. At the same time, I might also misunderstand what I heard as responses. To minimise this, I encouraged the interviewees to seek immediate clarification if my questions were not understood clearly, and likewise I also checked my understanding of their responses when it was necessary. Fortunately, being an Asian like the students, and having interacted closely with students at the institution on a daily basis, the cultural differences were not significant. There were several occasions when I found myself translating particular terms into the common slang, or rephrasing my questions into common phrases used by the young adults to ensure they understood me.

To reduce the need for me to take detailed notes which might slow down or disrupt the flow of the discussions, I sought the interviewees' consent to use a digital voice recorder to record the interviews with anonymity assured in the recording and in the final report. Each interview session lasted between 1½ to 2 hours. To minimize the discussions from being dominated by any particular group member, I moderated the process of responses from the members by encouraging and giving time for the quieter members to speak, and yet allowing some interactivity to refine ideas, help clarify and extend their thoughts (Morgan, 1996). I also assured the students frequently that there were no right or wrong answers, and that they were only required to reflect and share about their own learning experiences. This was intended to help, to some extent, ease any psychological pressure individual members may have felt to give answers they might think I would want to hear, or that the group would respect.

A semi-structured approach was adopted, using the interview guide that I had prepared, to ensure that I covered the key questions I wanted to discuss (Appendix B). I began each interview with a brief description of the purpose of the study and outlined Vermunt's ILS and its four domains to frame the context of the interview. The questions began by asking the students to think and share what they understood by the terms *learning* and *understanding.* This was intended to gain some insight into the students' conceptions of learning and how they would compare the two constructs.

The interview questions guided the students to discuss their own learning approaches to their current Engineering subjects and also non-Engineering subjects. They were also asked to discuss what they felt were the factors that might have influenced the way they learned, if they think they had changed their approach over a period of time. Some flexibility was allowed during the interview for students to offer observations and insights that might move outside of the original questions. The Professionals groups were requested, in addition to the common questions, to share what motivated them to come back to school to continue their education, and if this had influenced the way they approached their studies. Finally they were asked to think and share what they felt were important learning patterns for professionals like themselves to succeed in continuing education. At the end of all the sessions, the interview recordings were transcribed, coded and analysed using the Weft Quality Data Analysis (QDA) software tool. The codes were distilled into a priori themes using Vermunt's (1998) four learning domains: processing strategies, regulation strategies, learning orientations and mental models of learning, and to each subscale under each of the domains.

CHAPTER 4: RESULTS

This chapter reports the results of the quantitative and qualitative study as outlined in the preceding Chapter.

4.1 Quantitative Analysis

4.1.1 Internal Consistency Reliability – Coefficient Alpha

By means of SPSS analysis the internal consistency estimate of reliability using Cronbach's alpha (Cronbach, 1951) was examined for the four components of the ILS, and their respective subscales. This coefficient is particularly appropriate for tests that contain non-dichotomous items, that is, items that can individually be scored along a range of values, as in the case of this study. The results were tabulated in Table 4.1. For the purpose of identifying the subscales in SPSS, codes were assigned, for example, the *learning processes & results* subscale was assigned the code 'SSSELFR1'. The corresponding codes for each of the subscales are shown in the respective tables reported in this Chapter to facilitate referencing with the data in Appendix A.

Table 4.1

Components, subscales, respective codes for SPSS, number of items in each components and Cronbach's α for subscales for Vermunt's Inventory of Learning Styles (N=2099)

ILS Scale	**Respective Codes for SPSS**	**No. of Items**	**Cronbach's α**
Part A: Study Activities			
Domain I: Processing Strategies		***25***	***0.90***
Relating and structuring	SSDEEP1	6	0.74
Critical Processing	SSDEEP2	4	0.76
Memorising and rehearsing	SSTEP1	5	0.69
Analysing	SSTEP2	5	0.66
Concrete processing	CONCRETE	5	0.71
Domain II: Regulation Strategies		***25***	***0.87***
Self-regulation of learning processes and results	SSELFR1	6	0.74
Self-regulation of learning content	SSELFR2	4	0.73
External regulation of learning processes	SSEXTER1	5	0.62
External regulation of learning results	SSEXTER2	5	0.72
Lack of regulation	LACKREG	5	0.68
Part B: Study of Motives and Study Views			
Domain III: Learning Orientations		***25***	***0.82***
Personally interested	INTEREST	5	0.50
Certificate directed	CERTIFIC	5	0.69
Self-test directed	SELFTEST	5	0.80
Vocation directed	VOCATION	5	0.70
Ambivalent	AMBIVALE	5	0.70
Domain IV: Mental models of learning		***25***	***0.86***
Construction of knowledge	CONSTRUCT	5	0.66
Intake of knowledge	INTAKE	5	0.66
Use of knowledge	USEKNOW	5	0.70
Stimulating education	STIMED	5	0.70
Co-operation	COOPER	5	0.77

Alpha values for the four components fell between moderate to good, all close to, or exceeding, the 0.7 recommended by de Vaus (1995) except for the values for external regulation of learning processes (0.62), personally interested (0.50). As this was the first time Vermunt's ILS was used in

Singapore, the alphas from earlier literature that have reported the use of the ILS were referred to for comparison. Vermunt (1998), in his study of Open University students (N=654) in Netherlands using the full 120-item ILS, yielded values between 0.67 to 0.93 for all subscales, and for Regular University students (N=795) he reported alpha values between 0.68 to 0.89 for 21 out of 24 subscales, and lower alpha values for analyzing (0.63), learning processes (0.48), and personally interested (0.57).

Boyle et al (2003), in their study of British undergraduates (N=273), reported values of alpha between 0.66 to 0.74 for 14 out of 20 of the subscales, and lower alpha values for external regulation of learning processes (0.46), external regulation of learning results (0.61), construction of knowledge (0.60), stimulating education (0.64), personally interested (0.54) and certificate directed (0.49). The study done by Ajisuksmo & Vermunt (1999) where the 100-item ILS (translated into the Indonesian language) was administered in an Indonesian university in Jarkarta to first-year students (N=888) from various fields of study yielded alpha values ranging from 0.67 to 0.82 for 9 out of 20 sub-scales, with lower values noted for memorising & rehearsing (0.58), analysing (0.62), concrete processing (0.64), external regulation of learning results (0.59), lack of regulation (0.61), intake of knowledge (0.53), personally interested (0.22), certificate-oriented (0.62), self-test directed (0.55), vocation oriented (0.46) and ambivalent (0.64).

The current results for the ILS can thus be concluded to be comparable to Vermunt's results in the Netherlands study and found to have satisfactory internal consistency, and fairly generalisable in the context of this study.

4.1.2 Comparison of Means

Before the means for the Year 1, Year 2, Year 3 and Professionals (coded as 1, 2, 3, and 4 respectively in SPSS) were compared, the statistical descriptives and the tests for homogeneity of variances were determined using SPSS. Levene's test for homogeneity of variances was then carried out and the results can be found in Appendix A (Table A.1). In short, variances of the groups were found to be significantly different at the $p<.05$ level, except for SSSELFR1 ($F(3,2099)=1.78$, $p=0.16$), SELFTEST ($F(3,2099)=1.60$, $p=0.19$), VOCATION ($F(3,2099)=0.74$, $p=0.53$), and CONSTRUC ($F(3,2099)=0.85$, $p=0.47$).

Based on the above analysis, the assumption of homogeneity of variances for the ANOVA method was violated and the F statistics calculated may not be useful for most of the ILS subscales. An alternative analysis was then sought using the Welch and Brown-Forsythe tests, both of which determined the equality of group means without assuming homogeneity of variance. The Welch test adjusts the denominator of the F ratio so it has the same expectation as the numerator when the null hypothesis is true, despite the heterogeneity of within-group variance. The Brown-Forsythe test adjusts each group's contribution to the between-group variation by a weight related to its within-group variation; thus explicitly adjusting for heterogeneity of variance. Both these methods are more robust than the ANOVA method under the circumstances with good control of Type I errors (Tomarken & Serlin, 1986).

The Welch test indicated that all sub-scales were determined to have statistically significant differences between group means at the $p<.05$ level, except for LACKREG ($F(3,1.22)=1.28$, $p=0.30$), SELFTEST ($F(3,593.55)=1.16$, $p=0.33$) and INTAKE ($F(3,584.69)=1.55$, $p=0.20$). The Brown-Forsythe test did not change the significance and direction of the results. The detailed results can be found in Appendix A (Table A.2).

Post-Hoc analysis was then carried out to further examine the differences using the Tukey's Honestly Significant Difference (HSD) test and Tamhane's test. Tamhane's post hoc test adjusts for unequal variances and sample sizes in the groups and is more robust over Tukey's HSD in this context. The results, however, were very similar except for SSEXTER1 where the mean difference between the Year 1 and Year 3 groups was determined to be statistically significant at the $p<.05$ level for Tukey's HSD but not for Tamhane's test.

The Partial Eta Squared (η^2) values were also calculated for all the independent variables using the General Linear Model (GLM) Univariate procedure in SPSS as an estimate of the effect size for each of the variables respectively. The results are reported in Table A.3 of Appendix A. Kittler, Menard & Phillips (2007) and Barnette (2006) interpreted η^2 values of 0.01, 0.06 and 0.14 as small, medium and large effects respectively. Using this as a reference, the effect sizes in this study were found to be small, between 0.002 to 0.042. A summary of the means, standard deviations, and indication of significant differences between groups for each subscale of the ILS using data from the above analyses is presented in the following sections.

4.1.2.1 Domain I: Processing Strategies

(a) Deep Processing: Relating & structuring (SSDEEP1) and Critical Processing (SSDEEP2)

Table 4.2

Mean ratings for the Relating & Structuring and Critical Processing ILS scale items, and standard deviation (in parenthesis) compared across the four groups. Means not sharing common subscripts are significantly different from each other.

ILS Scale Item	**Code**	**Year 1** (N=638)	**Year 2** (N=616)	**Year 3** (N=705)	**Professionals** (N=140)
Relating & Structuring	SSDEEP1	2.93_a (0.70)	2.70_b (0.62)	2.83_a (0.69)	2.76_{ab} (0.67)
Critical Processing	SSDEEP2	2.60_a (0.84)	2.56_{ab} (0.85)	2.51_{ab} (0.78)	2.39_b (0.73)

There were significant differences between the student groups for Relating & Structuring ($F(3,591.52)=12.56$, $p<.001$). Post-hoc comparisons using Tamhane's method revealed that Year 2 students used less relating and structuring in their processing strategy compared to Year 1 students and Year 3 students. As for Critical Processing, there were significant differences found between the student groups ($F(3,602.60)=3.37$, $p<0.05$). Post-hoc analysis showed that Year 1 students used the critical processing strategy more than Professional students.

(b) Stepwise Processing: Memorising & Rehearsing (SSTEP1) and Analysing (SSTEP2)

Table 4.3

Mean ratings for the Memorising & Rehearsing and Analysing ILS scale items, and standard deviation (in parenthesis) compared across the four groups. Means not sharing common subscripts are significantly different from each other.

ILS Scale Item	**Code**	**Year 1** (N=638)	**Year 2** (N=616)	**Year 3** (N=705)	**Professionals** (N=140)
Memorising & Rehearsing	SSSTEP1	3.19_a (0.76)	3.02_b (0.65)	3.29_a (0.71)	2.99_b (0.66)
Analysing	SSSTEP2	2.95_{ab} (0.71)	2.86_a (0.63)	2.96_b (0.69)	2.59_c (0.64)

There were significant differences for memorising & Rehearsing found between the student groups (F(3,597.69)=21.57, p<.001). Year 1 and Year 3 students had the highest mean score for memorizing and rehearsing that was significantly higher compared to Year 2 and Professional students.

As for Analysing, there were significant differences found between the student groups (F(3,596.52)=14.252, p<.001). Comparison using post-hoc analysis found that the Professional students had significantly the lowest mean score for analyzing as a strategy among the four groups. In addition, Year 2 students scored less for this construct compared to Year 3 students.

(c) Concrete processing - CONCRETE

Table 4.4

Mean ratings for the Concrete Processing ILS scale item, and standard deviation (in parenthesis) compared across the four groups. Means not sharing common subscripts are significantly different from each other.

ILS Scale Item	**Code**	**Year 1** (N=638)	**Year 2** (N=616)	**Year 3** (N=705)	**Professionals** (N=140)
Concrete Processing	CONCRETE	2.93_{ac} (0.74)	2.76_{b} (0.69)	2.84_{ab} (0.72)	3.02_{c} (0.73)

There were significant differences found between the student groups (F(3, 588.39)=8.20, p<.001). Opposite of what was seen for the analysing strategy, the Professionals group had the highest mean score for concrete processing, showing significantly higher preference for this strategy than Year 2 and Year 3 students. Although they scored higher than Year 1 students, the difference was not significantly higher.

Summary

Among all the Processing Strategies, Year 1, Year 2 and Year 3 students scored generally higher means for memorising & rehearsing which highlight their preference for rote learning. The Professionals group scored the highest for concrete processing among the other Processing Strategies with statistical significance observed. It was not surprising that the Professionals would prefer to learn by concretising and associating what they have learnt to their own work experience, and seeking ways to apply the knowledge gained. However, being more matured and experienced learners I expected them to also use more Deep Processing techniques, but that was not evident from the results. In general, there did not appear to be any significant relation between year of study and processing strategies. This will be investigated further later.

4.1.2.2 Domain II: Regulation Strategies

(d) Self-Regulation: Learning Processes & Results (SSSELFR1) and Learning Content (SSSELFR2)

Table 4.5

Mean ratings for the Learning Processes & Results and Learning Content ILS scale items, and standard deviation (in parenthesis) compared across the four groups. Means not sharing common subscripts are significantly different from each other.

ILS Scale Item	**Code**	**Year 1** (N=638)	**Year 2** (N=616)	**Year 3** (N=705)	**Professionals** (N=140)
Learning Processes & Results	SSSELFR1	2.89_a (0.74)	2.77_b (0.68)	2.97_a (0.71)	2.70_b (0.71)
Learning Content	SSSELFR2	2.61_a (0.93)	2.46_b (0.73)	2.44_b (0.75)	2.38_b (0.78)

There were significant differences for Learning Processes & Results found between the student groups ($F(3, 590.10)=11.70$, $p<.001$). The Year 3 group showed significant preference for this construct compared to Year 2 and Professional students. While the Year 1 group mean score was lower than the Year 3 group (but not statistically significant), it was significantly higher than the Year 2 and Professional groups.

There were significant differences found for Learning Content between the student groups (F(3, 590.29)=5.891, p<.05). Year 1 students scored significantly higher for this construct over all other groups.

(e) External Regulation: Learning Processes (SSEXTER1) and Learning Results (SSEXTER2)

Table 4.6

Mean ratings for the External regulation of learning Processes and learning Results ILS scale items, and standard deviation (in parenthesis) compared across the four groups. Means not sharing common subscripts are significantly different from each other.

ILS Scale Item	**Code**	**Year 1** (N=638)	**Year 2** (N=616)	**Year 3** (N=705)	**Professionals** (N=140)
Learning Processes	SSEXTER1	3.07_{ac} (0.72)	3.04_{a} (0.66)	3.18_{c} (0.66)	2.73_{b} (0.59)
Learning Results	SSEXTER2	3.18_{a} (0.75)	3.00_{bc} (0.67)	3.09_{ab} (0.73)	2.87_{c} (0.67)

There were significant differences of means found for External Regulation of Learning Processes between the student groups (F(3, 605.71)=20.44, p<.001). The Year 3 group scored significantly higher for external regulation of learning processes compared to the Year 2 and Professionals groups. The Professional students, in fact, scored significantly lower than all the groups.

As for External Regulation of Learning Results there were also significant differences found in the means between the student groups (F(3, 598.61)=10.94, p<.001). Again the Professional students scored the lowest mean for this strategy, showing significantly lower scores compared to Year 1 and Year 3 students. The Year 1 students, scored significantly higher than for Year 2 and Professional students.

(f) Lack of regulation - LACKREG

Table 4.7

Mean ratings for the Lack of Regulation ILS scale item, and standard deviation (in parenthesis) compared across the four groups. Means not sharing common subscripts are significantly different from each other.

ILS Scale Item	**Code**	**Year 1** (N=638)	**Year 2** (N=616)	**Year 3** (N=705)	**Professionals** (N=140)
Lack of Regulation	LACKREG	2.74_a (0.76)	2.69_a (0.66)	2.73_a (0.62)	2.65_a (0.59)

There were no significant differences found between the four groups of students at the p<.05 level.

Summary

Year 1 students scored the highest among the rest for Self-Regulation of Learning Content. No significant increase in self-regulation nor external regulation strategies were reported at the later years. Interestingly the Professionals group reported generally low scores (though not significantly lower) for both the Self-Regulation and External Regulation constructs.

4.1.2.3 Domain III: Learning Orientations

(g) Personally interested – INTEREST

Table 4.8

Mean ratings for the Personally Interested ILS scale item, and standard deviation (in parenthesis) compared across the four groups. Means not sharing common subscripts are significantly different from each other.

ILS Scale Item	**Code**	**Year 1** (N=638)	**Year 2** (N=616)	**Year 3** (N=705)	**Professionals** (N=140)
Personally Interested	INTEREST	3.45_a (0.56)	3.27_b (0.62)	3.30_b (0.60)	3.15_b (0.66)

There were significant differences found between the student groups ($F(3, 580.70)=15.68$, $p<.001$). The Year 1 students scored significantly higher than all the other groups, indicating strong personal interest in their choice of studies.

(h) Certificate directed – CERTIFIC

Table 4.9

Mean ratings for the Certificate Oriented ILS scale item, and standard deviation (in parenthesis) compared across the four groups. Means not sharing common subscripts are significantly different from each other.

ILS Scale Item	**Code**	**Year 1** (N=638)	**Year 2** (N=616)	**Year 3** (N=705)	**Professionals** (N=140)
Certificate Oriented	CERTIFIC	3.61_a (0.76)	3.54_{ab} (0.67)	3.59_a (0.65)	3.40_b (0.66)

There were significant differences found between the student groups ($F(3, 594.50)=4.37$, $p<.05$). The Professional students scored the lowest among all the groups with significant differences compared to the Year 1 and Year 3 students in their view of acquiring a certificate as the goal for learning.

(i) Self-test directed – SELFTEST

Table 4.10

Mean ratings for the Self-Test Oriented ILS scale item, and standard deviation (in parenthesis) compared across the four groups. Means not sharing common subscripts are significantly different from each other.

ILS Scale Item	**Code**	**Year 1** (N=638)	**Year 2** (N=616)	**Year 3** (N=705)	**Professionals** (N=140)
Self-Test Oriented	SELFTEST	3.78_a (0.79)	3.73_a (0.74)	3.70_a (0.74)	3.75_a (0.733)

There were no significant differences found between the four groups of students at the p<.05 level. It was interesting to note that the mean scores for the self-test directed subscale for all groups were among the highest when compared with other subscales.

(j) Vocation directed – VOCATION

Table 4.11

Mean ratings for the Vocation Oriented ILS scale item, and standard deviation (in parenthesis) compared across the four groups. Means not sharing common subscripts are significantly different from each other.

ILS Scale Item	**Code**	**Year 1** (N=638)	**Year 2** (N=616)	**Year 3** (N=705)	**Professionals** (N=140)
Vocation Oriented	VOCATION	3.65_a (0.72)	3.65_a (0.68)	3.67_a (0.70)	3.92_b (0.63)

There were significant differences found between the student groups (F(3, 602.53)=7.32, p<.001). The Professional students scored significantly higher than all the other groups, indicating the importance of acquiring professional skills as a goal for their studies.

(k) Ambivalent - AMBIVALE

Table 4.12

Mean ratings for the Ambivalent ILS scale item, and standard deviation (in parenthesis) compared across the four groups. Means not sharing common subscripts are significantly different from each other.

ILS Scale Item	**Code**	**Year 1** (N=638)	**Year 2** (N=616)	**Year 3** (N=705)	**Professionals** (N=140)
Ambivalent	AMBIVALE	3.00_a (0.77)	3.15_b (0.77)	3.06_{ab} (0.66)	2.49_c (0.77)

There were significant differences found between the student groups ($F(3, 581.86)=27.88$, $p<.001$). Year 2 students scored highest among the other groups and were significantly more ambivalent in their attitude towards their studies compared to the Year 1 and Professional students. The Professionals' scores for ambivalence were significantly the lowest among all the groups.

Summary

Looking at Learning Orientations as a domain, it appears that Year 1 students were the most directed by their interest in Engineering, and the goal to attain their Diplomas. Somehow, Year 2 students appear to have lost their way and have become more ambivalent. The Professionals group, on the other hand, are significantly less ambivalent than all the other students, and are clearly more directed by their vocational goals, that is, to gain the knowledge and skills to enhance their ability to perform better in their current jobs, or perhaps to prepare themselves for a promotion or a career switch. However, it was interesting that they also reported low mean scores for the personal interest and certificate directed subscales. All groups generally reported high mean scores for self-test directed with no significant differences between groups. This could indicate that generally, students were motivated by the opportunity to prove to themselves and others that they were capable of successfully completing a programme in higher education.

4.1.2.4 Domain IV: Mental models of learning

(l) Construction of knowledge - CONSTRUCT

Table 4.13

Mean ratings for the Construction of Knowledge ILS scale item, and standard deviation (in parenthesis) compared across the four groups. Means not sharing common subscripts are significantly different from each other.

ILS Scale Item	**Code**	**Year 1** (N=638)	**Year 2** (N=616)	**Year 3** (N=705)	**Professionals** (N=140)
Construction of Knowledge	CONSTRUC	3.55_a (0.59)	3.44_b (0.60)	3.42_b (0.63)	3.56_{ab} (0.57)

There were significant differences found between the student groups ($F(3, 597.58)=6.89$, $p<.001$). Year 1 students scored significantly higher compared to Year 2 and Year 3 students in this conception of learning. Professional students did have a high mean score but not statistically higher than any group.

(m) Intake of knowledge - INTAKE

Table 4.14

Mean ratings for the Intake of Knowledge ILS scale item, and standard deviation (in parenthesis) compared across the four groups. Means not sharing common subscripts are significantly different from each other.

ILS Scale Item	**Code**	**Year 1** (N=638)	**Year 2** (N=616)	**Year 3** (N=705)	**Professionals** (N=140)
Intake of Knowledge	INTAKE	3.71_a (0.65)	3.77_a (0.61)	3.77_a (0.58)	3.70_a (0.64)

There were no significant differences found between the four groups of students at the $p<0.05$ level, however, like the self-test directed subscale, this construct also had generally higher means compared with the others.

This could indicate that generally, the students' learning conception was to take in knowledge mainly through memorising and reproduction, and they relied on their instructors to tell them what needs to be studied.

(n) Use of knowledge – USEKNOW

Table 4.15

Mean ratings for the Use of Knowledge ILS scale item, and standard deviation (in parenthesis) compared across the four groups. Means not sharing common subscripts are significantly different from each other.

ILS Scale Item	**Code**	**Year 1** (N=638)	**Year 2** (N=616)	**Year 3** (N=705)	**Professionals** (N=140)
Use of Knowledge	USEKNOW	3.71_a (0.67)	3.68_a (0.55)	3.68_a (0.64)	3.89_b (0.54)

There were significant differences found between the student groups ($F(3, 604.59)=6.119$, $p<.001$). The Professional students scored significantly higher than all the other groups indicating that they hold a stronger view of learning as a means to acquire knowledge that can be applied in their respective vocations.

(o) Stimulating education – STIMED

Table 4.16

Mean ratings for the Stimulating Education scale item, and standard deviation (in parenthesis) compared across the four groups. Means not sharing common subscripts are significantly different from each other.

ILS Scale Item	**Code**	**Year 1** (N=638)	**Year 2** (N=616)	**Year 3** (N=705)	**Professionals** (N=140)
Stimulating Education	STIMED	3.54_a (0.63)	3.43_b (0.61)	3.41_b (0.61)	3.40_{ab} (0.60)

There were significant differences found between the student groups ($F(3, 592.89)=5.86$, $p<.05$). Year 1 students scored significantly the highest mean compared to Year 2 and Year 3 students suggesting a higher dependence on teachers to stimulate learning. The Professional group scored the lowest mean, but not statistically significant compared to the others at the $p<0.05$ level. However, statistical significance could be found at the $p<.1$ level.

(p) Co-operation - COOPER

Table 4.17

Mean ratings for the Cooperative Learning ILS scale item, and standard deviation (in parenthesis) compared across the four groups. Means not sharing common subscripts are significantly different from each other.

ILS Scale Item	**Code**	**Year 1** (N=638)	**Year 2** (N=616)	**Year 3** (N=705)	**Professionals** (N=140)
Cooperative Learning	COOPER	3.46_{ab} (0.84)	3.40_{a} (0.79)	3.57_{b} (0.71)	3.20_{c} (0.74)

There were significant differences found between the student groups ($F(3, 593.03)=11.87$, $p<.001$). The Professional students scored significantly lower than all the other groups indicating their lower dependence on cooperation with fellow students and sharing the task of learning with them. Year 3 students scored the highest mean, with statistical significance found when compared to Year 2 and Professional groups.

Summary

For the Mental Models of Learning domain, Year 1 students and the Professionals held stronger views that learning involved constructing one's own knowledge and insights more than the other groups.

Year 3 students attached more value to learning in cooperation with fellow students and sharing the task of learning with them compared with Year 1 and Year 2 students, whereas the Professionals relied the least on this concept of learning. To the Professionals, their conception of learning is understandably more pragmatic, holding the view that knowledge gained is for the purpose of applying to their respective vocations. It was observed that they scored higher in this than any other construct in this domain. All groups generally reported higher mean scores for the Intake of Knowledge subscale compared to other subscales (other than self-test directed). This indicated that students generally expected the instructor to be quite specific in telling the class the scope of what would be tested in all their assessments, and to provide sufficient practice through questions, tutorials, and even past year papers.

4.1.3 Interactions between Domains

4.1.3.1 Factor Analysis

Before factor analysis was performed several commonly used criteria for the factorability of the 20 ILS subscale items were checked. Firstly, the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy were determined. The values obtained were 0.834, 0.878, 0.863 and 0.792 for the Year 1, Year 2, Year 3 and Professional groups respectively, well above the typical value of 0.6. The Bartlett's test for Sphericity was significant for all groups: Year 1 (χ^2 (190) = 10267.8, p<.001), Year 2 (χ^2 (190) = 6619.2, p<.001), Year 3 (χ^2 (190) = 8188.6, p<.001) and Professionals (χ^2 (190) = 1336.1, p<.001) respectively. Detailed data can be found in Table A.4 in Appendix A. Secondly all 20 items of the ILS correlated at a minimum of 0.3 with at least one other item for all the groups, except for LACKREG for the Year 3 group. Detailed data can be found in Tables A.5.1 to A.5.4 in Appendix A. Thirdly, the diagonals of the anti-image correlation were all at 0.5 or greater, supporting the inclusion of each item in the factor analysis (Tables A.6.1 to

A.6.4 in Appendix A). Finally, the communalities for all groups were determined and all were found to be above the typically recommended 0.3 value confirming that each item shared some common variance with other items (Tables A.7.1 to A.7.4 in Appendix A). Considering all the above indicators, the factorability of the of the ILS sub-scale items was confirmed and factor analysis was conducted.

Principal component analysis was carried out for this investigation, similar to Vermunt's (1998) study. The purpose was to identify the underlying factors that can be interpreted as the learning patterns of the respective groups. For the Year 1 and Year 2 groups, the initial eigenvalues for the first 4 factors were above 1 (Guttman-Kaiser rule) and explained 71.9% and 63.8% of the variance (cumulative) respectively. A 4-factor model was adopted for the two groups.

For the Year 3 and Professionals groups, the initial eigenvalues for the first 5 factors were above 1. Considering the first 4 factors contributed to 65.5% and 60.4% of the cumulative variances for the Year 3 and Professional groups respectively, and the contribution of the 5th factor for both groups was small, a 4-factor model was also adopted for these two groups. The total variance explained and scree plots are shown in Tables A.8.1 to A.8.4 in Appendix A.

In attempting to achieve a simple structure for easier interpretation of the 4 factors, two types of rotation were considered: orthogonal and oblique. In orthogonal rotation it is assumed that there is no correlation between the extracted factors. Oblique rotation does not require this assumption, thus the principal component analysis was done with oblique rotation using both Direct Oblimin and Promax techniques provided in SPSS. The Direct Oblimin rotation could not reach convergence within 25 iterations (default) so further analysis was not attempted. The Promax rotation with kappa = 4 (default) was used for all groups. Absolute values of factor loadings less than 0.3 were suppressed. Items that had cross-loadings across factors with differences less than 0.3 were ignored in the interpretation of the factors.

4.1.3.2 Learning Patterns of Year 1 Students

Table 4.18

Domains, subscales, factor loadings in a 4-factor oblique promax rotation for Year 1 students (principal component analysis; loadings >-.3 and <.3 omitted; N=638), eigenvalues, % explained variance and cumulative %.

Domains	Sub-scales		Factor loadings			
			1	2	3	4
Processing Strategies	Relating & structuring	SSDEEP1	0.92			
	Critical processing	SSDEEP2	0.68		-0.43	
	Memorising & rehearsing	SSSTEP1	0.61		0.38	
	Analysing	SSSTEP2	0.85			
	Concrete processing	CONCRETE	0.61			
Regulation Strategies	Self-regulation of learning processes & results	SSSELFR1	0.86			
	Self-regulation of learning content	SSSELFR2	0.91			
	External regulation of learning processes	SSEXTER1			0.56	
	External regulation of learning results	SSEXTER2	0.65		0.31	
	Lack of regulation	LACKREG				0.73
Learning Orientations	Personally interested	INTEREST		0.41		
	Certificate directed	CERTIFIC			0.61	
	Self-test directed	SELFTEST		0.93		
	Vocation directed	VOCATION		0.92		
	Ambivalent	AMBIVALE				0.84
Mental Models of Learning	Construction of knowledge	CONSTRUC		0.57		
	Intake of knowledge	INTAKE			0.83	
	Use of knowledge	USEKNOW			0.58	
	Stimulating education	STIMED		0.70		
	Co-operation	COOPER			0.32	0.64
Eigen value			8.0	3.2	1.8	1.4
% Explained variance			40.0	16.0	8.9	7.0
Cumulative %			40.0	56.0	64.9	71.9

For the first factor for Year 1 students, relating & structuring and analyzing, self-regulation of learning processes & results, self-regulation of learning content loaded highly. Critical processing, memorising & rehearsing, concrete processing, external regulation of learning results loaded moderately on this factor. No significant loadings from learning orientations and mental models of learning were found. This factor showed both deep and stepwise processing, as well as both self-regulation and external regulation strategies. This factor appeared similar to what Ajisuksmo and Vermunt (1999) found (see Table 2.6) and they labelled it an Active Meaning Directed pattern. However, I think that this pattern would be more precisely labelled as a Flexible learning pattern like what Donche et al. (2010) described.

Self-test directed, vocation directed and stimulating education loaded highly, and personally interested and construction of knowledge loaded moderately on the second factor. This factor did not have any significant loadings from the processing and regulation strategies. This factor could be interpreted as a Prove-yourself Directed learning pattern, similar to what Severiens and Ten Dam (1997) described.

The third factor had only intake of knowledge loading highly, while external regulation of learning processes, certificate directed, use of knowledge loaded moderately. In addition, memorising & rehearsing, external regulation of results, and cooperation had smaller loadings while critical processing had a negative loading. This factor resembled a Reproduction Directed learning pattern that was motivated by learning for the sake of getting a diploma. The fourth factor had high loadings for lack of regulation and ambivalent, and a moderate loading for co-operation. This most resembled an Undirected learning pattern.

4.1.3.3 Learning Patterns of Year 2 Students

Table 4.19

Domains, subscales, factor loadings in a 4-factor oblique promax rotation for Year 2 students (principal component analysis; loadings >-.3 and <.3 omitted; N=616), eigenvalues, % explained variance and cumulative %.

Domains	**Sub-scales**		**Factor loadings**			
			1	**2**	**3**	**4**
Processing Strategies	Relating & structuring	SSDEEP1	0.73			
	Critical processing	SSDEEP2	0.87			
	Memorising & rehearing	SSSTEP1			0.76	
	Analysing	SSSTEP2	0.54			
	Concrete processing	CONCRETE	0.65			
Regulation Strategies	Self-regulation of learning processes & results	SSSELFR1	0.78			
	Self-regulation of learning content	SSSELFR2	0.82			
	External regulation of learning processes	SSEXTER1			0.78	
	External regulation of learning results	SSEXTER2	0.34		0.57	
	Lack of regulation	LACKREG				0.54
Learning Orientations	Personally interested	INTEREST		0.73	-0.36	
	Certificate directed	CERTIFIC				0.48
	Self-test directed	SELFTEST		0.75		
	Vocation directed	VOCATION		0.76		
	Ambivalent	AMBIVALE				0.85
Mental Models of Learning	Construction of knowledge	CONSTRUC		0.70		
	Intake of knowledge	INTAKE		0.61	0.34	
	Use of knowledge	USEKNOW		0.80		
	Stimulating education	STIMED		0.58		0.31
	Co-operation	COOPER				0.47
		Eigen value	7.1	2.7	1.8	1.1
		% Explained variance	35.7	13.7	8.8	5.7
		Cumulative %	35.7	49.4	58.2	63.9

For Year 2 students, relating & structuring, critical processing, self-regulation of learning processes & results, self-regulation of learning content loaded highly on the first factor, while analysing and concrete processing loaded moderately. There was also a small loading from external regulation of learning results, but no loading from the external regulation of learning processes scale, and also no loadings from the learning orientations and mental models of learning. This factor resembled a Flexible learning pattern, but without memorisation & rehearsing.

Factor two had high loadings from personally interested, self-test directed, vocation directed, construction of knowledge, and use of knowledge. Moderate loading was observed for intake of knowledge and stimulating education for this factor. There were no significant loadings from the processing and regulation strategies. This factor could be interpreted as a Passive-idealistic learning pattern, similar to what Ajisuksmo and Verment (1999) described.

The third factor had memorising & rehearsing and external regulation of learning processes loading highly, external regulation of learning results loading moderately, and a smaller loading from intake of knowledge. Personally interested loaded negatively. This factor could be described as a Passive-reproduction Directed learning pattern because these learners did not have clear goals. The last factor had a high loading from ambivalent and moderate loadings from lack of regulation, certificate directed and co-operation, and a smaller loading from stimulating education. This factor appeared to be an Undirected learning pattern, but the moderate loading from the certificate directed scale and the negative loading from the personally interested scale could indicate that the students in this category have lost interest in their course and just want to finish it to get the Diploma. This could perhaps be interpreted as a Passive-certificate Directed learning pattern.

4.1.3.4 Learning Patterns of Year 3 Students

Table 4.20

Domains, subscales, factor loadings in a 4-factor oblique promax rotation for Year 3 students (principal component analysis; loadings >-.3 and <.3 omitted; N=705), eigenvalues, % explained variance and cumulative %.

Domains	**Sub-scales**		**Factor loadings**			
			1	**2**	**3**	**4**
Processing Strategies	Relating & structuring	SSDEEP1	0.85			
	Critical processing	SSDEEP2	0.82			
	Memorising & rehearing	SSSTEP1				0.53
	Analysing	SSSTEP2	0.80			
	Concrete processing	CONCRETE	0.86			
Regulation Strategies	Self-regulation of learning processes & results	SSSELFR1	0.84			
	Self-regulation of learning content	SSSELFR2	0.81			
	External regulation of learning processes	SSEXTER1	0.46			
	External regulation of learning results	SSEXTER2	0.63			
	Lack of regulation	LACKREG				0.61
Learning Orientations	Personally interested	INTEREST		0.82		
	Certificate directed	CERTIFIC				0.58
	Self-test directed	SELFTEST		0.99	-0.37	
	Vocation directed	VOCATION		0.81		
	Ambivalent	AMBIVALE				0.70
Mental Models of Learning	Construction of knowledge	CONSTRUC				
	Intake of knowledge	INTAKE			0.47	
	Use of knowledge	USEKNOW		0.66		
	Stimulating education	STIMED			0.72	
	Co-operation	COOPER			0.89	
		Eigen value	7.1	2.7	1.9	1.4
		% Explained variance	35.3	13.5	9.6	7.1
		Cumulative %	35.3	48.8	58.4	65.5

The first factor for Year 3 students had high loadings from relating & structuring, critical processing, analysing, concrete processing, self-regulation of learning processes & results and self-regulation of learning content, and moderate loadings for external regulation of learning processes and external regulation of learning results. This factor resembled a Meaning Directed learning pattern with elements of external regulation but it could be still be better described as a Flexible learning pattern like the Year 1 and Year 2 groups.

Personally interested, self-test-directed and vocation directed loaded highly on the second factor, while use of knowledge loaded moderately. As in the case for the Year 1 and Year 2 groups, there were no significant loadings from the processing and regulation strategies. This factor resembled a Prove-yourself Directed learning pattern that was strongly driven by the desire to prove one's own capability to succeed.

The third factor had only stimulating education and cooperation loading highly. This factor did not appear to correspond clearly to any of the factors found by Vermunt. It could be at best described as a Passive-reproductive learning pattern as there were no clear processing and regulation strategies, nor any learning orientations reported by these students.

The fourth factor had a high loading from ambivalent while having moderate loadings from memorising & rehearsing, lack of regulation and certificate directed. This factor seemed to represent learners who were Undirected, but would put in effort to at least memorise the course material, sustained only by the end goal of attaining the Diploma. It seems appropriate to describe this as an Active-certificate Directed learning pattern.

4.1.3.5 Learning Patterns of Professionals

Table 4.21

Domains, subscales, factor loadings in a 4-factor oblique promax rotation for Professionals (principal component analysis; loadings >-.3 and <.3 omitted; N=140), eigenvalues, % explained variance and cumulative %.

Domains	**Sub-scales**		**Factor loadings**			
			1	**2**	**3**	**4**
Processing Strategies	Relating & structuring	SSDEEP1	0.78			
	Critical processing	SSDEEP2	0.84			
	Memorising & rehearing	SSSTEP1			0.65	
	Analysing	SSSTEP2	0.68			
	Concrete processing	CONCRETE	0.68			0.37
Regulation Strategies	Self-regulation of learning processes & results	SSSELFR1	0.84			
	Self-regulation of learning content	SSSELFR2	0.82			
	External regulation of learning processes	SSEXTER1			0.82	
	External regulation of learning results	SSEXTER2	0.67			
	Lack of regulation	LACKREG			0.53	-0.39
Learning Orientations	Personally interested	INTEREST		0.58		
	Certificate directed	CERTIFIC			0.31	
	Self-test directed	SELFTEST		0.45		
	Vocation directed	VOCATION			0.34	0.62
	Ambivalent	AMBIVALE				-0.77
Mental Models of Learning	Construction of knowledge	CONSTRUC	0.33	0.63		
	Intake of knowledge	INTAKE		0.77		
	Use of knowledge	USEKNOW				0.52
	Stimulating education	STIMED		0.71		
	Co-operation	COOPER		0.58		
		Eigen value	5.9	2.7	2.1	1.3
		% Explained variance	29.6	13.5	10.7	6.6
		Cumulative %	29.6	43.1	53.8	60.4

For the Professionals group, high loadings on the first factor were observed from relating & structuring, critical processing, self-regulation of learning processes & results, and self-regulation of learning content. Moderate loadings were observed for analyzing, concrete processing and external regulation for learning results, and a smaller loading for construction of knowledge. This factor mostly resembled a Meaning Directed learning pattern, although it also included some reproductive elements.

The second factor had high loadings from intake of knowledge and stimulating education, and moderate loadings from personally interested, construction of knowledge and co-operation. This factor resembled the Passive-idealistic learning pattern found for the Year 2 group.

External regulation of Learning Processes loaded highly on the third factor, while memorising & rehearsing loaded moderately. There were smaller loadings from certificate directed and vocation directed. This factor most resembled a Reproduction Directed learning pattern that was motivated by the students' desire to attain their certificate and to enhance their vocations.

Interestingly, lack of regulation and ambivalence loaded negatively on the fourth factor, while vocation directed and use of knowledge loaded moderately. There was also a smaller loading from concrete processing. This factor most resembled an Application Directed learning pattern not observed in any of the other undergraduate groups.

4.2 Qualitative Analysis

Section 4.1 of this chapter examined the students' subscale scores of each learning domain (processing strategies, regulations strategies, learning orientation and mental models of learning) via their responses to Vermunt's ILS. In this section, I will attempt to bring together the findings from the group interviews with the aim to illuminate and extend the understanding of the students' reported subscale scores.

The interviews were recorded using a digital voice recorder and subsequently transcribed into text documents. These were then checked for accuracy against the recordings by a colleague and any transcription errors found were corrected. There were a few parts of the recordings for some groups that turned out to be muffled and unintelligible, or the respondents were mumbling too softly to be recorded clearly. A problem with the recorder was encountered during the interview of the second Year 2 group and almost 45 minutes of the approximately 90-minute interview was somehow not recorded. I did not realise this till I was attempting to transcribe it. For those parts that were unintelligible or not properly recorded, I had to rely on my own interview notes to extract the relevant data. The transcripts, therefore, did not represent a fully accurate representation of verbatim responses.

The transcripts were carefully analysed one at a time by reading and re-reading several times to search for key words or phrases that were perceived to be relevant and then tagged using Weft QDA, a qualitative analysis software program. The tags were assigned to a priori themes corresponding to the four domains in Vermunt's ILS, namely Processing Strategies, Regulation Strategies, Learning Orientations and Mental Models of Learning, and to each subscale under these domains. This was an iterative process to ensure that the tags were correctly assigned and duplication of tags for particular words or phrases were removed. The tagging process was not trivial as it took careful reading of the phrases to understand the underlying meaning of what the respondents were saying within the context of the discussion at the particular point of time. Examples of phrases, and the corresponding themes to which the phrases were tagged to are shown in Table 4.22.

Table 4.22

Illustration of sample phrases, student labels, and themes used in qualitative analysis

S/N	Sample Phrases	Student Label	Themes & Subscales
1	Teacher is always the **medium to pass the knowledge**, and **make it interesting**, and **make students like the subject.**	PRG1S4 (Professionals, Group 1, Student 4)	Regulation Strategies - External Regulation - Learning Processes
2	When the teacher tells me a new formula, **I try to understand it.** But sometimes it is hard to understand but I can still **memorise** and I can still pass the exam.	Y1G1S4 (Year 1, Group 1, Student 4)	Processing Strategies - Deep Processing and Stepwise Processing
3	For me , I **try to understand the logic of it all** by **trying out the questions - learn from mistakes - until I, like, get.**	Y2G2S4 (Year 2, Group 2, Student 4	Regulation Strategies - External Regulation - Learning Results

The first example was one that was relatively straightforward as the phrases pointed rather clearly to the student's view on the importance of the teacher's role as the source of information, and his expectation for the lecturer to stimulate learning. However, there were many instances where it was not clear as to which theme a phrase should be assigned to. The second example was initially tagged as a Stepwise Processing strategy because it stated the student's preference for memorising to pass an examination. However, on further analysis, the phrase could also suggest that the student attempted to understand the said formula, failing which he would resort to memorisation. Eventually I decided to tag it to both themes and later found other similar phrases that, when considered together, supported the idea that there were students who were able to use both deep and stepwise processing strategies to achieve their study goals. The third example seemed possible to be tagged as a self-regulation strategy for learning processes. However, after reviewing the context in which the statement was made, I assigned it to External Regulation for Learning Results because the main point the student was putting across was her need to practice until she could get the right answers. This point was one of several similar views expressed by students, and supported the idea that students expected their lecturers to provide the tutorial worksheets, assignments and other tasks for their practice. Students perceived that once they could answer the questions or solve the problems posed they considered themselves as having understood the topic and had no intention to explore the concepts further.

The following sections report the analysis of the students' concept of learning and understanding, followed by the analysis of the qualitative data using the structure of the ILS as a framework.

4.2.1 Concept of Learning and Understanding

Both the undergraduates and the Professionals were asked in the interviews what learning meant to them, their responses could be summarised as follows:

(i) Learning as increase of knowledge.

In every group that was interviewed, at least one or two students said that learning was mainly to gain new knowledge, for example:

"Learn new things, know more things (Y1G1S3)

"Learning means...educating ourselves with some knowledge that we don't already know, it's to gain knowledge." (Y2G1S2)

"Learning is gathering information". (PRG2S1)

These phrases suggested a conception of learning that may be more focussed on the intake of knowledge, rather than seeking to find deep meaning in the topics they were learning, or desiring to apply the knowledge gained. Analysing this learning conception in the context of the discussions in the interview, a key concern for these students was to be able to reproduce the knowledge gained in examinations.

(ii) Learning as the means of gaining access to a desirable job.

> *"Learning to me is to get a good job and make much money." (Y1G1S2)*

> *"Learning is to gain new knowledge, go out to society, get a job, earn money - otherwise I won't be able to find a job!" (Y3G1S1)*

It may be likely that these two students could be working towards acquiring their diplomas through learning and passing the examinations. The diploma was perceived as a valuable asset towards securing socio-economic mobility for them.

(iii) Learning as gaining practical experience

Three students expressed the importance of experiential learning, especially through laboratory experiments and practice, for example:

> *"[Learning] is an experience - if you experience something, then it's learning, it's not just head knowledge."* (Y1G2S3)

"I learn more from labs than the lectures - I [prefer] hands-on lessons". (Y2G1S2)

"I learn more from labs too - like if my [software] program [that I wrote] is not working, I find out what is wrong and I try to learn [the correct way of doing it]." (Y2G1S3)

These students could be said to be more practice-oriented and could have chosen the Engineering course because they preferred such learning experiences that the training programme could offer.

(iv) Learning as the processing of knowledge to abstract meaning for problem solving.

Only one student expressed this view, and she put it this way:

"[Learning] is to receive information, comprehend meaning, absorbing knowledge, and when you are given a problem, to solve it." (Y3G1S2)

This student's idea of learning involved three stages: acquisition of knowledge, processing to abstract meaning, and applying in problem solving, which is a higher order cognitive function.

(v) Learning as the acquisition of knowledge that can be usefully applied in a vocational context.

One undergraduate expressed his view as follows:

"You learn something because you want to use it, and it can help solve some problems in the future, it must be something you are interested in. So I think learning is to improve myself and to learn more about the world and about life." (Y1G1S1)

This student appeared to hold the perception that learning must be applied, but it was mainly focussed on general problem solving, self-development and enrichment. The Professionals were able to express a much clearer view of learning as the application of knowledge in real-life situations, and to improve personal competence, a few examples are reported as follows:

"Learning how to apply [knowledge] to my work place, upgrade my skills, and make me more competitive." (PRG1S1)

"Learning must be applied! If you don't know how to apply your knowledge, that means you haven't learned!" (PRG1S4)

"Learning [is to improve] efficiency - once you have the knowledge, you can do your job better, have more confidence, do things faster." (PRG3S3)

These learning conceptions seemed to have influenced at least three of the Professionals to be selective in their learning. One example is reported here:

> *"For me, if [the topic] is not related to my work....I just study to meet the requirements. For those parts which I find that are related and interesting, I will read further and go deeper." (PRG1S3)*

The first two views could be described as a rather more pragmatic conception of learning where studies were aimed at the acquisition of knowledge, and ultimately the diploma, mainly as a means to get a desirable job that would pay well. These were rather similar to what Säljö (1979) reported as reproductive learning conceptions. The third view was reflected by students who were more practice-oriented and would prefer experiential learning approaches. The fourth view appeared to be the least represented among all the interview groups. This would fit students who were meaning directed in their learning. The last learning conception was primarily held by the Professionals and was pragmatic but more specifically focussed on a purposeful use of knowledge in their jobs, that is, the students were more application-directed.

In comparing the conception of learning with the term understanding, the students gave the following responses:

> *"Learning is a process, understanding comes after the process."* (Y3G2S1)

> *"For me, it's more like, ok, I learn that 'Skin Depth' is this thing (a phenomenon of concern in high frequency electronic circuit design),*

then I try to make sense of it, so it's like, ok, I understand why this thing actually happens." (Y3G2S4)

"Understanding is like getting behind the scene - to know why and how things happen." (Y3G2S5)

"It's like different layers, understanding is a deeper level." (PRG1S3)

"Understanding is like you are able to take what you learnt and being able to reproduce and integrate into a different situation - it's the ability to implement knowledge." (PRG2S3)

Generally there was some alignment among the students' views that learning is a process that culminates with understanding, where understanding is viewed as being at a deeper level of the mental processes involved in learning. Understanding involves the student's effort to "make sense" of what he/she has heard or read, seen or experimented with in class, or during self-study, and drawing personal conclusions. Based on this, it resembles closely to Vermunt's constructs of relating & structuring and critical processing associated with the deep processing strategy. Taking this thought further, one student pointed out that "learning becomes permanent when you understand the concept, if you haven't understood it, you haven't learnt" (Y3G2S5). When asked to clarify what he meant by "permanent", the student said he meant a long retention period - like how one never seems to forget how to ride a bicycle even after a long period of not riding one since learning it at a very young age.

When probed further as to whether the students strived to understand all the subject matter that they were studying by their own definition of *understanding*, the majority of the undergraduates admitted that they did not. One student put it this way: *"I agree that I didn't really try to understand so I didn't really learn - I threw it all back to the teacher during the exams and that's it!"* (Y3G2S1) By that, the student meant that she had written everything she knew during the last examination, passed it up, and did not try to remember all that she had taken in during her classes after that. However it was encouraging that not all students shared this view. There were at least 3 students who did seek understanding of the subject matter.

In the course of the interviews, an interesting discussion about the relationship between understanding and memorising arose from one of the Year 2 groups. The following were three views expressed by the students:

> *"Before the exam I just try to remember all the important things – but most of the time I try to understand – I understand as I memorise."* (Y2G1S2)
>
> *"I memorise then I understand."* (Y2G1S3)
>
> *"Understand before memorise, then I do past papers, but for some things I don't understand, I just try to memorise. If I don't understand then I'll ask my friends, if they also don't know then I'll just memorise it."* (Y2G1S5)

The first view by Y2G1S2 suggested that the student learnt by taking in information via memorising and simultaneously processed it into understanding. The second student (Y2G1S3) indicated that he took in information via memorising and subsequently processed it into understanding. The third student (Y2G1S5) preferred to understand the material she was learning first and subsequently committed the material into memory, however if she failed to gain understanding either by herself or through the help of others, she would still try to memorise the material. It may be concluded that some students held the view that memorising and understanding were not mutually exclusive, and thus learning to them may involve both understanding (deep processing) and memorising as part of the process.

In summary, the undergraduate students interviewed generally appeared to view learning from a pragmatic stand point, mainly to take in knowledge, pass their examinations and attain their diplomas so that they could find a job. This may sometimes hinder their willingness to explore deeper into understanding the subject matter they are required to learn. Among the undergraduates there were also students who reported a practice-oriented learning conception. The Professionals groups also took a pragmatic approach, but they largely appeared to be better able to reflect on their learning and sought to find application of the knowledge gained into their current work situations. It was interesting to observe that there were some students who viewed understanding and memorising as part of the process of learning.

4.2.2 Summary of Qualitative Results Associated with Vermunt's Four Domains of Learning

4.2.2.1 Domain I: Processing Strategies

Year 1 Students:

Two Year 1 students interviewed seemed to advocate the need for understanding as part of their processing strategy. Their views were captured here as follows:

> *"If you want to study a new thing, I think everyone has different ways of learning. I think the best way we should learn is by first understanding what the teacher says and why we learn this module. You can also research and learn more from the internet and work hard and pay attention."* (Y1G1S1)

> *"I'll start by reading text books and try to understand the lectures, and labs. I also go on-line to research to learn more. I also use trial-and-error for my projects, and when I make mistakes that's when I learn. I also try to explore more things to add on new things that the teacher did not teach us in school - especially going on-line - like Google."* (Y1G2S3)

Using the description of the term, *understand*, as discussed in the preceding section, it appears that these students show a preference for deep processing as part of their learning pattern. This preference was observed in the quantitative analysis where the Year 1 students had the highest mean scores for relating and structuring and critical processing among all the groups, with statistical significance found when compared to the Year 2 and Professional groups respectively.

Some Year 1 students showed preference for deep processing, but resorted to memorising and rehearsing when they encountered difficulties understanding new materials:

> *"When the teacher tells me a new formula, I try to understand it. But sometimes it is hard to understand but I can still memorise and I can still pass the exam."* (Y1G1S4)

> *"I try to understand, if I can't then I have to memorise it."* (Y1G1S3)

One of the students explained that, *"Time is a factor. If we had more time, then we can really understand and practice. But if we have no time, then we just memorise"* (Y1G2S4). This perception of a lack of time could be due to relatively heavy workloads carried by Engineering students compared to some other courses, but it could also be related to how much time the students were willing to set aside for their studies with respect to other interests.

The latter perspective may be inferred from one of the students who added that outside of his scheduled classes, he would rather spend more time on his interest in investments. He explained, *"I read the business section in the newspaper every day, and also read on-line on US business news – I think this is more interesting. I spend a lot of time reading and analysing company information – I'm thinking of investing in stocks in the* *future. I like to find out about the company's performance and performance trends and so on"* (Y1G2S3).

Year 2 Students:

Comparing processing strategies with Year 1 students, the quantitative data for Year 2 students indicated significantly lower scores for three out of five subscales in this domain: relating and structuring, memorising and rehearsing, and concrete processing. From the interviews, there was a sense that the Year 2 students were weaker in their use of processing strategies. It could be possible that they were seeking to put in just the minimum effort into their studies to meet the course requirements. One student put it this way:

> *"I will study those subjects that...seem easier - it's not because I am interested in the subject - but because they are easier and I can score (get good marks)" (Y2G2S4).*

This apparent drop in effort might be explained by the following students:

> *"It took one year for me to figure out the system." (Y2G1S2)*

> *"In Year 1 I was definitely more hardworking, but now I know how it works so I got more slack* (slang for being unmotivated or lazy)*." (Y2G2S3)*

It seemed that the students have not been appropriately challenged in their studies, and they could have found it less necessary, compared with Year 1 students, to use any particular processing strategy.

Year 3 Students:

Throughout the interviews with both the Year 3 groups, very much like for the Year 2 students, there was also a sense that the students had figured out the expectations for the course they were studying and doing only what was necessary to achieve their goals. The students put it across as follows:

> *"Year 1 for me...it's more like trying to understand, find meaning; then as time passed by, I find that others were just studying the 'study guide' provided by the teacher and they managed to get through so I just followed them – make my life easier, right? The outcome is the same so why study so hard?"* (Y3G2S1)

> *"I just memorise because the teacher says it's important - it's important for the exams."* (Y3G1S1)

> *"I just memorise the formulae and pluck in the numbers to get the answers required - just to score the marks. I don't bother to find out why, what's behind the formulae."* (Y3G1S2)

> *"To me, I see - like - if the thing is very important to memorise, then I memorise. Then if some is - like - formula given, right, then you just remember how to apply it. If the formula is not given, then you try to remember the formula and then you also try to practice... practice makes perfect... so you just practice more."* (Y3G1S4)

From these responses it appeared that the students, having perceived that the course they were studying did not demand much deep processing to do well, have resorted to mostly memorising the necessary content. These students seemed to have come to adopt the view that memorisation is the most efficient way to study and two students shared how they devised ways to enhance their learning. The following is an example:

> *"When I want to memorise something like...a lot of things to memorise, I will take some, like colourful markers and mark it. I know that colours help me memorise things. For subjects like RFE* (Radio Frequency Engineering)*, there's a lot of information, then I'll do tabulation and practice the tutorials more."* (Y3G2S2)

This preference for memorising as a processing strategy was also observed in the quantitative study presented earlier where the Year 3 students displayed a higher mean score for memorising and rehearsing compared to all other groups, with statistical significance over the Year 2 and Professional groups.

While some students sought various ways to improve their technique for memorisation with the aim to score well for their assessments, there appeared to be others who chose memorisation as the easier path over deep processing and did not have high achievement goals in mind, but intended to just pass the examinations. These students felt that interest in what one wants to learn is an important motivation for deep processing. One student put it this way: *"If my interest is there, then I will research further"* (Y3G1S3). However, from the interviews, it could be gathered that a number of students actually had little or no interest in Engineering to start with. As such, when they were probed further, three of their responses were as follows:

"I mean, I believe when we are on the MRT (Mass Rapid Transport) *or what, we can just Google on the iPhone to find out more things... I think it's more like we don't bother, right or not? Will I go and find out? No right? Actually it's more that we don't bother."* (Y3G1S1)

"I don't bother to find out why, what's behind the formula." (Y3G1S2)

"Even if you want to find out more about a concept, right, if you go to the internet and search, right, there's so much stuff there you don't even know where to start, and I don't have time to digest everything - so I don't bother anymore." (Y3G2S3)

When asked if they held the same attitude if they wanted to study subjects that were outside of Engineering, one of the students (Y3G1S1) said that his approach would be different and explained, *"I am interested in Forensic Science. Because it's my passion, I have an interest in it…so I bother…so like I every time I watch CSI* (referring to the television series, Crime Scene Investigation)*, then - like - if there are things that I don't understand, then I go and search it up. I'll read up about Bio stuff* (things related to Biology)*, also on the internet."*

Not all the Year 3 students, however, shared the same views. There were students who differed in their reflection on their own processing strategies. To them understanding a concept was an important part of their strategy:

"In my first year, I just memorised, but as time went by I realised that it is easier to understand things first then I can store it in my brain. I try to read and match concepts together and it becomes easier for me to understand the whole thing - join everything together then I get the bigger picture." (Y3G2S4)

"The Wireless Communications module is theory-based – I try to understand - once we have understanding then no need to memorise, or less dependent on memorising." (Y3G1S5)

This seemed to support the quantitative data which showed that Year 3 students scored significantly higher than Year 2 students on the relating and structuring construct in the deep processing domain, almost as high as the Year 1 students.

Some Year 3 students interviewed also showed a preference for analysing as a stepwise processing approach, that is, they were inclined to study topics in detail but not connecting the topics into a larger concept. One student put it this way:

"When I come across a new formula, I use that to understand the topic... I pluck in some numbers to see how it works, see how it can be applied - that's how I work through the topics." (Y3G2S1)

This student seemed to be analysing each formula in relation to a particular topic, and he worked through each topic in this manner one at a time. He did not attempt to connect each discrete topic with other topics, or build the topics into a larger concept. This behaviour could also be due to the fact that the Engineering course is delivered in a modular manner and once a module is completed in a semester and assessed, the students sometimes forgot what was learnt. So when they progressed into the next semester and studied a new module, they do not attempt to connect new modules to previous modules even if the modules were related. One student described his experience as follows:

> *"In Year 2, the lecturers tried to link back to what I've studied in Year 1 - for some parts. But now I am in Year 3, I've forgotten what I learnt in Year 1...so I don't bother to link any more, I just study module by module to pass."* (Y3G2S2)

Their responses appeared to augur well with the finding from the quantitative data which showed Year 3 students showing significantly higher preference for analysing under the stepwise processing compared to Year 2 and the Professionals groups.

<u>Professionals Group:</u>

The interviews with the Professionals groups revealed that concrete processing was the most preferred processing strategy for them where they sought to relate content presented to their own experiences, to apply the knowledge gained in their work, or to prepare themselves for a change of job. Their views were captured as follows:

> *"Now I approach learning differently - now I already have some background, I have an overall view, so when they are teaching I can relate back to my work and process, and when I am doing my project it is much easier for me - I know where to find information."* (PRG2S4)

"I want to study this because I want to expand into something new, different from my current background." (PRG1S3).

This supported the findings from the quantitative study as well where the score for concrete processing was the highest among all the undergraduate groups. The quantitative study also revealed that the Professionals did not score highly for deep processing strategies. This result was not expected as it was thought that the Professionals would be more matured as life-long learners and would use more relating and structuring, and critical processing strategies. Perhaps the students' reflections on their own learning shared at the interviews could throw some light:

"There is a real time-constraint - I need to cover the syllabus to pass the exams so I just memorise whatever is needed; but there are parts of the course which I find are very relevant, very important to my work - that's when I really try to focus and understand." (PRG1S4)

"For me, if I think something is important, I will focus on it - I'm selective. Those that I think are not important or cannot understand, I just put it aside. I rely on the lecturers to tell us what is important - there's no time to learn everything. We are part-time students, so we don't have time - so I need to be selective and focussed." (PRG1S2)

"For me, what I'm studying is not directly related to my work - those things which I find not interesting I just study to meet the requirements. For those parts which I find interesting I will read further

- I will use Google and look for more information, and ask my lecturers for help." (PRG1S4)

"I just want to fulfil the requirements of the course, that's all I'm concerned - I don't really try to understand [the material]" (PRG1S1)

"*I just force feed it - if it is a core subject - must study. What to do?"* (PRG2S2)

It appeared that the key limiting factor was time for these working adults who had to balance their studies with their job demands, and family needs. So while they would like to study to deepen their understanding and enhance their competencies, time availability and other constraints restrict their learning to selected topics of relevance or of interest to them. There was one student, who took a particular module very seriously, shared her view as follows: *"For me, I try to understand everything, I sleep at 2-3 am every night, I want to understand totally. If I can't understand from one lecturer, I often go find another lecturer to seek a different perspective. I will try to find a way to learn"* (PRG1S5). In contrast, when the Professional students were required to study subject matter that were not related to their area of interest, they would approach it in the most time-efficient manner, and rather superficially, to meet the course requirements to pass.

4.2.2.2 Domain II: Regulation Strategies

Year 1

Year 1 students seemed to utilise a combination of both self-regulation of learning content, which is a preference to consult literature and sources outside the syllabus covered, and external regulation of learning results, which is a preference to test one's learning results by external means such as tutorials, assignments and projects. The following were some comments captured from the interviews of Year 1 students:

> *"I'll start by reading text books and try to understand the lectures, and labs (laboratory sessions). I also go on-line to research, to learn more. I also use trial-and-error for my projects, and when I make mistakes that's when I learn. I also try to explore more things, to add on new things, that the teacher did not teach us in school – especially [by] going on-line - Google."* (Y1G2S3)

> *"Depends on the module – some modules you cannot just practice, for example for programming you have to find out, because not everything is in the book so you have to go to Google and search for those parts that are not in the book. For others if you can practice then practice. I am bad at memorising – I just practice until I, like, understand – as I solve problems I slowly get to understand the concepts better."* (Y1G1S1)

"In secondary school most of it you need to know the concept, just understanding. Here you have a lot to do – it's not just understanding the concepts but you have to keep practicing. In Sec school we were all very dependent on the teachers, just read up your textbooks and that's it – I won't go further in my studies – I won't go online to search for more information, but here I need to read up more, be more independent, you can't depend only on your lecturers – those are my personal expectations" (Y1G2S4)

This finding seemed to support the results from the quantitative analysis where Year 1 students showed significantly higher preferences for self-regulation of learning content (above all groups) and external regulation of learning results (all except the Year 3 group where the Year 1 mean score was higher, but not significantly higher statistically). Further to this, it was also found that the mean for external regulation of learning results was higher than that of self-regulation of learning content. This again was supported by what was captured at the interviews where a dependence on the lecturers to provide the direction for learning, and practicing with tutorial questions and assignments or projects given by the lecturers was an important means for students to gauge their own learning. The following were some of the comments captured:

"They (lecturers) will guide us with the basic knowledge, but when we practice at home on our own then we will know how to approach a problem for ourselves. Of course we start with what the teacher has told us, but we improve on it, we build up from the basics." (Y1G1S4)

"We learn more from doing tutorials, and learnt Karnaugh Maps (a technique used to simplify Boolean expressions in the analysis of digital logic circuit design) which simplified things and then I practiced using his method." (Y1G1S2)

"Whatever is taught in class I just pay attention and copy down – then when exams are approaching I just open my tutorial sheets and try to get the answers." (Y1G2S5)

"I do tutorials and do the worksheets. I learn from doing tutorials. Lectures sometimes I don't really understand and I miss a lot of stuff - sometimes I never absorb – just stoning, and sometimes I'm absent for 1 or 2 sessions - I miss the basic concepts so I ask around and learn from the tutorials." (Y1G2S1)

"When it involves calculations, or programming – I have to practice – keep doing the questions over and over again – just know how to solve problems." (Y1G2S3)

"Now I start earlier to prepare for my exams. I have to think more, I do more questions, compare different methods to solve problems." (Y1G2S6)

"If let's say, for Math, if the teacher shows us a way to solve a problem, we try new ways to solve, but if we find that our solution is

harder than we take the teacher's way. So of course we will take the easier way because it is easier to understand." (Y1G1S2)

These students seemed to be focussed on practicing and finding the most optimal way to solve problems posed by their lecturers with the view that doing so would help them grasp the concepts taught and ultimately enable them to do well in the examinations.

<u>Year 2</u>

The interviews with the Year 2 groups revealed that they relied more on external regulation of both the learning processes and learning results rather than using self-regulation strategies. Four of their views were recorded as follows:

"When I attend lectures I just hear what the lecturer says, and take down notes - listen for what he says is important and take it down." (Y2G1S3)

"No, we just rely on what the teacher gives us - unless we really need [to look for other sources]." (Y2G1S1)

"I listen to the teacher and mark my lecture notes with stars where he said was important." (Y2G1S3)

"No, I don't really read further than what is provided - no need to if that is not coming out for the exams right?" (Y2G1S4)

This finding was in contrast with the Year 1 students where there was more enthusiasm to seek additional material from other sources to enhance their own understanding of the subject matter. Year 2 students relied more on external regulation of learning processes where they expected their lecturers to define what they needed to know - "mark my lecture notes with stars" - and this is usually related to what was important for the examinations.

With respect to the external regulation of learning results construct, the Year 2 students were quite similar to the Year 1 students in that they also viewed practicing on problems posed by the lecturers as an important part of their learning strategy. Some of their comments included:

> *"I learn from doing things (tutorial questions) over and over again until I get it right, and also ask around for help."* (Y2G1S4)

> *"I learn from practice – mostly labs, tutorials and past exam papers."* (Y2G1S5)

> *"For me, I try to understand the logic of it all by trying out the questions - learn from mistakes - until I like get it."* (Y2G2S4)

> *"When I get stuck, I see other people's solutions and try to understand and then I try out by myself again until I can get the answers."* (Y2G2S1)

It seemed that getting the answers to the problems posed by the lecturers was their way of testing their understanding of the subject matter, and when they could do the questions correctly, they considered themselves as having learned the subject. The implication is that the scope of knowledge to be acquired for a particular module is defined completely by the lecturer, and the students observed these as the extent of knowledge that they needed to acquire for the course and do not venture any further. The scope of the examinations were also well defined within these boundaries and over time, students seemed to have "figured out the system" as discussed in the section on processing strategies.

Year 3

The results from the quantitative data for the regulation strategies domain showed that Year 3 students had high scores for both self-regulation of learning processes and results, and external regulation of learning processes. These two constructs seemed to be opposite in nature, for one would not expect that a student could be self-regulated and externally regulated at the same time through his/her learning process. However, the following comment from one of the students might throw some light from the student's view point:

> *"Teacher – definitely important – but don’t expect teacher to tell you [everything]. Teacher is a resource person rather than information provider. Of course the teacher must be able to put forward the main knowledge, to make sure we understand, find different ways to help us understand, and must come down to our way of learning, and to facilitate understanding."* (Y3G1S2)

In other words, the student was implying that a teacher is necessary to bring across key concepts and facilitate understanding, and thus framing the knowledge to be acquired (external regulation). However, the teacher is not expected to provide all there is to know about a particular subject in class ("don't expect teacher to tell you everything") and a certain degree of self-regulation in the learning process is expected from the students.

This was an interesting observation of the Year 3 students' learning process that emerged from the interviews. The students spoke of the need to first accept the concepts taught by the lecturers and then proceed to learn on their own:

> *"The first thing that you got to convince yourself is - you got to accept the fact that this is the concept of 'stability circle' (a characteristic of an amplifier that needs to be considered when designing one). Then after that, you can process it, and try the tutorials."* (Y3G2S3)

> *"Ya, we need to accept that long time ago someone discovered the concept of 'stability circles', so we just accept it and use the concept."* (Y3G2S4)

> *"I listen to what the lecturer says, and define the problem, then I decide how to go about learning."* (Y3G1S5)

The students did not seem to see the need to explore deeper, as implied in the above discussion on amplifier design techniques, and were ready to accept the concept put across by the lecturer. One student explained it this way:

> *"Even if you want to find out the formula for the stability circles, right, if you go to internet and search, right, there will be a chunk of formula,*

so you also don't know where to start to derive the formula. So we just accept it." (Y3G2S1)

Once they accepted the concepts that were new to them, the students seemed to feel that they could carry on the learning process in a self-regulated way. Indication of this could be derived from what the following students said:

"I take this module called 'RF Simulation' - so after learning the theory of amplifier design using stability circles, we use the programme - the simulation software to try out different settings on our own to see what happens - test the idea, the concept - then we get a better understanding." (Y3G2S1)

"I read through the lecture notes and try to make my own notes - the main points. Then I practice the tutorials. Sometimes I try to think of my own questions and try to answer them - check my own understanding." (Y3G1S5)

<u>Professionals</u>

The Professionals groups that were interviewed appeared to have a mix of those who preferred self-regulated strategies, and those who preferred more external regulation in their learning process. For those who preferred self-regulation, they commented as follows:

"Now I am more self regulated, more independent learning – it comes with maturity, I guess. You know how to think, you know how to study, you know the value of the certificate, and money-wise it matters too." (PRG1S1)

"We need to do our own reading – doing projects requires us to dig deeper into journals, and other sources – frankly I learn more from reading the journals and my own research for the projects than from the lecturers." (PRG2S1)

"I learn more from assignments, not in preparing for exams. I usually like to Google to find answers and find out more about things." (PRG1S2)

"Here you write essays, you need to research on line to produce a good piece of work, you will gain knowledge by reading a lot." (PRG1S3)

Other students were more reliant on external regulation to guide their learning process. Their comments included:

"Teacher is always the medium to pass the knowledge, and make it interesting, and make students like the subject." (PRG1S4)

"Importance of the one who delivers – if I like him/her, it helps my interest and I can score better." (PRG1S5)

"If delivered in the right way, it's easier for us to understand, then I don't need to put in too much effort." (PRG2S2)

Along with the perception that the lecturer was instrumental in the delivery of the course contents and stimulating interest in the students, a number of students were also ready to adapt their learning to produce outcomes that aligned with the expectations of their lecturers with the aim to maximise their scores. Some comments from these students included:

> *"We learn from experience, [if the] first time we don't get it right, second time we try to understand and do it the lecturer's way."* (PRG1S5)
>
> *"Sometimes we don't know what they (the lecturers) want - what is the aim. We are afraid to approach the project assigned to us. It would help if they (the lecturers) could tell us which direction to go - we need to our align views, so that we can give them what they want."* (PRG2S2)
>
> *"I always try to optimise for the best results, so I will change my approach to get the maximum score."* (PRG2S4)
>
> *"I try to figure out what the lecturer wants us to understand, thinking maybe they want to test us to see if we can combine and link up the theories from various chapters into one."* (PRG2S5)

These views seemed to indicate that the students adopted a more strategic approach in their studies to increase their efficiency because time is a major limitation. One student put it this way: *"I studied more in my Poly days – I had more time to go deep so I learned more things there. Now I am working and my time is restricted and I have more obligations. I have to use the least time to study the most things so the lecturer is important. And the* *resources provided by the lecturer is important, and also they can point us to the most reliable sources."* (PRG2S3)

4.2.2.3 Domain III: Learning Orientations

<u>Year 1</u>

A few of the Year 1 students interviewed were positive toward their studies and shared that they had embarked on the Engineering course out of interest. Some of their comments were captured as follows:

> *"I am a student from China. I was only offered three choices when I applied for my study here. Since I had some knowledge in programming in China, I chose a course that had programming. There are also so many other modules [in this course] that I have interest in. I think this course can help me do many things in the future so I chose this course."* (Y1G1S1)
>
> *"I prefer Engineering compared to other things so I chose Engineering as my first choice. I didn't like Business, Life Science is out too. I like the hands-on stuff - the practical side of things."* (Y1G1S3)

However, the interviews also surfaced the fact that many others, including those who were not interviewed, did not choose the Electronics Engineering course as their first choice. It was also understood from the interviews that many of those who did apply for the Electronics course as their first choice did so because they knew they could not qualify for other courses that they had real interest in. Others were offered the course when they failed to meet the cut-off points in the courses they had selected based on the GCE Ordinary Level results. When probed further to find out if this has impacted their interest in their studies, a number of them said that they were initially disappointed and apprehensive, but later found that having embarked on the course, they could appreciate it better and have adopted a more positive attitude toward their studies. These students responded as follows:

> *"I didn't chose Engineering as my first choice - I was offered this course so I tried my best to study hard. After two semesters I found that I can cope quite well. It is actually not too difficult to study, so long as you can cope - it has a lot of projects and hands-on things. I think it is easier than those courses which you have to mug (a slang for studying hard) and study every day - for me I think I am more relaxed than those Business students."* (Y1G2S2)

> *"I applied for Biomedical Science but I could not get it because my points (GCE 'O' Level grades) were not enough so I was offered DECC. So far I am happy with the course."* (Y1G1S2)

> *"I wanted to join a Business course, but my grades were not good enough so I had no choice but to put Engineering as one of my choices. But I see now that Engineering has a wide scope. I think if you do an Engineering course here in Singapore, then it would be easier to go into a Business degree course overseas later. It is a stepping stone for my future. I believe Engineering and Business can*

go well together - because people nowadays want [technical] skill - so if you have skill and know how to manage stuff that would be a bonus." (Y1G2S3)

"I think I'll continue my studies in Engineering because I see that engineers can eventually become managers - as a manager, people want you to have a background in Engineering. It's the training - the analytical skills that I can gain." (Y1G2S4)

The enthusiasm of those who chose the Electronics course as their first choice, and the generally positive view of the course of those who did not indicate it as their first choice, appears to have influenced the quantitative findings where the Year 1 students showed a significantly higher score for the personally interested subscale compared to all other groups. This was an interesting observation because one might expect that personal interest should increase over time as the students became more knowledgeable in their field of study, and especially for the Professionals since they chose to return for a higher qualification. This will be discussed further along the way.

Another point that surfaced from the interviews was the aspiration of the students. Other than working in the Engineering field upon graduation, many of them saw the Diploma as a "stepping stone" to further their studies in Engineering or other fields. Some of their comments were captured as follows:

"I want to further my studies in Engineering in a university - and hope to find a career in Engineering." (Y1G2S2)

"I think I won't further my studies in Engineering - I'll do something I'm really interested in, if I can, and find a career that is in line with my interest which is Tourism - so I want to use this Diploma as a stepping stone." (Y1G2S5)

These motives could have influenced the moderately high scores in the quantitative analysis for the certificate directed and vocation directed subscales though not significantly higher.

Year 2

Like in the Year 1 interview groups, a number of the Year 2 students either applied for the Electronics Engineering course as their first choice, or were offered the course, because their GCE 'O' Level results did not qualify them for entry into the courses that they wanted. Responses from the students include:

"My O-Level results were not good and I didn't know what to choose so I just tried and got this - it was my first choice." (Y2G1S4)

"Yes, I chose DECC, but I chose realistically based on my results, rather than real interest." (Y2G2S5)

"I had no choice. I tried Food Science and Sports and Wellness, but my aggregate was not good enough so I was offered this." (Y2G1S1)

One student was influenced by her parents to pursue the DECC. Her response as follows:

> *"I was interested in the Media side - like film or mass comms, but my parents said that the future was not there, and my sister was in this (DECC) course also, so they were saying just stick to this course - and the future is more guaranteed."* (Y2G2S2)

From the interviews, the majority of these students who did not consider the Electronics course as their first choice did not plan to proceed on to further their studies in the Electronic Engineering field, and would not embark on a career in the Electronics as one student remarked: *"Don't think so. I hope to score well for my GPA and go on to a uni* (university) *and do Media Studies."* (Y2G2S2). Other students indicated aspirations to move into the beauty industry, sports and professional ballet. Still others did not know what they wanted to do when they finished their course.

Overall there was a sense that the Year 2 students were less enthusiastic and less sure of their future direction compared to the Year 1 students. As previously mentioned, the Year 2 students indicated that they had "figured out" the system and have become "more slack" than when they were in Year 1. One student added that she did not really like the subjects in Year 2 *"so I started to lose interest in studying - just study only when exams are coming. Not much motivation"* (Y2G2S4). Another student supported that and added that *"I don't have any subjects that I am really interested in - I just whack* (slang for doing something using brute force) *and get it over and done with"* (Y2G2S5).

These perceptions were likely to have been revealed in their significantly lower score for Interest when compared with Year 1 students, and higher score for ambivalent as a learning orientation across all groups, with significant differences when compared to Year 1 and the Professional groups. When probed further during the interviews, this lower motivation from personal interest and greater sense of ambivalence appeared to be moderated to a certain extent by a fear of failure:

> *"I am afraid to fail any subjects because I need to retake the module - then I'll be in different classes from my friends in the next semester - it is very miserable...so avoiding failure is itself a motivation!"* (Y2G2S5)
>
> *For me, I was slack in Year 1 but now I work harder - the modules now are harder so I have to put in more effort so that I won't fail."* (Y2G1S4)

Interestingly, this concept of motivation by the fear of failure was not included explicitly anywhere in Vermunt's (1998) ILS.

Year 3

In the course of the interviews with the Year 3 students, it was apparent that the students were more focussed in their study goals compared to the Year 2 students which, understandably, was to complete their course and get their Diplomas. Some of their comments were recorded as follows:

> *"Ok, put in a blunt way, we Poly students come to the Poly to study, to get the certificate, the...you know, the diploma, so whatever extra things…we just come to a point in time we just don't bother to know. If there is no need for it...like it's not coming out for the exams...people won't bother to find out more."* (Y3G1S2)

"Ya, I don't really think we will remember any of these when we actually go out to work – so it's studying because we have to – just to get the diploma." (Y3G1S5)

"For me, I just want to get through the tests, exams, and get the cert." (Y3G1S4)

"The common test and exam papers are quite similar to past year papers – so I try the past year papers, and if I understand and can do the past year papers then I can score well – that's how I learn – aim to score well, don't get to go deep." (Y3G2S1)

"The system is a credit modular system – so for some modules, what we study will not be used in other modules. If you study and don't apply you eventually forget – so in conclusion we only study for the sake of exams." (Y3G2S3)

"Yup, right now in Poly, it's more like module credit system. Your optimum goal is to score as high as possible." (Y3G2S4)

This motive to attain the Diploma came across most strongly for the Year 3 students compared to all the other groups interviewed. However, in the quantitative analysis their score was not significantly higher for the Certificate Directed subscale compared to the other groups except for the Professionals group.

A second study motive that came through in the interviews was the need to prepare for the future after their graduation - either for further studies or for their vocation. Some of their comments were:

> *"Now I am more efficient - it's a big difference from previous years - now I want to learn, to absorb as much as possible to prepare for my future job."* (Y3G2S4)

> *"Once you have an aim in life, you will change. In the past, I didn't know what I want - but now I want to go to the university [after my Diploma]."* (Y3G2S5)

> *"When I was in the first year I found things to be easy and I didn't try to connect [what I studied] to my future job. Now in my third year I am learning more things and found that they could be applied to my future job, so my aim changed. Now I know I must learn all this to help me in my future."* (Y3G2S1)

> *"I study for personal benefit - I know I am not studying just to compete with the students here. My family is not wealthy so I know it's time for me to start working hard, get a good job."* (Y3G2S2)

Again there appeared to be no significant differences in the quantitative data between the Year 3 students' scores on Vocation compared to the Year 1 and Year 2 students. However, from the interviews, there was a notable sense that the Year 3 students were more intrinsically motivated as can be seen in the comments above where they spoke of a change in aim for their studies and have become more purposeful.

Professionals

The Professionals groups interviewed shared several common reasons for returning for continuing education after working for some time in the industry. Most of them have at least an Electronics Engineering Diploma, and others have Electronics Engineering Degrees. These students were sponsored by their current employers to attend these part-time courses to upgrade their knowledge and skills in specific areas to enhance their ability to perform their current jobs better. Some students have Engineering degrees but from other fields. These were seeking to attain professional certification so as to make a career switch into a specific area of work.

With the above understanding of their backgrounds, it was not surprising that for the Professionals group, their study motives were strongly vocation directed. Some of their comments were recorded as follows:

> *"I'm very clear what I'm doing here – but there is a time constraint – I need to cover the syllabus to pass the exams so I just memorise whatever is needed; but there are parts of the course which I find are very relevant, very important to my work, that's when I really try to focus and understand."* (PRG1S4)
>
> *"I want to study this [course] because I want to expand into something new, different from my current background."* (PRG1S3)

"Oh I think you must remain competitive, there are now so many diploma holders out there, so you have to be different, you need to constantly upgrade yourself." (PRG1S1)

This strong motivation has clearly influenced their score for Vocation Directed in the quantitative analysis which was significantly higher than all the other groups. This could also explain their significantly lower score for ambivalence among all the other groups as they had embarked on their respective formal certification courses with very clear motives.

Interestingly, the Professionals group also scored significantly lower for certificate directed compared to the Year 1 and Year 3 students. Perhaps what this student shared could throw some light on this:

"Of course getting the cert (certificate) is important, but I would still study this course even if there was no cert for those subjects that are directly related to my work - the vocation part, how it helps my work, is more important than the certificate itself" (PRG2S5).

So unlike the undergraduates in the Polytechnic who do not hold any formal qualifications yet, some of the Professionals, seemed to value the training in their specific competencies more than the paper qualifications they would get at the end of the course.

4.2.2.4 Domain IV: Mental Models of Learning (or Conceptions of Learning)

Among the five sub-scales, intake of knowledge was the most common conception of learning across all groups interviewed. This meant that generally students adopted the view that the lecturer had to define clearly what was important to know, especially with respect to the examinations, and the students' role was to make sure that they could carry out the assigned tasks required in the course and reproduce the information. Some of the common comments were as follows:

> *"Oh, for me, at the lectures, I just hear what the lecturer says, take down notes, listen for what he says is important and take it down."* (Y2G2S4)

> *"I find Poly exams are easier to pass because you just need to attend the last few lectures before the exams and the lecturers will give you the things you need to know - so you just study those things."* (Y2G2S5)

> *"Whatever is taught in class I just pay attention and copy down - then when the exams are approaching I just open my tutorial sheets and practice till I can get the answers."* (Y1G2S5)

> *"I just memorise because teacher says it's important - it's coming out in the exams."* (Y3G1S1)

"Ya...I study and throw it back to the lecturer at the end of it." (Y3G1S3)

This augurs well with the quantitative analysis where this sub-scale showed moderately high mean scores across all groups and no significant differences were found between groups. For other subscales, there were some differences found and these will be presented in the following sections.

Year 1

While intake of knowledge was a common conception of learning, the Year 1 students interviewed appeared to also see learning as requiring individuals to explore further, to try new approaches to solve problems, and build new knowledge on their own. The following could give some insight into this:

"Sometimes the teacher shows us a way to solve a problem, then I will try new ways to solve it." (Y1G1S1)

"In the past we try to learn from teacher, textbooks, but here at the higher level we have to also learn by ourselves, by reading, searching the internet to get more information." (Y1G1S2)

"I'll start by reading text books and try to understand the lectures, and labs. I also go on-line to research, to learn more... to explore more things, to add on new things that that the teacher did not teach us in school." (Y1G2S3)

This conception of learning seemed to be strong among the Year 1 students and was reflected in their significantly higher scores for the construction of knowledge subscale in the ILS compared to Year 2 and Year 3 students.

As Year 1 students, the majority of students would be encountering subjects that they may not be familiar with because their knowledge base at this stage of their education would have only be been at the Secondary school level for local students, or its equivalent if they were from other countries. As such, students expected more guidance and support from their lecturers. One student put it this way:

> *"We need to learn from lecturers because they have more experience, more knowledge than us – both a guide and source of information. They will guide us with the basic knowledge, but when we practice on problems at home, then we will know how to approach a problem for ourselves. Of course we start with what the lecturer has told us, but we improve on it, we build up from the basics."* (Y1G1S4)

This conception of learning seemed to have been reflected in the significantly higher scores for stimulating education for Year 1 students compared with Year 2 and Year 3.

<u>Year 2</u>

The Year 2 groups that were interviewed showed to be relatively less clear about their conception of learning compared to the Year 1 students.

This could have been influenced by their general sense of ambivalence as noted in the previous section. One student put it across as follows:

> *"Now I'm not so sure any more - I don't know where to get information, it's less structured - it's like - the lecturers expect us to be more independent and all that - but I feel super lost - so I have no motivation!"* (Y2G2S3).

Another student added, *"Yeah, I was slack* (slang for being unmotivated or lazy) *before and still slack now - I just want to get out of here quickly!"* (Y2G2S4)

Going back to the quantitative analysis, the Year 2 students did not score significantly higher in any of the subscales.

Year 3

Among the Year 3 students interviewed, the common attitudes towards learning adopted by the students were to "just get through the tests, exams, and get the diploma"; to "gain new knowledge, go out to society, get a job and earn money"; and they valued learning with fellow students to help them along the way. In fact, Year 3 students scored significantly higher for cooperative learning among all the groups. The following comments were gathered from the students:

> *"Depends on your environment, depends on the people around you also - when your friends go for it, then you also go for it. When they slack, you also slack."* (Y3G2S5)

"My results in the first sem (semester) *was quite bad - I was disappointed - but with my friends' influence I learnt how to study - we did past year papers, practiced, studied more examples together."* (Y3G2S4)

"Sometimes when I missed a lecture, my friends will explain to me - I try to read the textbook, but I prefer to find my friends - it's faster!" (Y3G1S4)

"When I need to do a design for my project, I seek help from friends, even from other schools - I talk to them, I look at other people's designs and find out more." (Y3G1S6)

"In a lecture it's very difficult for interaction so it's hard to ask questions. In the tutorials the tutor is rushing to complete going through the tutorial sheets - I also forget the questions I wanted to ask during the lecture. Then after the class you need to go and look for the lecturer in his room - no one will bother - I'd rather just discuss with my friends." (Y3G2S2)

These comments suggested that peer pressure could be a positive motivator, but having friends with lower motivation towards their studies could be a setback. There was also a sense that convenience had a part to play where discussing areas of doubt among friends who were always close by, was a more convenient option than to go out of the way to look for a lecturer. However, there could be an underlying fear felt by the students of revealing their ignorance to their lecturers, whereas friends may be more forgiving and ready to help.

Professionals

The Professionals groups that were interviewed were much less favourable towards collaborative learning in comparison to the Year 3 students. In fact they showed significantly lower scores for the subscale among all the other groups. This could stem from the fact that these were part-time students who work during the day and come for classes only in the evenings thus leaving relatively less time for interaction among classmates. The Professionals were also more matured and independent as individuals who were motivated by their own goals rather than being dependent on peers to support their learning:

> *"Poly days were fun - but there was peer pressure, and when everyone was studying I was motivated as well. Now I am concerned more with the monetary aspects - I am paying for this course myself because I want to upgrade myself - so it will be more painful if I fail - so I motivate myself to study harder, to be more serious"* (PRG1S3).

> *"Now I am more self-regulated, [I do] more independent learning – it comes with maturity, I guess. You know how to think, you know how to study, you know the value of the certificate, and money-wise it matters too."* (PRG1S1).

Having a clearer focus on what they want to gain through their course, the professionals were understandably more keen to concretise and apply their knowledge. Some of their comments were captured as follows:

> *"Attending this course is helping me in my work - basically now I know what I don't know, and it enhances my confidence to do my work better!"* (PRG2S3)

> *"Oh it's different for me now - as you grow older, your mentality changes, you get more serious - and I tell myself, "No fail!" - I have to pass every module and progress smoothly, I don't want to stay for additional semesters - I want to meet the requirements and graduate as soon as possible - this is for future advancement."* (PRG1S1)

> *"I'm very clear where I want to focus - my time is limited, and sometimes I need to travel for work - those parts of the course which are relevant to my work, I really try to focus and understand well; for other parts which are just needed to cover the syllabus, I just memorise for the sake of passing the exams."* (PRG1S3)

This conception of learning for the sake of applying their knowledge in their work or a career switch came across strongly in their scores for use of knowledge in the ILS where they scored significantly above all the other groups, and augers well with their significantly high score for vocation directed as a study motive.

4.2.2.5 Learning Patterns for Lifelong Learning Reported by Professionals

The Professionals were asked specifically to reflect on themselves as working adults who have returned for continuing education, and then to discuss what learning patterns they thought would be useful for lifelong learning. Eight students reported that they thought either one or both the meaning directed and application directed patterns were the most suitable. This supported Vermunt's (2007) findings.

Students who advocated the meaning directed pattern explained that this was the "most suitable for any learning situation" (PRG1S3) because it is important that learners should understand concepts deeply thus forming a strong foundation upon which they could build their knowledge. One student put it this way:

> *"...students should be trained to use [the] meaning directed [pattern] - get a more solid base - if that is shaky, they can't build on it in the future when they go out to work!"* (PRG2S4).

To encourage learners to adopt a meaning directed pattern, one student suggested that it was important to stimulate interest in the topic to be learned which would then encourage them to *"put in more effort and time, be engaged in their learning, and enrich themselves - for the sake of a better future!"* (PRG2S1).

With regards to the Application Directed learning pattern, one student proposed that this was an important pattern to foster in undergraduate students because it would help "stir their interest, then [eventually] they will become meaning directed". The Professionals argued that it was their strong motives for undertaking further studies to enhance their knowledge and competency in their respective job areas that influenced them to be more application directed because "we know what we want to learn and why - we are more targeted". Some other students indicated the need to have a blend of both meaning directed and application directed patterns to balance deep theoretical understanding and practical application of knowledge.

An interesting suggestion that arose from the qualitative study was a process to encourage undirected learners to become meaning directed. The student proposed that undirected learners could first be taught to become reproduction directed learners when, at least, they would be more actively engaged in learning. Then if these learners could find an area of interest in what they were learning, they could become meaning directed, *"and that's what will keep them going!"* (PRG1S4)

CHAPTER 5: DISCUSSIONS ON RESEARCH QUESTIONS

Chapter 4 has reported in detail the data from both the quantitative and qualitative studies for the subscales and learning domains. The following chapter shall further merge the data into the learning patterns obtained by the principal component analysis and answer the research questions that were set out in Chapter 2.

(i) *What learning patterns do Engineering students within the context of a Polytechnic in Singapore prefer to employ? What, if any, do these students think were the factors that influenced their patterns?*

To answer this question, I shall discuss the various learning patterns observed from the respective factor analyses for each undergraduate group. Results from the quantitative and qualitative studies will be brought together to provide a more in-depth understanding of these patterns observed.

Year 1

The results of the factor analysis for Year 1 students (Table 4.18) were rather similar to what was observed by Ajisuksmo & Vermunt (1999) as described in the literature review in Chapter 2 (Table 2.6). There were some distinct variations in the underlying factor structures - dissonant patterns, when compared with the original results that Vermunt (1998) obtained in his investigation (Table 2.4). The Dutch studies showed that four factors were each defined by loadings of at least three learning domains, indicating clear associations between the learning strategies students used and their learning conceptions and orientations. These factors were identified by Vermunt

(1998) as Meaning Directed, Reproduction Directed, Application Directed and Undirected learning patterns. For the Year 1 students in this study, the four learning patterns that were identified included: *Flexible*, *Prove-yourself Directed*, *Reproduction Directed* and *Undirected*. The first two were dissonant patterns that were quite distinct.

The Flexible learning pattern reported by the Year 1 students was characterised by the combination of deep and stepwise processing strategies, and a mix of both self- and external regulation (Table 4.18). The qualitative data suggested that these student adapted their learning strategies to meet the demands of the context that they encountered. For instance, some students reported that they preferred deep processing strategies, and sought to understand their course material well. However, they would readily to switch to memorising, which was a more stepwise (surface) approach, if they encountered difficulties understanding the material they need to learn (Section 4.2.2.1). A perceived lack of time was a key factor, and this could be the result of a heavy workload typically expected to be carried by Engineering students (Section 4.2.2.1). This supported what Entwistle, McCune & Hounsell (2003) reported where constraints like heavy workload were linked to surface approaches to learning. In other words, if these students were not under the pressure of time or a heavy workload, they would prefer to go deep in their learning, researching and accessing other related materials beyond what is provided in the course to help their understanding. However, this study also found that for some students, this perceived lack of time could be related to the amount of time the students were willing to set aside for their studies with respect to their other interests outside of their course (Section 4.2.2.1). These students seemed to be willing to use deep processing strategies to grasp subjects that they wanted to learn so long as they had an interest in them.

Year 1 students who were Flexible learners also utilised a combination of self-regulation and external regulation strategies. The qualitative data suggested that these students perceived the need to be more independent, compared with their time in Secondary School, as they embarked on their course at the Polytechnic (Section 4.2.2.2). This involved putting in extra effort, such as accessing relevant materials beyond what was taught in class, to enhance their understanding. Year 1 students reported the highest mean among all groups in this study for self-regulation of learning content (Table 4.5). However, the students also reported that their lecturers played an important role in their learning process, and expected their lecturers to provide adequate tutorial questions and problems for their practice. Knowing how to solve these tutorial questions and problems seemed essential to the students because they perceived that doing so would help them define the scope of knowledge required of them and would be relevant to the examinations at the end of the course (Section 4.2.2.2).

The second factor for the Year 1 group comprised only loadings from the Learning Orientations and Mental Models of Learning domains (Table 4.18). Again a similar learning pattern was observed by Ajisuksmo & Vermunt (1999) in their Indonesian study and they called it a "passive-idealistic" (p. 53) learning pattern (Table 2.4). Vermunt & Minnaert (2003) observed a similar dissonant factor in their study in the Netherlands that failed to "exhibit integration with aspects of learning strategies" (p. 55) and they called it a "belief factor". Both studies found a factor that had four to five scales from the Mental Models of Learning dimension loading moderately to highly on it, together with one or two scales from the Learning Orientations dimension. The labels of "passive-idealistic" and "belief factor" were suitable for the learning pattern observed in these earlier studies. However, on closer examination of the results for Year 1 students, a different factor structure was found. The current data (Table 2.4) showed three scales from the Learning Orientations dimension loading on it, namely Personally Interested, Self-test Directed, and Vocation Directed. Two scales from the Mental Models of Learning dimension loaded on the factor - Construction of Knowledge and Stimulating Education. This was somewhat closer to perhaps what Severiens & Ten Dam (1997) found in their study among adult students who enrolled in secondary-level courses because they had failed previously in regular education, or somehow missed the opportunity when they were younger. In my investigation, the structure for this factor seemed to suggest that students who reported this learning pattern want to prove themselves to others, and perhaps even to themselves, that they can succeed in tertiary education and eventually find good jobs.

As discussed in Chapter 1, many of the students who enrolled in the Engineering course at the current Polytechnic did not do well enough for their GCE 'O' Levels to qualify for a place at a Junior College to take their 'A' Levels. In Singapore, the latter option is perceived by students as the preferred path for those who are academically strong and are likely to proceed on to higher education at one of Singapore's local universities. In fact, generally opting to enrol at any polytechnic to get a Diploma is often perceived as a second choice for 'O' Level leavers. Polytechnics in Singapore do offer many choices of courses, and places for the most popular ones such as Business, Management, Accounting, Life Sciences, and Tourism & Hotel Management are keenly fought. Only the best will get places in these courses leaving the less academically strong with less popular courses, such as Engineering. Suhaimi (2009) reported that in 1999, three in ten of 16,000 Polytechnic applicants picked Engineering as their first-choice course; by 2006, only 15 per cent of 18,000 applicants did so. Of course there are students who choose Engineering as their first choice out of a real interest, but the majority enrolled for, or are offered, the course because they could not qualify for other courses. Many of the above views were reported in Section 4.2.2.3. It is therefore very likely that these students who were eventually offered places at the Polytechnic would want to prove themselves, and expect their lecturers to help them, thus explaining for the learning pattern found in the second factor for Year 1 students.

Students who were Prove-yourself Directed, were generally enthusiastic about their studies and reported strong personal interest (Table 4.8). These apparently comprised students who applied for the course out of genuine interest, and those who did not qualify for other courses but took a positive attitude to prove themselves (Section 4.2.2.3). Students seeking to prove themselves had a mental model of learning that comprised the construction of knowledge for themselves, but at the same time having a higher expectation of their lecturers to provide stimulation to aid learning than any other undergraduate group (Table 4.18 and 4.16). This expectation was not surprising because the majority of the subjects that the students were learning in their first year would be the first time they were encountering them (Section 4.2.2.4).

The third factor represented students who were Reproduction Directed. From the pattern structure (Table 4.18), it may be inferred that the students mainly relied on memorising and rehearsing, together with external regulation, as their processing and regulation strategies respectively. They were motivated by their desire to attain a diploma. Students with this learning pattern appeared to view learning as the intake and application of knowledge. These students relied on their lecturers to guide them and help them manage their learning processes.

The last factor represented students who were Undirected in their learning approach. It may be inferred from the pattern structure (Table 4.18) that these students were generally unsure if they had made the right choice of course to study and perhaps even doubted their own ability to complete their studies (ambivalent). They preferred to lean on their peers to motivate and guide them in their studies.

Year 2

The four learning patterns identified for Year 2 students were: *Flexible*, *Passive-idealistic*, *Passive-reproduction Directed and Passive-certificate Directed*. The first two were dissonant patterns, while the latter two were essentially Reproduction and Undirected learning patterns with some small structural differences observed.

The Flexible learning pattern found for Year 2 students was similar to that found for the first year students, with the absence of the Memorising &

Rehearsing subscale (Table 4.19). Like the Year 1 students who used the Flexible learning patter, these students also used a combination of deep and stepwise processing strategies, and self- and external regulation strategies. However, a closer examination of the data at the subscale level indicated that Year 2 students reported lower scores for deep processing, especially for Relating & Structuring (Table 4.2) compared with Year 1 students. They also scored less for self-regulation strategies, both Learning Processes & Results and Learning Content, (Table 4.5) compared to the first year students. While the students indicated a reliance on their lecturers to provide External Regulation of Learning Results, and viewed practicing on problems as an important part of their learning strategy, their score for that subscale was again significantly lower compared to their juniors in Year 1 (Table 4.6 and Section 4.2.2.2). Generally, Year 2 students seemed less enthusiastic about their studies than Year 1 students, which supported what Lieberman & Remedios (2007) found when they studied whether students' goals change as they progressed through university studies. In that study they found that students after Year 1 were "substantially less likely to want to master their subjects" and were also "more concerned with grades and less likely to expect to enjoy their courses" (p. 379). Several interpretations were proposed in their paper, for example, the decline could be relative to unrealistically high expectations and high interest levels of Year 1 students. It seemed that over time, students found that the course they had chosen was not as interesting as they first thought and eventually lost interest. From the interviews with Year 2 students in this present study, there were indications that students were indeed losing interest in their studies because they did not like the subjects they were studying (Section 4.2.2.3). As discussed earlier, this would not be surprising because many students reported that they did not choose Engineering as their first choice to begin with. These students could have decided to take a positive attitude when they embarked on their studies in Year 1, but after one year, many may have come to realise that they really did not like what they were studying. (Section 4.2.2.3). Others indicated that they had "figured out the system", meaning that they knew the expectations of the course well, or perhaps they came to perceive that they did not need to put in as much effort as initially expected to meet the requirements of the course (Section 4.2.2.3). This could suggest that the students did not find the course challenging enough and became less motivated.

The second factor represented the learning patterns of students who were Passive-idealistic Directed similar to what Ajisuksmo & Vermunt (1999) found in their Indonesian study. They posited that students with this learning pattern were "occupied with exploring their conceptions of what learning is" (p. 56) and suggested that cultural differences could have influenced these deviations from Vermunt's Dutch studies. The findings from this present study seemed to suggest that it may not only be a cultural influence on the development of learning patterns in a Singapore context, otherwise this learning pattern should be rather more consistent for all other groups. Perhaps this pattern could be caused by the students' general perception of being unsure of their direction and the loss of motivation. One student spoke of feeling "super lost" in his studies (Section 4.2.2.4). From the interviews, there were indications of this, and students have mentioned about moving on to pursue other areas of interest in their future studies and careers (Section 4.2.2.3).

The third factor resembled the Reproduction Directed learning pattern found by Vermunt (1998), but the Certificate Directed and Self-test Directed subscales did not load on this factor (Table 4.19). As such, there were no clear and positive learning orientations (motives) in the students' approach to learning, and therefore labelled as a Passive-reproduction Directed learning pattern. This could be indicative of students who only wanted to take in information and reproduce this information in the examinations without any clear motivation other than, possibly, the fear of failure as mentioned in the interviews (Section 4.2.2.3). Personally Interested loaded negatively on this factor further supporting the idea that these students had little or no interest in their course of studies (Table 4.19).

The fourth factor had an interesting pattern where the students showed an almost characteristic Undirected learning pattern except for the fact that the Certificate Directed scale moderately loaded on it (Table 4.19). Based on that, this factor was interpreted as a Passive-certificate Directed learning pattern. These Year 2 students scored significantly higher for the Ambivalent subscale compared with all other groups (Table 4.12). The prevailing sense of being lost, and the lack of motivation that had influenced the other three learning patterns for Year 2 students is seen most strongly here. It seemed that the only goal that was keeping them in the course was the hope of attaining the diploma, and perhaps again the fear of failure (Section 4.2.2.3). Here, this fear could also have a social dimension because the students were afraid that if they had to re-take some modules, they would feel miserable to be in different classes from their friends in the following semester. This underscored the importance the students placed on peer support in their studies.

Year 3

The learning patterns for Year 3 students were identified as: *Flexible, Prove-yourself Directed, Passive-reproduction Directed and Active-certificate Directed.* The Flexible learning pattern seemed to be generally consistent among the all the undergraduate students, regardless of their year of study in the Polytechnic. There were some variations if the pattern structures were examined at the subscale level, but it could be observed that for all three undergraduate groups, the first factor only comprised loadings from the Processing and Regulation Strategies domains. For Year 3 students, the subscale loadings on the first factor looked almost similar to the corresponding factor pattern for Year 1 except that Memorising & Rehearsing subscale did not load on it, while the External Regulation of Learning Processes subscale loaded here. These Year 3 students utilised the Relating & Structuring subscale significantly more compared with Year 2 students, and quite similar to the Year 1 students (Table 4.2). The qualitative data suggested that some students preferred to seek understanding of the topics that they had to study, and, in fact, found that there was no need to memorise content once they could understand (Section 4.2.2.1).Their use of the Analysing scale was also higher with respect to Year 2 students (Table 4.2).

With regards to regulation strategies, the Year 3 students used a combination of both self- and external regulation in general. Specifically, Year

3 students scored significantly higher for the Self-regulation of Learning Processes & Results and External Regulation of Learning Processes subscales compared to Year 2 students (Table 4.5 and 4.6). These two strategies initially appeared to be contradicting, however, the qualitative data suggested it could be possible that Year 3 students viewed their teachers as a source of knowledge and were expected to teach in a way that students could understand, and at the same time, the students acknowledged the need to be independent in their learning (Section 4.2.2.2). Some students expressed their expectation for their lecturers to scope the key knowledge content that they were expected to master, and to guide them along. Once they were clear of the knowledge boundaries, they were able to regulate their own learning processes (Section 4.2.2.2).

The second factor was interpreted as a Prove-yourself Directed learning pattern. It was similar to the pattern found for Year 1 students with regards to the loadings from the Learning Orientations domain, but different for loadings from the Mental Models domain where there was only one loading which was the Use of Knowledge scale (Table 4.20). This learning pattern could be influenced by the fact that it was the graduating year for these students and thus studying had become more focussed on getting through the examinations and scoring well (Section 4.2.2.3). In view of that, some students also suggested that there was no reason to go too deep in their studies, since their conception of learning was to just gain sufficient knowledge, get a job, and earn a salary. (Section 4.2.2.3). There were some students who were looking forward to furthering their studies at a university so obtaining the diploma was an important step for them (Section 4.2.2.3).

The third factor was described as a Passive-reproduction Directed learning pattern, quite similar to that found in the analysis for Year 2 students. Here there was a negative loading for the Self-test Directed subscale, and no loadings from the Certificate Directed and Vocation Directed subscales (Table 4.20). It may be inferred from their learning pattern that, like the Year 2 students, the Passive-reproduction Directed students in the third year did not apply any particular processing nor regulation strategies (Table 4.20). A negative loading for Personal Interest subscale may suggest that this category of learners had a low interest in what they were studying, either having carried over since they entered the course, or perhaps they lost their interest after the first two years of the course. Their Mental model of Learning was mainly to take in knowledge with the aim of reproducing it in an examination (Table 4.20). Like the second year students, they also expressed that they had "figured out the system" and resorted to doing only what was necessary to meet the requirements to graduate. They relied on their lecturers to tell them what was important, and some even expected a "study guide" to be handed out by the lecturers to help them focus on topics in the course that would be assessed (Section 4.2.2.1).

Passive-reproduction learners in Year 3 also relied on their lecturers to stimulate their learning by giving precise instructions as to how to go about solving a task or doing an assignment (Table 4.20), but the most prominent characteristic is their reliance on their peers to support their learning. They scored higher than all groups for the Cooperative Learning scale, with statistical significance compared to Year 2 and the Professional groups, indicating their strong dependence on their peers (Table 4.17). This scale is usually associated with students who adopted an Undirected learning pattern. Year 3 students who relied on Cooperative Learning were not Undirected but were likely to be directed by the influence from peers who could have either a positive or negative impact on their learning. That is, peer pressure could be a positive motivator, but having friends who had lower motivation towards their studies could be a setback (Section 4.2.2.4).

The last factor showed an interesting variation of an Undirected learning pattern. It had both the Lack of Regulation and Ambivalent subscales loading on it, but at the same time it also had loadings from the Memorising & Rehearsing and Certificate Directed subscales, and no loadings from the Mental Models of Learning dimension (Table 4.20). As seen in earlier, the corresponding pattern found for Year 2 students indicated that the students relied on lecturers to stimulate their learning, and also peer support. They were thus rather passive as learners, depending on others to aid their learning. However, for the third year students, the Stimulating Education and Co-operation subscales were not associated with the factor, instead, the students seemed to be putting in some effort to use memorising and rehearsing as a processing strategy. This factor was thus named as an Active-certificate Directed learning pattern. Fear of the consequences of dropping out of the course in the final year without a diploma could be a strong motivation in itself.

(ii) What learning patterns do Engineering professionals who actively pursue continuing education for self-development in the Engineering field prefer to employ? What, if any, do these professionals think were the factors that influenced their preferences?

The learning patterns identified for the Professionals group were: *Meaning Directed, Passive-idealistic Directed, Reproduction Directed and Application Directed*. Other than the Passive-idealistic Directed pattern, the other three had factor structures that were rather similar to those found by Vermunt (1998) (comparing Table 4.21 and Table 2.4). Unlike what was observed for the undergraduates' learning patterns, this seemed to support the developmental hypothesis where older, more experienced learners were expected to be better able to differentiate various learning strategies, conceptions and orientations compared to younger learners and expected to show stronger interrelations between these domains (Vermunt & Vermetten, 2004; Vermetten, Vermunt & Lodewijks, 1999). However, there were differences and these will be discussed as follows.

The first factor had similarities to a Flexible learning pattern like for the undergraduate groups, but on closer examination, it had a greater resemblance to a meaning directed learning pattern as it included the Construction of Knowledge subscale (Table 4.21). However it was noted that the External Regulation of Learning Results subscale also loaded on it - a scale that consistently appeared in all the undergraduate groups studied (Tables 4.18 to 4.21). This could indicate that while the Professionals who adopted a meaning directed learning pattern generally sought to apply deep and self-directed learning strategies, they still relied on some external regulation via tutorials, assignments, tests and past year papers to test their own learning. This seemed to be a persistent characteristic of Singapore students across all groups in the present context - perhaps a characteristic that had been ingrained into their learning pattern and carried over from the way they were conditioned to learn in primary and secondary education.

Looking further into the scores for particular subscales, it was noted that the Professionals scored relatively low for the Deep Processing subscales (Relating & Structuring and Critical Processing), and the Self-regulation subscales (Learning Processes & Results and Learning Content) (Table 4.2 and Table 4.5). This was contrary to what Vermetten et al. (1999) posited. Being more matured and experienced learners, it was expected that their scores for subscales within these two domains would be higher than for the undergraduates. The lack of time for their studies was generally perceived by the Professionals group as a hindrance for using deep processing and self-regulation strategies (Section 4.2.2.1). From those who were interviewed, it could be observed that the Professionals took a very pragmatic view to their studies. Most of them were studying to either enhance their competence to do their job better or seek career advancement, or to gain new knowledge and skills in preparation for a career switch (Section 4.2.1). Given the perceived time constraints, they appeared very clear about what they wanted to learn, focussing on topics that had relevance to their objectives, and skimmed over topics they had no interest in (Section 4.2.2.1). Their learning strategy involved mainly Concrete Processing (Table 4.4) where they sought to relate the course contents presented to them back to their own work experiences, and sought ways to apply the knowledge gained.

The second factor, the Passive-idealistic learning pattern, looked somewhat like that of the second factor for Year 2 students with four out of five subscales from the Mental Models of Learning loading on the factor, and two from Learning Orientations (Table 4.21). This was an unexpected learning pattern for the Professionals group because, unlike the Year 2 students, these students should have a clearer conception of learning and motive when they returned for further studies. It was not mentioned in the interviews but it maybe speculated that the Professionals who reported this behaviour could have embarked on the course and found that it was more difficult than expected to cope, thus causing dissonance in their learning pattern.

The third factor most resembled the Reproduction Directed learning pattern found by Vermunt (1998), although a few subscales, such as the External Regulation of Learning Results, Self-test Directed, and Intake of Knowledge, did not load on this factor (Table 4.21). The Professionals who reported this learning approach seemed to depend on their lecturers to regulate their learning processes. From the interviews, they appeared to be ready to adapt their learning to produce outcomes that aligned with the expectations of their lecturers with the aim to maximise their academic results (Section 4.2.2.2). Here again the time constraint faced by these working adults could have influenced them to adopt a more strategic approach in their learning where they aim to minimise the time spent to maximise their results, if possible (Section 4.2.2.2).

The last factor most closely resembled an Application Directed learning pattern, which was not found among the undergraduate groups.

Vermunt & Vermetten (2004) noted from their own studies that this Application Directed learning is "especially found as a strong separate dimension among adult students" (p. 379). The Professionals had the highest mean scores for the Vocation Directed and Use of Knowledge subscales (both significantly higher when compared with all undergraduate groups). Their score for the Concrete Processing subscale was also high, with statistical significance when compared with Year 2 and Year 3 students. However, the Certificate Directed subscale did not load on this factor. This was an interesting observation that could indicate that these students, all of whom have some form of tertiary qualification, valued the training in their specific competencies more than the paper qualifications that they would get at the end of the course (Section 4.2.2.3). In other words, it may be possible that these students signed up for their respective courses with the main aim to enhance their personal knowledge and competencies for their current jobs, and not so much to obtain a certificate. It was also noted that the Lack of Regulation and Ambivalent scales loaded negatively on this factor, suggesting that these students were very clear about the purpose and direction of their studies.

(iii) Are there any similarities or differences between the preferred learning patterns of Engineering students and those of professional engineers who are actively engaged in continuing education in their field?

All the various learning patterns reported by students from the four groups in this study have been discussed. Several similarities and differences could be observed the in learning patterns between the Engineering undergraduates and the Professionals. The differences seemed more important so I'll discuss those first.

Differences in Learning Patterns

Comparing the undergraduates and the Professionals, the meaning directed and application directed patterns reported by the latter group appeared to be rather more distinct. This could point to a developmental phenomenon where the associations among the learning strategies students used and their learning conceptions and orientations increases as they mature as learners (Vermunt & Verloop, 2000). However, this development was not apparent during the three undergraduate years and only seemed to be more obvious among the Professionals. The possible influencing factors that contributed to the differences may be related to the students' conceptions of learning and their study motives.

The qualitative data have suggested that the Professionals were clearer in their learning conceptions where they viewed learning as the acquisition of knowledge that can be applied especially in their current vocation, or in preparation for a career switch (Section 4.2.1). This resonates with the quantitative data which showed a significantly higher score for the Use of Knowledge subscale relative to all groups. For the Construction of Knowledge subscale, they also scored significantly higher than the Year 2 and Year 3 students. These two subscales were associated with the application directed and meaning directed learning patterns respectively. The linkages between students' learning development and their changing beliefs about the nature of knowledge (epistemological development) were investigated by Vermunt (1998) and Lonka & Lindblom-Ylänne (1996). Epistemological development was studied by Perry (1970) who proposed that students advanced through four stages as they mature as learners: (1) dualism, represented by an absolutist, right-and-wrong view of knowledge, (2) multiplicity, encompassing the understanding that one can approach a situation from different angles, (3) relativism, which a consciousness that objective information is interpreted and that these interpretations are the building blocks of certain views from which numerous possible conclusions can be drawn, and (4) commitment within relativism, which the represents the development of a personal opinion of issues, acknowledging that all knowledge and ideas are relative. Vermetten et al. (1999) postulated that mental learning models were important in influencing the adoption of certain learning strategies, and thus developments in this domain were likely explanatory factors for changes in learning behaviour. Some of the Professionals may have had some years of education at a university level, and worked for a number of years before embarking on their present course at the Polytechnic. It is thus likely that they may have, over time, experienced epistemological changes because they have become more competent in a particular area of knowledge, or they had a better grasp of how knowledge could be applied in real-world situations. These changes could have influenced their conceptions of learning.

In comparison, the undergraduates' conceptions of learning were primarily focused on the intake of knowledge and as a means to gain access to a desirable job (which may or may not be related to engineering) (Section

4.2.1). These were rather similar to what Säljö (1979) described as reproductive learning conceptions. In this light, the undergraduates would likely be more concerned with applying strategies that would maximise academic grades, or perhaps just to stay on the course, and eventually graduate. Thus a flexible learning pattern that was more strategic in approach, rather than a meaning directed or application directed one, was reported across all three undergraduate groups.

Other than clearer conceptions of learning, the study motives of the Professionals were also more distinct where their Vocation Driven subscale was scored significantly higher compared with the undergraduate groups (Table 4.11). This construct was associated with their application directed learning pattern (Table 4.21). First year undergraduates reported significantly higher scores for their Personal Interest subscale, but other year groups showed lower interest levels. Generally, the qualitative data indicated that the learning orientations of the undergraduates were mainly focused on attaining their certificate (Section 4.2.2.3). This certificate directed motive was associated with the reproduction directed and, interestingly, the undirected learning patterns reported by the undergraduates (Tables 4.18 to 4.20).

Another difference between the learning behaviour of Professionals compared with the undergraduates was the absence of the Undirected learning pattern among the more matured learners. For the undergraduate groups, a clear Undirected learning pattern was found for the Year 1 students, while Year 2 and Year 3 students revealed an Undirected learning pattern that had the Certificate Directed scale loaded on it (Tables 4.18 to 4.20). This difference between the Professionals and the undergraduates was not surprising as the Professionals would have likely signed up for continuing education courses out of clear motives as already discussed.

Similarities in Learning Patterns

Two of the learning patterns found among the Professionals that were largely similar to those among the undergraduates were reproduction directed and passive-idealistic directed. The reproductive approach appeared to be a preferred learning behaviour for some students across of all groups, and has been reported as a largely common characteristic of Chinese learners by various researchers (Murphy, 1987; Nelson, 1995; Marton et al. 1997).

Several western authors have written about Chinese learners describing them as being more inclined to make extensive use of rote memorisation, and were generally more passive and less interactive in class than their Western counterparts (Samuelowicz, 1987; Kember & Gow, 1991). This distinct learning behaviour has been said to be a transfer of the Confucian ethic of filial piety, coupled with a sense of proper protocol in the presence of elders (Murphy, 1987). The influence of this Confucian cultural heritage on students' conception of learning has been observed in classrooms broadly in East and Southeast Asia, in particular China, Taiwan, Singapore, Hong Kong, Japan, and Korea (Biggs & Watkins, 1996). These have been referred to as *Confucius Heritage Cultures*, or CHCs, by Ho (1991). However, a number of researchers (Kennedy, 2002; Dahlin & Watkins, 2000; Grimshaw, 2007; Biggs, 1996; Watkins & Biggs, 1996, 2001), have written to debunk the Western misconceptions of CHCs. Studies have found that Chinese students' conceptions of learning could include memorisation and understanding as complementary rather than opposites (Wen & Marton, 1993). Marton, Dall'Alba and Tse (1996) used the term "memorisation with understanding" (p.76) to describe the approach used by some Chinese students who mixed memorising and a deep approach to studying. Au & Entwistle (1999) posited that rote memorisation could be an approach adopted by students as a response to the perceived demand of assessments that they are faced with, and could be adopted by Western students as well.

In my current study, the nuances in the relationship between memorising and understanding surfaced in the course of the interviews although it was not specifically asked (Section 4.2.1). There seemed to be a broad consensus that learning is a process of taking in knowledge, and understanding is the culmination of that process when that knowledge makes sense to the learner, and he or she is able to apply that knowledge in different contexts. To some students, memorisation could therefore be considered as part of their learning process to imbibe knowledge from their lecturers, lecture notes, textbooks and other sources, and understanding of that knowledge can happen simultaneously or at a later stage. There were other students who opined that understanding should come first, then memorising would be easier. Either way, the common objective of their learning, especially for the undergraduates, was to be able to reproduce what they had learnt at an examination. The students therefore seemed to be responding to what they perceived as the demands of particular assessments. It was noted that this preference for reproductive learning was also found in other Asian studies, such as in Sri Lanka (Marambe et al., 2007), Indonesia (Ajisuksmo & Vermunt, 1999) and Thailand (Eaves, 2009). Thus the preference for the use of memorisation may not necessarily be a characteristic of just Chinese learners.

It should be noted at this juncture that the earlier studies of students in CHCs did not involve the use of Vermunt's ILS or his theoretical framework and thus a more extensive discussion vis-à-vis this current investigation would not be possible.

The other similar learning pattern found among the Professionals and the undergraduates (in particular the Year 2 students) was the Passive-idealistic directed approach. As discussed earlier, this was a rather unexpected pattern that was detected and could likely describe Professionals who were struggling with their studies in the midst of pressures from work, and family life. It could be speculated that their conceptions of learning and their study motives could have become less clear as they attempted to cope with the various challenges.

(iv) How far has the existing learning environment at the Institution in this study shown to have fostered in the students the necessary learning patterns that are useful for lifelong learning?

The idea of lifelong learning in the Singapore context was presented in Chapter 1 of this thesis. Extensive changes in the curricula were implemented across all primary, secondary and post-secondary institutions to foster the relevant skills that included primarily self-directed learning and critical thinking that were thought to be relevant for continuing education by the MOE. This view aligns well with Vermunt (2007) who said that "the ultimate goal of higher education is to prepare students for lifelong self-regulated, cooperative and work-based learning" (p. 73). Other literature such as Zimmerman (2001), Pintrich & Schrauben (1992) and Corno (1989) have shown the significance of self-regulation in explaining academic achievement, and could foster deep and meaningful learning (for example, Entwistle & Entwistle, 1991; Vermunt & Vermetten, 2004; and Vrieling, Bastiaens & Stijnen, 2010). Being able to self-regulate learning could also mean that learners would be able to develop knowledge, skills, and even attitudes that could be transferred from one learning context to another and from learning situations in which this information is acquired to work or other contexts (Boekaerts, 1999). These learning skills are encompassed in the meaning directed learning pattern which was found by Vermunt (2007), together with the application oriented learning approach, to be the most useful for lifelong learning.

Qualitative data from my investigations also appear to lend support to the above idea as expressed by the views of the Professionals. Indications from the interviews with the Professionals seem to suggest that the meaning directed and application directed learning patterns were the two most relevant approaches that would be important for successful lifelong learning. This has been discussed in Section 4.2.2.5.

In this present study, there was evidence that learning patterns differed between year groups, and the scores for the various scales showed significant differences when the four groups were compared. However, there was not enough evidence from this present study to infer that the meaning directed learning pattern has been intentionally developed via the curricula or the methods of delivery for this course in Engineering. Any differences observed were more likely to be due to changes in contexts, and the developmental phenomena.

Reflections on the Findings

It seems rather disappointing that the existing implementations at the Polytechnic, and the curricula implemented by the MOE through the Primary and Secondary schools, to foster deep, self-directed learning, have not yielded strong evidence in this study. As a lecturer at the Polytechnic for almost 15 years, and having contributed to the implementation of the curricula, I may speculate that several factors could have diminished the intended effects. These are discussed as follows.

Inadequate Implementation of Self-directed Learning Opportunities

While the Engineering programme at the Polytechnic had timeslots catered for elements of self-directed learning across all three undergraduate years, the purpose may not have been well understood by the lecturers and students. Delivery of lessons were still very much instructor-led for topics that were deemed as essential to the curricula (the "must know" topics, as it is commonly known among lecturers in the school), and would be assessed in the common tests and final examinations. Even if any of these "must know" topics were developed into self-directed e-learning packages, these self-directed learning sessions were scheduled into the time-table and supervised in an e-learning laboratory. These sessions of self-directed e-learning were therefore used more as a form of revision to enhance or supplement the instructor-led lectures and tutorials. Other topics that were of less importance but included in the curricula for completeness (those commonly known as "good to know" or "nice to know") have also been developed into e-learning packages for self-directed learning, but these were not assessed formally and usually perceived by the students as optional. There were also unsupervised self-study (SS) learning periods in the time-table on alternate weeks but most students perceived these as additional free periods. Instructor-led lectures and tutorials were still very much geared to covering the syllabus required for the final examinations, and lecturers often struggle with a time constraint to complete the syllabus. In fact, lecturers often perceived that the hours set aside for self-directed e-learning sessions and self-study sessions were debited from their delivery hours, leaving them with less time to complete the syllabus and prepare the students for the examinations. Ultimately the school management still expected good examination results so lecturers view it as their responsibility to prepare the students well.

Inadequate Training for Lecturers

All lecturers that join any of the Polytechnics in Singapore have relevant Bachelor degrees and post-graduate degrees, and the majority have very good industry experience. These requirements were, and still are, important because lecturers were expected to not only teach in-depth technical knowledge, but also inject real-life problems from their own industry experiences to better prepare the students for a career in the Engineering field. However, in my opinion as a lecturer myself, and also managing a team of lecturers, there is insufficient working knowledge among the teaching faculty to design and implement curricula that can foster self-regulated, deep learning in students. Majority of lecturers in all the Polytechnics in Singapore do not come in with any formal training in higher education teaching unlike those deployed to Primary and Secondary schools, and Junior Colleges. Mandatory in-house training and certification only started in the last three years or so in this Polytechnic, but the coverage only provides foundational concepts. As such most lecturers would usually teach the way they were taught in the past, thus preferring more traditional didactic approaches in their delivery methods, leaving little room for students to develop deep processing strategies, self-regulation, critical and analytical thinking, and to shape their motives and learning orientations to become more Meaning Directed learners.

Limitations in Academic Ability of Students and Lack of Interest

The School of Engineering has the largest population of students in the Polytechnic under study, and understandably there exists a wide range of academic abilities among the students. There are students who are academically strong and chose to read Engineering at the Polytechnic instead of studying for the 'A' Levels at a Junior College. These students are generally confident about their own abilities, have higher self-efficacy and therefore more likely to be able to regulate their learning processes, and adopt deep learning strategies (Ferla, Valcke & Schuyten, 2008). However, as found and discussed in the earlier sections, the majority of students in the Engineering course either chose it because they knew that their overall aggregates were not good enough to apply to other courses, or they were posted to the course as one of their less preferred choices in their course application because they did not meet the cut-off aggregate points.

Following this observation, the majority of students here, therefore, would not be academically strong, and may not have a high interest to pursue an Engineering course, nor to work in the Engineering field after graduation. These students would be more likely to have lower self-efficacy and would tend to adopt learning patterns other than the Meaning Directed or Flexible patterns (Ferla, Valcke & Schuyten, 2008), and in the context of this present study these could include the Prove-yourself Directed, Passive-idealistic Directed, Reproduction Directed, Active/Passive-Certificate Directed or Undirected learning pattern.

In the delivery of the curricula, lecturers have to cater to the wide spectrum of students' learning abilities, but often pitching their level of teaching where the majority are so as to accomplish a good pass rate at the final examinations. In so doing, coupled with the limitation of time to cover the syllabus, they tend to design their delivery to be more didactic rather than to challenge students with deep processing and thinking. Lecturers also perceive that the students would need as much help as possible and often over-manage their learning processes. Examples include specifying very clearly which parts of the materials are important and to be assessed, providing 'study guides' to help students focus in their preparation for examinations, and providing revision classes or mock examinations using papers from previous years. Assessments are also set at a level that the majority could pass if they had carried out the necessary preparations and attended tutorials and revision classes.

As an unintended consequence to this facilitation, students who have a Meaning Directed learning pattern to begin with may become less motivated, as could be observed when some mentioned in the interviews that they had "figured out the system" after the first year of the course. They realised that there was no need for deep processing, and by closely following the instructions of the lecturers, they could still achieve very good grades in the examinations.

These areas highlighted could be good starting points to review and enhance the existing delivery approaches; develop appropriate training programmes to equip lecturers with the teaching approaches that would help encourage the desired learning behaviours from the students; and develop additional learning support programmes to assist the academically weaker students and strengthen self confidence and self efficacy.

CHAPTER 6: SUMMARY, FINDINGS AND CONCLUSIONS

6.1 Summary

Since 1997, the Singapore Ministry of Education (MOE) has effected widespread changes to curricula across Primary and Secondary schools in Singapore, as well as the Institutes of Higher Learning, towards developing lifelong learning skills as part of its vision to build 'Thinking Schools' and a 'Learning Nation'. The changes included a drastic reduction in didactic, teacher-centred instruction so as to free up more time for students to engage in self-directed learning and group project work. It was envisaged that both of these will foster abilities such as independent inquiry and learning, and critical thinking, which were thought by the MOE to be important for lifelong learning. At the time of this study, the cohort of students who began the first year of their school life at Primary 1 in 1997 would have completed their Secondary education. Those who embarked on post-secondary education at a Polytechnic would be in their final year of their 3-year undergraduate training. This present investigation was therefore timely to gather insights into the learning patterns of a sample of the cohort studying in a Polytechnic and whether they have indeed adopted patterns that would be effective for lifelong learning. I envisaged that the results of this research would be relevant to me as an educator in a Polytechnic, and serve to inform future revisions to curricula and instructional design within the School of Engineering at the institution.

6.1.1 Overview of Thesis

Before embarking on the study, I reviewed prior research in the role of individual differences in student learning processes, primarily focussing on two key directions, namely, learning styles and student approaches to learning. The review sought to briefly trace the historical foundations from which important theories in both these directions were built upon. The theories, their respective measurement instruments, and outcomes were then critically assessed and reported in Chapter 2. The review surfaced the difficulty involved in defining, identifying and measuring learning styles. It also brought to attention the complex interactions between learners and their particular learning contexts (such as teaching methods, curriculum, assessment methods and culture) that influence their approaches to learning. Attempts to implement interventions to manipulate learning contexts to achieve particular desired learning outcomes have met with mixed results. The literature has shown that given a particular context, different learners may adopt different approaches to learning. Several researchers have attempted to find the underlying constructs that can influence a learner's behaviour. Richardson(2011), for example, proposed that students' conceptions of learning, and of themselves as learners, could be important influences on both their perception of their learning context and their approaches to learning.

Vermunt (1998) found that other than conceptions of learning, students' learning orientations (study motives) could also act together and have direct influence on their regulation strategies and indirect influence on their cognitive processing strategies. From this theoretical model, he developed the Inventory of Learning Styles (ILS). Several studies that used Vermunt's (1998) ILS in different academic contexts across various countries were reviewed, including four Asian studies in Indonesia, Sri Lanka, Thailand and Hong Kong respectively. This present study was set on the theoretical foundations laid out in the literature review, and the research questions were developed with a focus to understand the learning patterns of students in the Singapore educational context, in particular, Engineering students in a Polytechnic. There were four main questions:

(i) What learning patterns do Engineering students within the context of a Polytechnic in Singapore adopt? What, if any, do these students think were the factors that influenced their preferences?

(ii) What learning patterns do Engineering professionals who actively pursue continuing education for self-development in the Engineering field adopt? What, if any, do these professionals think were the factors that influenced their preferences?

(iii) Are there any similarities or differences between the learning patterns of Engineering students and those of professional Engineers who are actively engaged in continuing education in their field?

(iv) How far has the existing learning environment at the Institution in this study shown to have fostered in the students the necessary learning patterns that are useful for lifelong learning?

Chapter 3 examined the potential benefits and limitations of quantitative and qualitative research methods and determined that a mixed methods research approach would be the most suitable technique to achieve the purpose of this present study. As a method, it focuses on collecting, analyzing, and allows the mixing of both quantitative and qualitative data in a single study or series of studies and provides the researcher with the possibility to capture both the trends and the details of a situation and to add depth and context to quantitative results (Creswell & Clark, 2007). The selection of participants was discussed and these were organised into four groups - three undergraduate groups: Year 1, Year 2, Year 3; and one Professionals group who were working adults returning to the Polytechnic for continuing education. The decision for using Vermunt's (1998) ILS was justified. I also set out how I carried out a pilot study, followed by both the quantitative and qualitative approaches for the main study. The quantitative techniques for measuring internal consistency of the ILS, comparison of means and factor analysis using principal component analysis were also discussed. For the qualitative study, I argued for the use of group interviews as a more suitable approach in the present context.

Chapter 4 reported the results from both the quantitative and qualitative studies. For the quantitative study, Cronbach's alpha values for each of the subscales of the ILS were found to be comparable to with those found by Vermunt (1998) and slightly higher for some subscales compared to those found in the UK study by Boyle et al. (2003) and the Indonesian study by Ajisuksmo & Vermunt (1999). As this study is likely the first to be done in Singapore using the ILS, the results have given me confidence to conclude that the ILS has satisfactory internal consistency and thus fairly generalisable in the context of this investigation. Comparison of means yielded statistically significant differences between the four groups in the study for all sub-scales, except for Lack of Regulation, Self-test Directed and Intake of Knowledge. Partial eta squared (η^2) values were also calculated and found to be between the range of small to medium using criteria proposed by Kittler et al. (2007) and Barnette (2006). Factor analysis using Principal Component Analysis yielded four factors which could be identified as four learning patterns for each of the four groups under study.

The qualitative data from the interviews were transcribed and coded using four key themes that corresponded to the four domains in Vermunt's (1998) ILS structure, namely Processing Strategies, Regulation Strategies, Learning Orientations and Conceptions of Learning. I thought it might be useful to gain a better understanding of how students perceived learning and understanding, and perhaps how these might shape the learning patterns they adopt so I specifically asked the participants their views on the two terms. These were reported as Concept of Learning and Understanding. The Professionals groups were also asked for their views on what they thought were useful learning patterns for lifelong learning.

Chapter 5 laid out a detailed discussion of the results and the major findings are now crystallised in the following section.

6.2 Crystallisation of Major Findings and Their Implications

6.2.1 Learning Patterns

This present research has developed some valuable insights into the learning patterns of Singapore Engineering students in the Polytechnic under study. Similarities and differences in patterns were found between all four groups studied. Of the four learning patterns found for each group, two factors were found to be dissonant patterns compared to those found by Vermunt (1998).

The first factor had loadings mainly from sub-scales in the Processing Strategies and Regulation Strategies domains, and little or no loadings from sub-scales from the Mental Models and Learning Orientations domains (Tables 4.18 to 4.20). I described it as a Flexible learning pattern because students who adopted this pattern appeared to use both meaning directed and reproduction directed strategies at the same time. This learning pattern was found to be persistent throughout all three undergraduate groups. Ajisuksmo & Vermunt (1999) found a similar learning pattern in their Indonesian study with first-year Medical students and proposed that this dissonant pattern could be due to cultural differences in pedagogical and educational practices in Indonesia. This was affirmed by Vermunt & Vermetten (2004). However, I have noted that the Indonesian study only investigated the learning patterns of one year group and so it was not clear whether the cultural influence would persist into the later years of education. Other studies using the ILS carried out in Asian contexts, such as Sri Lanka (Marambe et al., 2007), Thailand (Eaves, 2009) and Hong Kong (Law &

Meyer, 2008), did not attempt to identify learning patterns by factor analysis so a direct comparison was not possible.

In their Sri Lankan study, Marambe et al. (2007) utilised independent sample t-tests, and reported that after implementing a new curriculum that encouraged meaning directed learning, the use of concrete processing and critical processing strategies did increase but reproduction strategies also increased along with these over a one year period. This was an unexpected outcome and they proposed that Asian learners were more adaptive in the use of strategies to achieve the results they want.

The present study in Singapore supports the findings in Ajisuksmo & Vermunt (1999) and Marambe et al. (2007), and also suggests that this particular learning pattern could be persistent even in the later years of education. This was not expected because existing theory suggests that dissonant patterns were temporal and learning patterns should become more clearly defined with increasing associations among learning strategies and the conceptions of learning and learning motives (Vermunt & Verloop, 2000; Vermunt & Minnaert, 2003). In this study, only memorising and rehearsing became more clearly associated with the reproduction directed pattern in Year 2 and Year 3. As research using the ILS is still relatively scarce in Asia, more studies need to be carried out to confirm this.

One aspect of the Asian cultural influence on students' learning patterns is their view of their lecturers as people of authority. Today it is still culturally not acceptable to question their authority in the Asian classroom (Ajisuksmo & Vermunt, 1999). The qualitative data in this study has shown that the culture in Singapore, as an Asian country is quite similar, and students do expect their lecturers to be the main source of knowledge, and to define the scope of what needs to be learnt and which parts of the syllabus will be assessed. Understanding this, students' perception of the role of the lecturer in an environment that seeks to foster self-directed learning and critical thinking will have to be changed over time. Lecturers will also need to gradually relinquish their position of authority - a position they are likely to have held for a long time, if they want to encourage student-centred teaching and learning (Trigwell, Prosser, & Waterhouse, 1999). Appropriate training for lecturers could be provided including equipping them with skills to move from the current teacher-centred approach to a more student-centred approach, influencing students' learning strategies through a variety of classroom and technology-enhanced methods to purposefully encourage self-regulated, deep-level and critical learning, and redesigning assessments to correspondingly measure such levels of learning. This would thus call for a change of mindset for both students and lecturers. Earlier studies have also shown that just manipulating the learning environment alone is insufficient to bring about changes in the way students learn, due consideration must also be given to their perception of their learning environment (Entwistle, 1991; Zeegers, 2001; Vermetten, Vermunt & Lodewijks, 2002). How students' perceptions and teachers' perceptions interact in a learning environment, and how these perceptions can be modified, remains an important subject for further study.

This study has also found that in addition to the Asian cultural context, Singapore students hold a rather pragmatic view towards education. The qualitative data in this study revealed that a common conception of learning, especially among the undergraduate students, was to gain knowledge and experience, and to apply these in their future vocation. The concept of understanding was generally viewed as being a deeper level of the mental processes involved in learning, but not required to achieve the outcomes they desired from their education. This conception of learning, coupled with the highly competitive education environment in Singapore and the strong emphasis on academic grades, could help explain the learning patterns reported in this study. The current Ministry and Polytechnic's interventions seemed to have only attempted to manipulate some of the context-bound factors, such as reduction of curricula, self-directed e-learning sessions, self-study sessions, group project work and others. There could be other conflicting context-bound factors that have been presented to the students at the same time, such as lecturers' teaching approaches, types of assessments and learning tasks that may not be aligned to the intent of the interventions. As such, the present learning environment may be confusing to the students at the Polytechnic. Difficulty in grasping the more abstract concepts, time constraints and heavy workloads were mentioned by students, for example, as possible hindrances to adopt more deep processing and self-regulation strategies, thus producing the Flexible learning pattern (Entwistle, McCune & Hounsell, 2003; Entwistle & Tait, 1990; Kember, 2004; Diseth, Pallesen, Hovland & Larson, 2006). Under such pressures, these students would appear to quickly adapt their learning processes and regulation strategies to achieve the outcomes they want. In each group that was interviewed, there were at least one or two students who alluded to the fact that deep processing was not necessary to achieve good grades in their studies. If the curricula, and its delivery, have been designed to produce students who are ready for lifelong learning as part of its learning outcomes, then there seems to be a mismatch between assessment strategies and those desired outcomes in the current context. Appropriate levels of workload with reasonable deadlines that would provide the right balance for deep learning would need to be determined, but this, obviously, would be challenging for curriculum developers and lecturers, if such an ideal balance indeed existed.

The cultural and education context in Singapore was likely to have also influenced the second dissonant factor. This factor was the opposite of the first factor with no loadings from the Processing Strategies or Regulation Strategies domains (Tables 4.18 to 4.20). On closer analysis of the loading of sub-scales from the Mental Models of Learning and Learning Orientations domains, some differences could be found and two patterns could be distinguished. One resembled the Prove-yourself Directed pattern proposed by Severiens & Ten Dam (1997) and the other was closer to the Passive-idealistic Directed pattern found by Ajisuksmo & Vermunt (1999) in their Indonesian study.

A possible explanation for this phenomenon could be gathered from the fact that many students who were in the Engineering course at the Polytechnic were generally academically weaker compared with their peers who had gone on to study in Junior Colleges. Evidence from the interviews has shown that these students were also unsuccessful in gaining entry into the more popular courses at the Polytechnic and thus they opted for the Engineering course, or were allocated to it. There may be several ways these students could perceive this situation. My investigation suggests that two different perceptions could have influenced the two variations to this phenomenon. The first could be students who perceived their situation positively. These students would likely adopt the Prove-yourself Directed pattern which was found among Year 1 and Year 3 students. From the interviews there were Year 1 students who came to accept their situation and decided to make the best of their opportunity for higher education to prove to others, and perhaps to themselves, that they could be successful. Year 3 students who were Prove-yourself Directed were more purposeful in their conception of learning compared to Year 1 students and were focussed mainly on the acquisition of knowledge and were optimistic about their future.

Considering the Passive-idealistic learning pattern, it was interesting to note that Ajisuksmo & Vermunt (1999) reported this among their Year 1 students and proposed that these students could be struggling to find their own conception of learning in a new academic context. In contrast, this present study identified this pattern among Year 2 students so they were no longer in a new context. These findings could thus suggest a different view. In general, the students in Year 2 were found to have lower interest in their studies among the three undergraduate groups and supported by the interviews where some students shared that they did not like the subjects they had to learn. This was not surprising because, as I mentioned earlier, students did not want to study Engineering in the first place.

Both the Prove-yourself and Passive-idealistic patterns fall under Factor 2 with no sub-scale loadings from the Processing Strategies and Regulation Strategies domains and, like the Flexible learning pattern, this structure remains generally consistent for all three undergraduate years

(Tables 4.18 to 4.20). While the overarching cultural and educational context in Singapore could have shaped their learning patterns, students' perceptions of their particular contexts appeared to modify them further. This phenomenon underscores the complexity of the interactions between learners, their context, and their perceptions. As mentioned earlier, as far as I am aware, no other research has been conducted in the Asian context that has examined learning patterns in Year 2 and Year 3 students in undergraduate programmes so it was difficult to compare the findings in this study. Nevertheless, the evidence in this thesis suggests that students who are Prove-yourself Directed or Passive-idealistic could benefit from greater attention by the Institution.

While the Meaning Directed and Application Directed learning patterns described by Vermunt (1998) did not show up distinctly among students from all three undergraduate years, the Reproduction Directed pattern was detected for all groups (with some variations observed) (Tables 4.18 to 4.20). This learning pattern was most likely influenced by the students' mental model of learning as the taking in of knowledge for the purpose of reproducing information in examinations. Quantitative data for this sub-scale showed relatively high means that were consistent across all three undergraduate groups. There was some indication from the interviews that some students viewed memorising as part of their learning process. This, again, could to be culturally-linked and concurs with research that is not only related specifically to the influence of Confucian ethics on Chinese learners (Murphy, 1987; Nelson, 1995; Marton et al. 1997), but also among other Asian learners in general (Ajisuksmo & Vermunt, 1999; Marambe et al., 2007; Eaves, 2009)). In addition, there were indications from both quantitative and qualitative data that some students who adopted this pattern generally seemed to go about their studies without a clear motivation and have reported that they did not have interest in the subjects they were learning but just wanted to complete the course. Others were motivated by a fear of the consequences of failure, including being left behind while their peers progressed on. This has implications on what learning outcomes were to be expected at the end of the respective courses, and how students understand the way they would be assessed. Perhaps students need to be encouraged to change their conception of learning from that of seeing learning as merely the intake of knowledge, to that of construction of knowledge or the application of knowledge in the real world. Some suggestions could include lecturers bringing in real-world problems into the classroom for discussion to generate interest, and also to show concrete examples of how the theories being taught could be applied in reality. More well-structured independent study assignments with clear learning goals could be introduced to foster deep and self-directed learning (Trigwell & Posser, 1991). As already mentioned earlier, the assessments should also be designed to progressively test for deep, critical thinking. Implementing a progressive instructional design to gradually move from a teacher-centred delivery to student-centred learning over a period of time has been advocated by several researchers (ten Cate, Snell, Mann & Vermunt, 2004; Bolhuis, 2003; Candy, 1991; Grow, 1991). This would take students from their current level of dependency on lecturers towards greater self-direction over a period of time in their course. This might be possible if learning responsibility could be gradually shifted toward students over a phased approach by scaffolding and reducing support (Azevedo, Cromley & Seibert, 2004). Much also depends on skill of the lecturers and their willingness to participate as a change agent to bring about the desired transformations. The list is, of course, non-exhaustive and the difficulties of implementing interventions like these have to be acknowledged because students' conceptions of learning are known to be relatively stable (Richardson, 2011) and therefore prone to resist change. These conceptions could have been formed over time, often influenced by students' past learning experiences (including their cultural background), their intentions, as well as situational demands in a given educational context (Pillay, Purdie & Boulton-Lewis, 2000). The quest to design "powerful" learning environments (Vermetten et al., 2002, p. 283) that could significantly influence the conceptual domain of learning conceptions and beliefs of students remains a challenging one.

Students with an Undirected learning pattern could be found among the undergraduate groups, however, other than the Year 1 students, the Certificate Directed learning orientation was observed to be associated with this pattern for the other students (Tables 4.18 to 4.20). That implied that while these students were generally ambivalent about their studies, and less able to monitor their own learning processes, attaining the Diploma at the end of the course somehow was a key motivator for them to continue their studies and not drop out of the course altogether. This may be also related to the fear of 'losing face' if they failed in their studies - another influence of the Asian cultural context. Looking at the Undirected learning pattern, it is likely that these students, in general, do not possess adequate processing and regulation strategies to approach their studies with. It may be possible to develop these strategies through a peer-assisted learning programme

(Damon, 1984) where carefully selected senior students who have proven track records of high academic success act as mentors to those who are Undirected. The mentors could share their successful strategies, and instil self-confidence through helping their charges achieve incremental successes. Self-confidence, together with the self-efficacy that comes over time, could encourage the Undirected students to shift towards deeper, self-directed learning (Papinczak, 2009; Rodriguez, 2009).

In this study, I also included an investigation of the learning patterns of Professional Engineers who have returned to the Polytechnic for continuing education. I had considered this group as role models of lifelong learners in the Engineering field and I hoped that their learning patterns could thus be useful as a reference for comparison against the undergraduate groups. Two learning patterns were found that were more distinct compared with all the undergraduate groups: the Meaning Directed and Application Directed learning patterns (Table 4.21). This finding concurs with the development hypothesis put forward by Vermetten et al. (1999) to a certain extent, where older, more experienced learners were expected to be better able to distinguish various learning strategies, conceptions and orientations compared to younger learners. However, it was also noted that the Meaning Directed students among the Professionals still relied on External Regulation of Learning Results. This sub-scale seemed to be a persistent one that also appeared in the Flexible learning pattern of all the undergraduate groups. This gave some indication that learners from all groups in this Singapore study expect their lecturers to provide clear directions on what needs to be studied, together with questions, assignments and past papers for practice.

The presence of the Application Directed learning pattern among the Professionals concurs with Vermunt & Vermetten (2004) who posited that the this pattern was most likely to be found among advanced learners or adults. This pattern was clearly different from all other groups as could be observed from the quantitative data where the Professionals scored significantly higher means for the Concrete Processing strategy, Vocation as a learning motive, and Use of Knowledge as a conception of learning (Tables 4.4, 4.11, and 4.14 respectively). It was interesting to note that there were no distinct Undirected learning pattern found among the Professionals. This was supported by evidence from the qualitative data where these working adults were reported to be more purposeful in their studies compared to the undergraduates with clearer goals such as to enhance their competency at work, or to acquire the necessary certification for career advancement or a career switch. This was different from what Vermunt (1998) found in his study that involved Open University (OU) adult learners in undergraduate programmes. In that study he identified a distinct Undirected learning pattern unlike the current investigation. It is possible that the OU students had embarked on their respective courses with different aims compared with the Professionals in this study. This difference suggests, once again, the importance of students' conceptions of learning and their motives for studying on their learning patterns. Research on working adults using the ILS were found to be scarce, especially in the Asian context, and as such, further research will be required to verify these results.

The Passive-idealistic pattern reported by the Professionals was found to be rather close in structure to that of Year 2 undergraduates except for absence of the use of knowledge and vocation directed subscales. It was evident that not all the Professionals had clear mental models of learning and strong study motives. This could have been attributed to their difficulty in coping with their studies due to the challenges posed in trying to balance work, family and study commitments.

The Reproduction Directed pattern was also reported by the Professionals like for the undergraduate groups. It was likely that this pattern had become ingrained from their previous learning experiences when they were undergraduates (Prosser & Trigwell, 1999; Vermetten et al.,1999, Donche et al., 2010) and when faced with time pressures, they fell back on a familiar pattern that was perceived to be the most effective to meet the learning challenges. The Professionals spoke of being selective in their learning where they would apply effort to understand topics that they found to be relevant to their work, or what they wanted to learn. For other topics that they deemed as irrelevant, they would "study to meet the requirements" of the course and thus adopt a more reproductive approach.

The three sets of learning patterns for the undergraduate groups were compared by examining the subscale loadings under each factor. In general it may be observed that the learning patterns between the three undergraduate groups were rather similar in structure, with only some differences found upon close examination of the internal structures of the factors. These differences were discussed in Chapter 4 and appeared to be primarily influenced by the students' perception of their particular context at different stages of their academic careers.

In comparing with research carried out in other Asian countries, particularly Indonesia, Sri Lanka and Thailand, some similarities could be observed, but data from these other studies were inadequate to draw firm conclusions. My investigation suggests that the Asian cultural context, and the Singapore educational context, as macro-contexts had a large part to play in the shaping of the learning patterns adopted by the Singapore students at the Polytechnic. However, it is important to note that at the time of writing, there was insufficient evidence to assert that the learning patterns found were unique to the Asian, or in particular the Singaporean, context. Isolated studies carried out elsewhere, such as in Australia (Smith, Krass, Sainbury & Rose, 2010) and Portugal (Rocha, 2011), have shown differences when compared against Vermunt's (1998) findings, especially the preference for students to mix self-regulation and external regulation strategies. In that light, my study adds to the growing understanding of how both cultural and educational contexts can influence learning pattern development.

6.2.1 Inventory of Learning Styles Sub-scale Scores

A more detailed look at the cross-sectional quantitative data for the sub-scale scores among the undergraduate groups also revealed that the use of deep processing strategies comprising the relating and structuring of knowledge, and the critical processing of information were not higher for the senior students compared to the younger ones in Year 1 (Table 4.2). The same can be said of their use of processes which involve concretising and applying the knowledge gained, and self-regulation strategies (Tables 4.4 and 4.5 respectively). In terms of learning motives, again, the scores for the senior students were not higher for personal interest in the subjects they were studying, nor the scores for their view of their future vocation as a study goal (Tables 4.8 and 4.11 respectively) compared to Year 1. As for their mental models of learning, their conceptions of learning as the construction of knowledge and personal insights, and learning for the application of knowledge were also not higher in the later years (Tables 4.13 and 4.15 respectively). Moreover, the lack of regulation and ambivalent sub-scales did not decline, in fact for Year 2 the Ambivalent score was the highest (Tables 4.7 and 4.12 respectively). The undergraduate students did not show clearer Meaning Directed and Application Directed learning patterns in Year 3 as expected, but these observations further confirmed that the undergraduate students did not change in that direction. These findings were quite similar to what Busato et al. (1998) found, and did not support the development hypothesis posited by Vermetten et al. (1999). Of course, cross-sectional studies capture data only at a single point in time and are therefore limited in their ability to determine cause and effect, and they are always hindered by the cohort effect (Sheperis, Daniels and Young, 2010; Vermetten et al., 1999). However the differences in age between the three undergraduate groups are relatively small and the revised curricula at the Polytechnic had been implemented several years before the Year 3 students even started their studies so the educational experience of all three groups would have been relatively similar. These considerations, together with the affirmations from the qualitative data, should mitigate this weakness to some extent. Nevertheless it is acknowledged that Year 2 and Year 3 students may not have benefited from incremental improvements in pedagogical approaches and other environmental changes experienced by the Year 1 students.

6.2.2 Comparing Learning Patterns of Undergraduates with Working Adults

Clearer differences could be found when the undergraduates were compared with the Professionals group as indicated above. Maturation would be one possible contributor (Vermunt, 2005). Most of the Professionals would have worked for a number of years before they decided to embark on formal continuing education. As discussed earlier in Chapter 5, it is likely that over time, many of them would have experienced epistemological changes perhaps because they have become more competent in a particular area of knowledge or they have a better grasp of how knowledge can be applied in real-world situations (Perry,1970; Vermunt, 1998). This could have led to differences in their mental models of learning and their motives compared with the undergraduate groups that gave rise to more distinct meaning directed and application directed learning patterns. Given that the macro-contexts - the cultural and educational contexts, that influenced the undergraduate groups would have been similarly experienced by the Professionals, it seems that these person-bound factors were sufficient to influence the differences in learning patterns of the Professionals to some extent. This implies that learning patterns can change over time and concurs with the development hypothesis proposed by Vermetten et al. (1999) when students become more matured. It could also imply that this development happens slowly and thus was not clearly evident among the three undergraduate groups at the Polytechnic. However, it would be erroneous to conclude that the meaning directed and application directed learning patterns would naturally come about with maturity and work experience. If one of the aims of higher education is to prepare students to become lifelong learners then certainly more needs to be understood as to how this transformation can be effectively facilitated at the undergraduate levels.

While the meaning directed learning pattern was more clearly defined among the Professionals, a closer examination of the sub-scale scores revealed that the reported use of deep processing and self-regulation strategies were not significantly higher than those of the undergraduate students (Tables 4.2 and 4.3 respectively). This could indicate that some of the Professionals perceived themselves as meaning directed learners, but did not report higher use of deep processing and self-regulation strategies in practice compared with the undergraduate groups. However, there was evidence that the Professionals reported less use of memorising and rehearsing of course contents (significantly less than Year 1 and Year 3 groups) and studying topics in isolation without attempting to make linkages (significantly less than all groups) (Table 4.3). The Professionals can be said to be very pragmatic in their approach to learning and relied more on concrete processing, making connections between what they learn and their own experiences. The interviews revealed that the lack of time had caused them to seek more time-efficient ways to learn using whichever strategy that was necessary for particular subjects, and even to decide on which topics to focus on that were found useful to their purpose. This suggests that the meaning directed learners were likely to have adapted the way they learned according to how they perceived their context, much like the undergraduates. This could imply that while the mental models of learning and learning orientations of students influenced the learning pattern adopted by students, they could adapt their learning strategies according to the demands of the context. This concurs with the way Richardson (2000) described Vermunt's (1998) model where he likened conceptions of learning and learning orientations as the inner, more stable, layer of Curry's (1983) onion, and the regulation and processing strategies as being more adaptable depending on the learning context. Another possible interpretation could be that the students who perceived themselves as meaning directed learners were limited by their lack of proficiency in applying deep processing and self-directed strategies in their learning approach. Either way, the importance of careful implementations of learning environments that would encourage and develop these desired strategies is emphasised.

6.2.3 Key limitations of the study

Several limitations are acknowledged in the study and I will outline these as follows:

First, I have observed some possible weaknesses in the design of the ILS for use in an Asian/Singapore context. The English version of the ILS was obtained directly from Dr Jan Vermunt himself and was used without any modifications in this Singapore study. It was piloted, and feedback was sought from my colleagues and students. No significant difficulties surfaced in terms of understanding the statements in the questionnaire. However, from analysing and reflecting on the data, it would appear that the accuracy of the ILS could be further enhanced for use in the Asian context, and in particular the Singapore context. The Certificate Directed sub-scale under the Learning Orientations domain includes the following items:

55. I aim at attaining high levels of study achievements.
58. The main goal I pursue in my studies is to pass exams.
63. What I want in these studies is to earn credits for a diploma.
65. I study above all to pass the exam.
75. To me, written proof of having passed an exam represents something of value in itself.

In determining the final Cronbach's alpha value for the Certificate Directed sub-scale, item 55 was removed to improve the value from 0.58 to 0.69. It appears that Singapore students may not agree that studying to achieve high grades and studying to just pass an examination both point to the same construct of being Certificate Directed. Perhaps a separate sub-scale called Achievement Directed under Learning Orientations could be added and I would speculate that this sub-scale would then load onto the Flexible learning pattern. Other considerations might be to include a Fear of Failure sub-scale, and to redesign the Personally Interested sub-scale under Learning Orientations. Fear of Failure may be a strong motivation in an Asian culture and is somewhat related to the fear of 'losing face', not only for themselves but also their families. The Personally Interested sub-scale seems to have the lowest Cronbach's α value even in the Indonesian study and perhaps the items need to be reconstituted for future studies.

Secondly, this study has focussed mainly on Engineering students in one Polytechnic. As described in the study, many of the students taking the course may not have chosen this course as their first choice. This could have influenced their conception of learning, and of themselves as learners, and thus also affected their perception of their learning environment. Given the importance that these factors have on learning pattern development, the resulting patterns established in this study may not be easily generalisable to other discipline areas. Further studies carried out in different faculties for comparison of results would broaden understanding of the influencing factors that could shape students' learning patterns.

Thirdly, given the nature of this investigation, a quantitative study was carried out using a cross-sectional design to capture data from the four groups targeted. As acknowledged earlier, cross-sectional studies capture data only at a single point in time and are therefore limited in their ability to determine cause and effect, and they are always hindered by the cohort effect. A longitudinal design could be more effective to measure developmental changes in learning patterns over the three undergraduate years and should be considered if this study were to be extended in future.

Fourthly, in my qualitative study I had eight interview groups, comprising two groups for each level of study and the Professionals. This was a rather small sample size and may not be representative of the entire population at the School of Engineering at the Polytechnic. However, given the nature of the study, the qualitative data was intended to serve to illuminate the findings of the quantitative study to gain a richer understanding of the data, and help to answer questions that the numerical analysis alone could not offer. If this study were to be extended in future, a larger sample size for the qualitative study could be considered. Perhaps five or more interview groups for each undergraduate cohort and the Professionals, or until data saturation is achieved, would have enhanced the qualitative data.

Fifthly, I had chosen to use a semi-structured approach with an interview guide in my qualitative study. This was chosen to ensure I could cover the key questions and issues yet allow for some level of spontaneity from the participants. However, one of the weaknesses of this approach is that an interviewer's flexibility in sequencing and wording questions could result in substantially different responses from different perspectives, thus reducing the comparability of responses (Johnson & Christensen, 2004). For instance, the issue of the relationship between memorising and understanding was surfaced by the interviews with the Year 2 groups but did not emerge in the other groups. It is likely that other year groups would have their views on this topic but were not discussed.

Finally, qualitative data gathering and analysis is by nature rather subjective. Being the only researcher in this investigation provided some consistency in the gathering and analysis of the data, however, it has to be acknowledged that the threat of personal biasness cannot be fully eliminated. Another independent rater for the analysis of the data would have increased the reliability of the qualitative study and should be employed in future research of this nature. The other limitations were highlighted as questions that have been left unclear in my major findings. These could serve as bases for future research as proposed in the following section.

6.2.4 Recommendations for future research

There is no doubt that higher education in the 21st century has to enable students to cope with the increasing demands of employment and society in an environment of complexity and uncertainty (Barnett, 2007) when they graduate. To that end, much more understanding is needed by institutes of higher learning as to how the 'right' learning patterns should be fostered. This present study has provided some insights into the learning patterns of

Singapore students and some similarities have been found when compared to Indonesian and Sri Lankan students. However, further research will be needed to confirm the findings of this study, and to build up the body of knowledge in learning pattern development in the Asian, and in particular, the Singapore context. A strong theoretical base in learning pattern development could then inform policies in institutions of higher learning, and at the national level, to effect necessary changes in the macro-contexts and thus facilitate the creation of learning environments that are congruent with the intention of developing Singapore into a "learning nation".

Coming down to the institutional and classroom level, further research is needed to better understand the relationships between students' conceptions of learning, and lecturers' conceptions of teaching and how these affect learning behaviour. This knowledge may then inform how such person-bound factors affect students' perceptions of particular contexts, and how it may be possible to change the perceptions that affect learning processes. This was earlier pointed out as being necessary because merely manipulating the learning environment alone is insufficient to bring about changes in the way students learn. In relation to that, this study has reported that one of the hindrances to students adopting the meaning directed learning pattern was their perception of time, workload, and possibly other demands. This indeed poses a challenge to instructional design and further research is needed to look into the appropriateness of assigned learning tasks, their levels, the time allocated for these tasks, and how these can be balanced to bring about deep learning. Another interesting question that could be further explored would be the effectiveness of interventions carried out within an institution if the external macro-contexts cannot be changed.

This study investigated the learning patterns of working adults. The literature for such studies using the ILS is scarce, and even more so in the Asian and Singapore context. Further research is much needed to understand how learning patterns developed in school, and at the higher education level, are transferred, modified, or self-developed, as they progress into adult working life. This would have implications to the development of effective 'transition pedagogies' that could facilitate students' learning as their progress through the various stages of their academic careers.

6.3 Conclusions

While the use of the ILS in research in various parts of the world is gradually increasing, most of the studies have been done in Western countries. Of these, many of the studies were based on data collected from students across various academic disciplines rather than focussing on particular disciplines. Only a few have targeted a specific population of students, such as those studying Psychology, Sociology and Medicine. There has been relatively few reports of research carried out using the ILS in Asian countries, and, as far as I know, this is the first investigation using this instrument in the context of post-secondary education in Singapore among Engineering students. It is also likely the first in Asia to be done using the English version whereas the other Asian studies were translated into their respective native languages. This could provide a more direct reference for comparisons with studies done elsewhere in English without the concern of possible differences due to the translation process. From this unique position, this study has, to some extent, contributed to the understanding of learning patterns development particularly in the Singapore context, and also generally in the wider Asian context.

This study supports many of the findings of the earlier work carried out in Asian contexts, mainly, Ajisuksmo and Vermunt (1999) and Marambe et al. (2007). Similarities were found, such as, in the dissonant learning patterns compared with those describe by Vermunt (1998), the use of mixed processing and regulation strategies, and the reliance on memorisation as part of the learning process. While the earlier studies did not explore beyond first year students, results from this study extends this understanding and suggests that these learning patterns persists even in the later years of students' academic progression. This reinforces the idea that the cultural context does influence learning pattern development and the resulting behaviour is rather stable.

The education systems in Asian countries have traditionally stressed on grades rather than the learning processes (Ajisuksmo & Vermunt, 1999). The Singapore government's policies that are firmly based on meritocracy have heightened the value of academic achievements to gain socio-economic mobility. Good grades and tertiary qualifications are seen as the main pathways to good vocations and the strive for these has contributed to the intense competitive educational environment in Singapore. Such views were evident in this study, and together with the cultural influences, these macro-contexts appear to have manifested in the students' conceptions of learning and learning orientations, and appear to have shaped the learning patterns of the Engineering students at the Polytechnic. The general structures of the learning patterns have been found to be rather persistent among the undergraduate students and was contrary to the development hypothesis (Vermunt & Verloop, 2000; Vermunt & Minnaert, 2003). However, there were some differences found within each structure when compared between groups and these were due to the students' perception of their respective contexts at the different stages of their education.

Efforts by the Singapore Ministry of Education and the Polytechnic to manipulate the learning context towards fostering deep and self-directed learning were evidently not as effective as expected. Conflicting context-bound factors such as time constraints, workload, and the perception that deep learning was not necessary to achieve good results were reported in this study. These were perceived to be hindrances that worked against the intent of the interventions. The results of this investigation supports those of earlier studies where superficial manipulation of the environment without considering students' perception of their context is not likely to bring about the desired change of behaviour (Entwistle, 1991; Zeegers, 2001; Vermetten et al., 2002).

Learning patterns of working adults engaged in continuing education at the same institute were also studied and used as a reference for comparison. In this case, the characteristics of lifelong learners were more distinctive for the meaning directed and application directed learning patterns found among the working adults. Considering that they were also immersed in the same cultural and educational contexts as the undergraduates, the key difference that shifted their learning patterns was their conceptions of learning and their study motives. This suggests that learning patterns can be shaped, at least partially, if these person-bound domains can be changed.

This study has thrown some light on the complex interrelations between the person-bound domains of learning conceptions and motives, and the context-dependent domains of study regulation and cognitive processing strategies. Interventions aimed at fostering the characteristics of quality learning that can be transferable to lifelong learning, would need to influence all the four domains of a learner, and this has to be supported within a congruent and conducive learning environment to effectively bring about change. This remains a major challenge for institutions of higher learning, but a necessary one that must be taken up so as to prepare learners for the demands of the 21st of the Century.

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APPENDIX A: Detailed Quantitative Data

In the tables reported in this Appendix, the following are the definitions of the respective codes used for the subscales of Vermunt's Inventory of Learning Styles (ILS):

Domain I: Processing Strategies

Relating and structuring	- SSDEEP1
Critical Processing	- SSDEEP2
Memorising and rehearsing	- SSTEP1
Analysing	- SSTEP2
Concrete processing	- CONCRETE

Domain II: Regulation Strategies

Self-regulation of learning processes and results	- SSELFR1
Self-regulation of learning content	- SSELFR2
External regulation of learning processes	- SSEXTER1
External regulation of learning results	- SSEXTER2
Lack of regulation	- LACKREG

Domain III: Learning Orientations

Personally interested	- INTEREST
Certificate directed	- CERTIFIC
Self-test directed	- SELFTEST
Vocation directed	- VOCATION
Ambivalent	- AMBIVALE

Domain IV: Mental models of learning

Construction of knowledge	- CONSTRUCT
Intake of knowledge	- INTAKE
Use of knowledge	- USEKNOW
Stimulating education	- STIMED
Co-operation	- COOPER

Table A.1

Summary of Tests for Homogeneity of Variances showing the Levene statistic, degrees of freedom and significance levels

	Levene Statistic	df1	df2	Sig.
SSDEEP1	3.537	3	2095	0.014
SSDEEP2	6.013	3	2095	0
SSSTEP1	4.096	3	2095	0.007
SSSTEP2	4.056	3	2095	0.007
CONCRETE	3.439	3	2095	0.016
SSSELFR1	1.748	3	2095	0.155
SSSELFR2	16.936	3	2095	0
SSEXTER1	3.684	3	2095	0.012
SSEXTER2	4.275	3	2095	0.005
LACKREG	14.44	3	2095	0
INTEREST	3.619	3	2095	0.013
CERTIFIC	4.671	3	2095	0.003
SELFTEST	1.595	3	2095	0.189
VOCATION	0.739	3	2095	0.529
AMBIVALE	8.342	3	2095	0
CONSTRUC	0.847	3	2095	0.468
INTAKE	4.213	3	2095	0.006
USEKNOW	5.196	3	2095	0.001
STIMED	3.931	3	2095	0.008
COOPER	12.752	3	2095	0

Table A.2

Summary of Tests of Equality of Means using the Welsh and Brown-Forsythe tests showing the Statistic values, degrees of freedom and significance values

Robust Tests of Equality of Means					
		Statistic[a]	df1	df2	Sig.
SSDEEP1	**Welch**	12.562	3	591.52	0
	Brown-Forsythe	12.144	3	1076.319	0
SSDEEP2	**Welch**	3.372	3	602.597	0.018
	Brown-Forsythe	3.159	3	1292.032	0.024
SSSTEP1	**Welch**	21.571	3	597.69	0
	Brown-Forsythe	20.772	3	1196.492	0
SSSTEP2	**Welch**	14.252	3	596.519	0
	Brown-Forsythe	13.641	3	1170.03	0
CONCRETE	**Welch**	8.198	3	588.385	0
	Brown-Forsythe	8.091	3	1020.251	0
SSSELFR1	**Welch**	11.704	3	590.096	0
	Brown-Forsythe	11.354	3	1054.934	0
SSSELFR2	**Welch**	5.891	3	590.293	0.001
	Brown-Forsythe	6.954	3	1110.908	0
SSEXTER1	**Welch**	20.441	3	605.707	0
	Brown-Forsythe	17.846	3	1329.421	0
SSEXTER2	**Welch**	10.94	3	598.612	0
	Brown-Forsythe	11.001	3	1204.166	0
LACKREG	**Welch**	1.218	3	602.791	0.302
	Brown-Forsythe	1.184	3	1320.551	0.314
INTEREST	**Welch**	15.678	3	580.696	0
	Brown-Forsythe	14.513	3	883.111	0
CERTIFIC	**Welch**	4.366	3	594.502	0.005
	Brown-Forsythe	4.283	3	1167.213	0.005
SELFTEST	**Welch**	1.159	3	593.547	0.325
	Brown-Forsythe	1.219	3	1125.234	0.302
VOCATION	**Welch**	7.322	3	602.525	0
	Brown-Forsythe	6.416	3	1269.57	0
AMBIVALE	**Welch**	27.88	3	581.858	0
	Brown-Forsythe	29.755	3	963.423	0

Robust Tests of Equality of Means					
		Statistic[a]	**df1**	**df2**	**Sig.**
CONSTRUC	**Welch**	6.889	3	597.575	0
	Brown-Forsythe	6.991	3	1180.414	0
INTAKE	**Welch**	1.549	3	584.694	0.201
	Brown-Forsythe	1.568	3	979.111	0.196
USEKNOW	**Welch**	6.119	3	604.586	0
	Brown-Forsythe	5.178	3	1310.295	0.001
STIMED	**Welch**	5.864	3	592.894	0.001
	Brown-Forsythe	6.08	3	1107.184	0
COOPER	**Welch**	11.873	3	593.031	0
	Brown-Forsythe	10.863	3	1153.527	0

a Asymptotically F distributed.

Table A.3

Between-years factorial analysis using Tukey's HSD and Tamhane's method – mean differences, standard errors, significance, confidence level and effect size (partial eta-squared).

Dependent Variable		(I) YEAR	(J) YEAR	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound	Partial Eta Sq
SSDEEP1	Tukey HSD	1	2	.225(*)	0.038	0	0.127	0.322	0.017
			3	0.092	0.0368	0.06	-0.003	0.187	
			4	0.162	0.0629	0.05	0	0.323	
		2	1	-.225(*)	0.038	0	-0.322	-0.127	
			3	-.133(*)	0.0371	0.002	-0.228	-0.037	
			4	-0.063	0.0631	0.75	-0.225	0.099	
		3	1	-0.092	0.0368	0.06	-0.187	0.003	
			2	.133(*)	0.0371	0.002	0.037	0.228	
			4	0.07	0.0623	0.68	-0.091	0.23	
		4	1	-0.162	0.0629	0.05	-0.323	0	
			2	0.063	0.0631	0.75	-0.099	0.225	
			3	-0.07	0.0623	0.68	-0.23	0.091	
	Tamhane	1	2	.225(*)	0.0374	0	0.126	0.323	
			3	0.092	0.0381	0.092	-0.008	0.192	
			4	0.162	0.0629	0.063	-0.005	0.328	
		2	1	-.225(*)	0.0374	0	-0.323	-0.126	
			3	-.133(*)	0.0362	0.002	-0.228	-0.037	
			4	-0.063	0.0617	0.891	-0.227	0.101	
		3	1	-0.092	0.0381	0.092	-0.192	0.008	
			2	.133(*)	0.0362	0.002	0.037	0.228	
			4	0.07	0.0621	0.842	-0.096	0.235	
		4	1	-0.162	0.0629	0.063	-0.328	0.005	
			2	0.063	0.0617	0.891	-0.101	0.227	
			3	-0.07	0.0621	0.842	-0.235	0.096	
SSDEEP2	Tukey HSD	1	2	0.039	0.0461	0.834	-0.08	0.157	0.004
			3	0.086	0.0446	0.212	-0.028	0.201	
			4	.206(*)	0.0761	0.034	0.011	0.402	
		2	1	-0.039	0.0461	0.834	-0.157	0.08	
			3	0.048	0.045	0.715	-0.068	0.163	
			4	0.168	0.0763	0.125	-0.029	0.364	
		3	1	-0.086	0.0446	0.212	-0.201	0.028	
			2	-0.048	0.045	0.715	-0.163	0.068	
			4	0.12	0.0754	0.385	-0.074	0.314	
		4	1	-.206(*)	0.0761	0.034	-0.402	-0.011	
			2	-0.168	0.0763	0.125	-0.364	0.029	
			3	-0.12	0.0754	0.385	-0.314	0.074	
	Tamhane	1	2	0.039	0.0477	0.96	-0.087	0.164	
			3	0.086	0.0442	0.27	-0.03	0.203	
			4	.206(*)	0.0698	0.021	0.021	0.392	
		2	1	-0.039	0.0477	0.96	-0.164	0.087	
			3	0.048	0.0452	0.874	-0.071	0.167	
			4	0.168	0.0704	0.104	-0.019	0.354	
		3	1	-0.086	0.0442	0.27	-0.203	0.03	
			2	-0.048	0.0452	0.874	-0.167	0.071	
			4	0.12	0.0681	0.393	-0.061	0.301	
		4	1	-.206(*)	0.0698	0.021	-0.392	-0.021	
			2	-0.168	0.0704	0.104	-0.354	0.019	
			3	-0.12	0.0681	0.393	-0.301	0.061	
SSSTEP1	Tukey HSD	1	2	.179(*)	0.0399	0	0.076	0.281	0.028
			3	-0.098	0.0386	0.056	-0.197	0.002	
			4	.204(*)	0.0659	0.01	0.035	0.374	

Dependent Variable		(I) YEAR	(J) YEAR	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound	Partial Eta Sq
		2	1	-.179(*)	0.0399	0	-0.281	-0.076	
			3	-.276(*)	0.0389	0	-0.376	-0.176	
			4	0.026	0.0661	0.98	-0.144	0.195	
		3	1	0.098	0.0386	0.056	-0.002	0.197	
			2	.276(*)	0.0389	0	0.176	0.376	
			4	.302(*)	0.0653	0	0.134	0.47	
		4	1	-.204(*)	0.0659	0.01	-0.374	-0.035	
			2	-0.026	0.0661	0.98	-0.195	0.144	
			3	-.302(*)	0.0653	0	-0.47	-0.134	
	Tamhane	1	2	.179(*)	0.0399	0	0.074	0.284	
			3	-0.098	0.0402	0.089	-0.203	0.008	
			4	.204(*)	0.0632	0.008	0.037	0.372	
		2	1	-.179(*)	0.0399	0	-0.284	-0.074	
			3	-.276(*)	0.0375	0	-0.375	-0.178	
			4	0.026	0.0615	0.999	-0.138	0.189	
		3	1	0.098	0.0402	0.089	-0.008	0.203	
			2	.276(*)	0.0375	0	0.178	0.375	
			4	.302(*)	0.0617	0	0.138	0.466	
		4	1	-.204(*)	0.0632	0.008	-0.372	-0.037	
			2	-0.026	0.0615	0.999	-0.189	0.138	
			3	-.302(*)	0.0617	0	-0.466	-0.138	
SSSTEP2	Tukey HSD	1	2	0.089	0.0381	0.091	-0.009	0.187	0.019
			3	-0.01	0.0369	0.992	-0.105	0.084	
			4	.354(*)	0.063	0	0.193	0.516	
		2	1	-0.089	0.0381	0.091	-0.187	0.009	
			3	-.099(*)	0.0372	0.038	-0.195	-0.004	
			4	.266(*)	0.0632	0	0.103	0.428	
		3	1	0.01	0.0369	0.992	-0.084	0.105	
			2	.099(*)	0.0372	0.038	0.004	0.195	
			4	.365(*)	0.0624	0	0.204	0.525	
		4	1	-.354(*)	0.063	0	-0.516	-0.193	
			2	-.266(*)	0.0632	0	-0.428	-0.103	
			3	-.365(*)	0.0624	0	-0.525	-0.204	
	Tamhane	1	2	0.089	0.0378	0.108	-0.011	0.189	
			3	-0.01	0.0383	1	-0.111	0.091	
			4	.354(*)	0.0608	0	0.193	0.516	
		2	1	-0.089	0.0378	0.108	-0.189	0.011	
			3	-.099(*)	0.0361	0.036	-0.194	-0.004	
			4	.266(*)	0.0595	0	0.108	0.424	
		3	1	0.01	0.0383	1	-0.091	0.111	
			2	.099(*)	0.0361	0.036	0.004	0.194	
			4	.365(*)	0.0598	0	0.206	0.524	
		4	1	-.354(*)	0.0608	0	-0.516	-0.193	
			2	-.266(*)	0.0595	0	-0.424	-0.108	
			3	-.365(*)	0.0598	0	-0.524	-0.206	
CONCRETE	Tukey HSD	1	2	.163(*)	0.0406	0	0.059	0.267	0.012
			3	0.089	0.0393	0.103	-0.011	0.19	
			4	-0.098	0.067	0.464	-0.27	0.075	
		2	1	-.163(*)	0.0406	0	-0.267	-0.059	
			3	-0.074	0.0396	0.248	-0.175	0.028	
			4	-.261(*)	0.0673	0.001	-0.434	-0.088	
		3	1	-0.089	0.0393	0.103	-0.19	0.011	
			2	0.074	0.0396	0.248	-0.028	0.175	
			4	-.187(*)	0.0665	0.025	-0.358	-0.016	
		4	1	0.098	0.067	0.464	-0.075	0.27	
			2	.261(*)	0.0673	0.001	0.088	0.434	

Dependent Variable		(I) YEAR	(J) YEAR	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound	Partial Eta Sq
			3	.187(*)	0.0665	0.025	0.016	0.358	
	Tamhane	1	2	.163(*)	0.0404	0	0.057	0.269	
			3	0.089	0.04	0.144	-0.016	0.195	
			4	-0.098	0.0687	0.64	-0.28	0.085	
		2	1	-.163(*)	0.0404	0	-0.269	-0.057	
			3	-0.074	0.0387	0.3	-0.175	0.028	
			4	-.261(*)	0.0679	0.001	-0.441	-0.08	
		3	1	-0.089	0.04	0.144	-0.195	0.016	
			2	0.074	0.0387	0.3	-0.028	0.175	
			4	-.187(*)	0.0677	0.037	-0.367	-0.007	
		4	1	0.098	0.0687	0.64	-0.085	0.28	
			2	.261(*)	0.0679	0.001	0.08	0.441	
			3	.187(*)	0.0677	0.037	0.007	0.367	
SSSELFR1	Tukey HSD	1	2	.119(*)	0.0402	0.017	0.015	0.222	0.016
			3	-0.081	0.0389	0.163	-0.18	0.019	
			4	.187(*)	0.0664	0.026	0.016	0.358	
		2	1	-.119(*)	0.0402	0.017	-0.222	-0.015	
			3	-.199(*)	0.0393	0	-0.3	-0.098	
			4	0.068	0.0666	0.736	-0.103	0.24	
		3	1	0.081	0.0389	0.163	-0.019	0.18	
			2	.199(*)	0.0393	0	0.098	0.3	
			4	.267(*)	0.0659	0	0.098	0.437	
		4	1	-.187(*)	0.0664	0.026	-0.358	-0.016	
			2	-0.068	0.0666	0.736	-0.24	0.103	
			3	-.267(*)	0.0659	0	-0.437	-0.098	
	Tamhane	1	2	.119(*)	0.0402	0.019	0.013	0.225	
			3	-0.081	0.0397	0.232	-0.185	0.024	
			4	.187(*)	0.0671	0.035	0.009	0.365	
		2	1	-.119(*)	0.0402	0.019	-0.225	-0.013	
			3	-.199(*)	0.0383	0	-0.3	-0.098	
			4	0.068	0.0663	0.887	-0.108	0.244	
		3	1	0.081	0.0397	0.232	-0.024	0.185	
			2	.199(*)	0.0383	0	0.098	0.3	
			4	.267(*)	0.066	0	0.092	0.443	
		4	1	-.187(*)	0.0671	0.035	-0.365	-0.009	
			2	-0.068	0.0663	0.887	-0.244	0.108	
			3	-.267(*)	0.066	0	-0.443	-0.092	
SSSELFR2	Tukey HSD	1	2	.146(*)	0.0455	0.008	0.029	0.262	0.01
			3	.160(*)	0.044	0.002	0.047	0.274	
			4	.258(*)	0.0752	0.003	0.065	0.452	
		2	1	-.146(*)	0.0455	0.008	-0.262	-0.029	
			3	0.015	0.0444	0.987	-0.099	0.129	
			4	0.113	0.0754	0.44	-0.081	0.307	
		3	1	-.160(*)	0.044	0.002	-0.274	-0.047	
			2	-0.015	0.0444	0.987	-0.129	0.099	
			4	0.098	0.0745	0.554	-0.094	0.289	
		4	1	-.258(*)	0.0752	0.003	-0.452	-0.065	
			2	-0.113	0.0754	0.44	-0.307	0.081	
			3	-0.098	0.0745	0.554	-0.289	0.094	
	Tamhane	1	2	.146(*)	0.0471	0.012	0.021	0.27	
			3	.160(*)	0.0464	0.003	0.038	0.283	
			4	.258(*)	0.0755	0.004	0.058	0.459	
		2	1	-.146(*)	0.0471	0.012	-0.27	-0.021	
			3	0.015	0.0408	0.999	-0.093	0.123	
			4	0.113	0.0722	0.535	-0.079	0.305	
		3	1	-.160(*)	0.0464	0.003	-0.283	-0.038	

Dependent Variable		(I) YEAR	(J) YEAR	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound	Partial Eta Sq
			2	-0.015	0.0408	0.999	-0.123	0.093	
			4	0.098	0.0717	0.682	-0.093	0.289	
		4	1	-.258(*)	0.0755	0.004	-0.459	-0.058	
			2	-0.113	0.0722	0.535	-0.305	0.079	
			3	-0.098	0.0717	0.682	-0.289	0.093	
SSEXTER1	Tukey HSD	1	2	0.031	0.0381	0.845	-0.067	0.129	0.023
			3	-.096(*)	0.0369	0.045	-0.191	-0.001	
			4	.336(*)	0.063	0	0.174	0.498	
		2	1	-0.031	0.0381	0.845	-0.129	0.067	
			3	-.128(*)	0.0372	0.004	-0.223	-0.032	
			4	.305(*)	0.0632	0	0.142	0.467	
		3	1	.096(*)	0.0369	0.045	0.001	0.191	
			2	.128(*)	0.0372	0.004	0.032	0.223	
			4	.432(*)	0.0625	0	0.272	0.593	
		4	1	-.336(*)	0.063	0	-0.498	-0.174	
			2	-.305(*)	0.0632	0	-0.467	-0.142	
			3	-.432(*)	0.0625	0	-0.593	-0.272	
	Tamhane	1	2	0.031	0.039	0.963	-0.071	0.134	
			3	-.096	0.038	0.066	-0.196	0.004	
			4	.336(*)	0.0576	0	0.183	0.489	
		2	1	-0.031	0.039	0.963	-0.134	0.071	
			3	-.128(*)	0.0363	0.003	-0.223	-0.032	
			4	.305(*)	0.0565	0	0.155	0.455	
		3	1	0.096	0.038	0.066	-0.004	0.196	
			2	.128(*)	0.0363	0.003	0.032	0.223	
			4	.432(*)	0.0558	0	0.284	0.58	
		4	1	-.336(*)	0.0576	0	-0.489	-0.183	
			2	-.305(*)	0.0565	0	-0.455	-0.155	
			3	-.432(*)	0.0558	0	-0.58	-0.284	
SSEXTER2	Tukey HSD	1	2	.178(*)	0.0406	0	0.074	0.282	0.015
			3	0.095	0.0392	0.075	-0.006	0.196	
			4	.312(*)	0.067	0	0.14	0.484	
		2	1	-.178(*)	0.0406	0	-0.282	-0.074	
			3	-0.083	0.0396	0.153	-0.185	0.019	
			4	0.134	0.0672	0.191	-0.039	0.307	
		3	1	-0.095	0.0392	0.075	-0.196	0.006	
			2	0.083	0.0396	0.153	-0.019	0.185	
			4	.217(*)	0.0664	0.006	0.046	0.388	
		4	1	-.312(*)	0.067	0	-0.484	-0.14	
			2	-0.134	0.0672	0.191	-0.307	0.039	
			3	-.217(*)	0.0664	0.006	-0.388	-0.046	
	Tamhane	1	2	.178(*)	0.0403	0	0.072	0.284	
			3	0.095	0.0406	0.114	-0.012	0.202	
			4	.312(*)	0.0639	0	0.142	0.481	
		2	1	-.178(*)	0.0403	0	-0.284	-0.072	
			3	-0.083	0.0387	0.175	-0.185	0.019	
			4	0.134	0.0626	0.186	-0.032	0.3	
		3	1	-0.095	0.0406	0.114	-0.202	0.012	
			2	0.083	0.0387	0.175	-0.019	0.185	
			4	.217(*)	0.0628	0.004	0.05	0.384	
		4	1	-.312(*)	0.0639	0	-0.481	-0.142	
			2	-0.134	0.0626	0.186	-0.3	0.032	
			3	-.217(*)	0.0628	0.004	-0.384	-0.05	

Dependent Variable		(I) YEAR	(J) YEAR	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound	Partial Eta Sq
LACKREG	Tukey HSD	1	2	0.05	0.0381	0.554	-0.048	0.148	0.002
			3	0.011	0.0369	0.991	-0.084	0.106	
			4	0.091	0.063	0.474	-0.071	0.253	
		2	1	-0.05	0.0381	0.554	-0.148	0.048	
			3	-0.039	0.0372	0.722	-0.135	0.057	
			4	0.041	0.0632	0.918	-0.122	0.203	
		3	1	-0.011	0.0369	0.991	-0.106	0.084	
			2	0.039	0.0372	0.722	-0.057	0.135	
			4	0.08	0.0624	0.579	-0.081	0.24	
		4	1	-0.091	0.063	0.474	-0.253	0.071	
			2	-0.041	0.0632	0.918	-0.203	0.122	
			3	-0.08	0.0624	0.579	-0.24	0.081	
	Tamhane	1	2	0.05	0.0402	0.762	-0.056	0.156	
			3	0.011	0.0382	1	-0.09	0.112	
			4	0.091	0.0583	0.538	-0.064	0.245	
		2	1	-0.05	0.0402	0.762	-0.156	0.056	
			3	-0.039	0.0352	0.847	-0.132	0.054	
			4	0.041	0.0564	0.978	-0.109	0.19	
		3	1	-0.011	0.0382	1	-0.112	0.09	
			2	0.039	0.0352	0.847	-0.054	0.132	
			4	0.08	0.055	0.621	-0.066	0.226	
		4	1	-0.091	0.0583	0.538	-0.245	0.064	
			2	-0.041	0.0564	0.978	-0.19	0.109	
			3	-0.08	0.055	0.621	-0.226	0.066	
INTEREST	Tukey HSD	1	2	.178(*)	0.0337	0	0.091	0.265	0.021
			3	.154(*)	0.0326	0	0.07	0.238	
			4	.295(*)	0.0557	0	0.152	0.438	
		2	1	-.178(*)	0.0337	0	-0.265	-0.091	
			3	-0.024	0.0329	0.887	-0.108	0.061	
			4	0.117	0.0558	0.154	-0.026	0.261	
		3	1	-.154(*)	0.0326	0	-0.238	-0.07	
			2	0.024	0.0329	0.887	-0.061	0.108	
			4	0.141	0.0552	0.052	-0.001	0.283	
		4	1	-.295(*)	0.0557	0	-0.438	-0.152	
			2	-0.117	0.0558	0.154	-0.261	0.026	
			3	-0.141	0.0552	0.052	-0.283	0.001	
	Tamhane	1	2	.178(*)	0.0334	0	0.09	0.266	
			3	.154(*)	0.0314	0	0.071	0.237	
			4	.295(*)	0.0597	0	0.136	0.454	
		2	1	-.178(*)	0.0334	0	-0.266	-0.09	
			3	-0.024	0.0336	0.98	-0.113	0.065	
			4	0.117	0.0609	0.292	-0.045	0.279	
		3	1	-.154(*)	0.0314	0	-0.237	-0.071	
			2	0.024	0.0336	0.98	-0.065	0.113	
			4	0.141	0.0599	0.111	-0.018	0.3	
		4	1	-.295(*)	0.0597	0	-0.454	-0.136	
			2	-0.117	0.0609	0.292	-0.279	0.045	
			3	-0.141	0.0599	0.111	-0.3	0.018	
CERTIFIC	Tukey HSD	1	2	0.074	0.0391	0.229	-0.026	0.175	0.006
			3	0.027	0.0378	0.894	-0.07	0.124	
			4	.213(*)	0.0646	0.005	0.047	0.379	
		2	1	-0.074	0.0391	0.229	-0.175	0.026	
			3	-0.047	0.0382	0.6	-0.146	0.051	

Dependent Variable		(I) YEAR	(J) YEAR	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval		Partial Eta Sq
							Lower Bound	Upper Bound	
			4	0.139	0.0648	0.14	-0.028	0.306	
		3	1	-0.027	0.0378	0.894	-0.124	0.07	
			2	0.047	0.0382	0.6	-0.051	0.146	
			4	.186(*)	0.064	0.019	0.022	0.351	
		4	1	-.213(*)	0.0646	0.005	-0.379	-0.047	
			2	-0.139	0.0648	0.14	-0.306	0.028	
			3	-.186(*)	0.064	0.019	-0.351	-0.022	
	Tamhane	1	2	0.074	0.0405	0.341	-0.032	0.181	
			3	0.027	0.0388	0.982	-0.075	0.129	
			4	.213(*)	0.063	0.005	0.046	0.38	
		2	1	-0.074	0.0405	0.341	-0.181	0.032	
			3	-0.047	0.0365	0.727	-0.144	0.049	
			4	0.139	0.0617	0.142	-0.025	0.303	
		3	1	-0.027	0.0388	0.982	-0.129	0.075	
			2	0.047	0.0365	0.727	-0.049	0.144	
			4	.186(*)	0.0606	0.014	0.025	0.347	
		4	1	-.213(*)	0.063	0.005	-0.38	-0.046	
			2	-0.139	0.0617	0.142	-0.303	0.025	
			3	-.186(*)	0.0606	0.014	-0.347	-0.025	
SELFTEST	Tukey HSD	1	2	0.047	0.0428	0.692	-0.063	0.157	0.002
			3	0.078	0.0414	0.237	-0.029	0.184	
			4	0.029	0.0706	0.976	-0.152	0.211	
		2	1	-0.047	0.0428	0.692	-0.157	0.063	
			3	0.031	0.0417	0.881	-0.076	0.138	
			4	-0.018	0.0709	0.995	-0.2	0.165	
		3	1	-0.078	0.0414	0.237	-0.184	0.029	
			2	-0.031	0.0417	0.881	-0.138	0.076	
			4	-0.048	0.07	0.9	-0.229	0.132	
		4	1	-0.029	0.0706	0.976	-0.211	0.152	
			2	0.018	0.0709	0.995	-0.165	0.2	
			3	0.048	0.07	0.9	-0.132	0.229	
	Tamhane	1	2	0.047	0.0433	0.861	-0.067	0.161	
			3	0.078	0.042	0.33	-0.033	0.189	
			4	0.029	0.0695	0.999	-0.155	0.214	
		2	1	-0.047	0.0433	0.861	-0.161	0.067	
			3	0.031	0.0408	0.972	-0.077	0.139	
			4	-0.018	0.0688	1	-0.2	0.165	
		3	1	-0.078	0.042	0.33	-0.189	0.033	
			2	-0.031	0.0408	0.972	-0.139	0.077	
			4	-0.048	0.068	0.98	-0.229	0.132	
		4	1	-0.029	0.0695	0.999	-0.214	0.155	
			2	0.018	0.0688	1	-0.165	0.2	
			3	0.048	0.068	0.98	-0.132	0.229	
VOCATION	Tukey HSD	1	2	-0.004	0.0395	1	-0.106	0.097	0.009
			3	-0.023	0.0382	0.932	-0.121	0.075	
			4	-.268(*)	0.0652	0	-0.436	-0.101	
		2	1	0.004	0.0395	1	-0.097	0.106	
			3	-0.019	0.0385	0.963	-0.118	0.081	
			4	-.264(*)	0.0654	0	-0.432	-0.096	
		3	1	0.023	0.0382	0.932	-0.075	0.121	
			2	0.019	0.0385	0.963	-0.081	0.118	
			4	-.245(*)	0.0647	0.001	-0.412	-0.079	
		4	1	.268(*)	0.0652	0	0.101	0.436	

Dependent Variable		(I) YEAR	(J) YEAR	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound	Partial Eta Sq
			2	.264(*)	0.0654	0	0.096	0.432	
			3	.245(*)	0.0647	0.001	0.079	0.412	
	Tamhane	1	2	-0.004	0.0398	1	-0.109	0.1	
			3	-0.023	0.039	0.992	-0.126	0.08	
			4	-.268(*)	0.0605	0	-0.429	-0.108	
		2	1	0.004	0.0398	1	-0.1	0.109	
			3	-0.019	0.0382	0.997	-0.119	0.082	
			4	-.264(*)	0.06	0	-0.423	-0.105	
		3	1	0.023	0.039	0.992	-0.08	0.126	
			2	0.019	0.0382	0.997	-0.082	0.119	
			4	-.245(*)	0.0595	0	-0.403	-0.087	
		4	1	.268(*)	0.0605	0	0.108	0.429	
			2	.264(*)	0.06	0	0.105	0.423	
			3	.245(*)	0.0595	0	0.087	0.403	
AMBIVALE	Tukey HSD	1	2	-.148(*)	0.0415	0.002	-0.255	-0.041	0.042
			3	-0.065	0.0402	0.367	-0.168	0.038	
			4	.504(*)	0.0686	0	0.328	0.681	
		2	1	.148(*)	0.0415	0.002	0.041	0.255	
			3	0.083	0.0405	0.172	-0.021	0.187	
			4	.652(*)	0.0688	0	0.476	0.829	
		3	1	0.065	0.0402	0.367	-0.038	0.168	
			2	-0.083	0.0405	0.172	-0.187	0.021	
			4	.570(*)	0.068	0	0.395	0.744	
		4	1	-.504(*)	0.0686	0	-0.681	-0.328	
			2	-.652(*)	0.0688	0	-0.829	-0.476	
			3	-.570(*)	0.068	0	-0.744	-0.395	
	Tamhane	1	2	-.148(*)	0.0435	0.004	-0.263	-0.033	
			3	-0.065	0.0392	0.46	-0.169	0.038	
			4	.504(*)	0.0722	0	0.313	0.696	
		2	1	.148(*)	0.0435	0.004	0.033	0.263	
			3	0.083	0.0398	0.204	-0.022	0.188	
			4	.652(*)	0.0725	0	0.46	0.845	
		3	1	0.065	0.0392	0.46	-0.038	0.169	
			2	-0.083	0.0398	0.204	-0.188	0.022	
			4	.570(*)	0.07	0	0.383	0.756	
		4	1	-.504(*)	0.0722	0	-0.696	-0.313	
			2	-.652(*)	0.0725	0	-0.845	-0.46	
			3	-.570(*)	0.07	0	-0.756	-0.383	
CONSTRUC	Tukey HSD	1	2	.113(*)	0.0343	0.005	0.025	0.202	0.01
			3	.132(*)	0.0332	0	0.047	0.218	
			4	0.004	0.0567	1	-0.142	0.15	
		2	1	-.113(*)	0.0343	0.005	-0.202	-0.025	
			3	0.019	0.0335	0.943	-0.067	0.105	
			4	-0.11	0.0569	0.217	-0.256	0.037	
		3	1	-.132(*)	0.0332	0	-0.218	-0.047	
			2	-0.019	0.0335	0.943	-0.105	0.067	
			4	-0.128	0.0562	0.102	-0.273	0.016	
		4	1	-0.004	0.0567	1	-0.15	0.142	
			2	0.11	0.0569	0.217	-0.037	0.256	
			3	0.128	0.0562	0.102	-0.016	0.273	
	Tamhane	1	2	.113(*)	0.0338	0.005	0.024	0.202	
			3	.132(*)	0.0334	0	0.044	0.22	
			4	0.004	0.0537	1	-0.139	0.147	

Dependent Variable		(I) YEAR	(J) YEAR	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval		Partial Eta Sq
							Lower Bound	Upper Bound	
		2	1	-.113(*)	0.0338	0.005	-0.202	-0.024	
			3	0.019	0.0341	0.995	-0.071	0.109	
			4	-0.11	0.0542	0.238	-0.253	0.034	
		3	1	-.132(*)	0.0334	0	-0.22	-0.044	
			2	-0.019	0.0341	0.995	-0.109	0.071	
			4	-0.128	0.0539	0.104	-0.272	0.015	
		4	1	-0.004	0.0537	1	-0.147	0.139	
			2	0.11	0.0542	0.238	-0.034	0.253	
			3	0.128	0.0539	0.104	-0.015	0.272	
INTAKE	Tukey HSD	1	2	-0.055	0.0346	0.381	-0.144	0.034	0.002
			3	-0.061	0.0335	0.258	-0.148	0.025	
			4	0.011	0.0572	0.998	-0.136	0.158	
		2	1	0.055	0.0346	0.381	-0.034	0.144	
			3	-0.006	0.0338	0.998	-0.093	0.081	
			4	0.066	0.0574	0.657	-0.081	0.214	
		3	1	0.061	0.0335	0.258	-0.025	0.148	
			2	0.006	0.0338	0.998	-0.081	0.093	
			4	0.072	0.0567	0.581	-0.074	0.218	
		4	1	-0.011	0.0572	0.998	-0.158	0.136	
			2	-0.066	0.0574	0.657	-0.214	0.081	
			3	-0.072	0.0567	0.581	-0.218	0.074	
	Tamhane	1	2	-0.055	0.0355	0.535	-0.149	0.038	
			3	-0.061	0.0336	0.345	-0.15	0.027	
			4	0.011	0.0599	1	-0.148	0.17	
		2	1	0.055	0.0355	0.535	-0.038	0.149	
			3	-0.006	0.0328	1	-0.092	0.08	
			4	0.066	0.0595	0.846	-0.092	0.224	
		3	1	0.061	0.0336	0.345	-0.027	0.15	
			2	0.006	0.0328	1	-0.08	0.092	
			4	0.072	0.0584	0.771	-0.083	0.227	
		4	1	-0.011	0.0599	1	-0.17	0.148	
			2	-0.066	0.0595	0.846	-0.224	0.092	
			3	-0.072	0.0584	0.771	-0.227	0.083	
USEKNOW	Tukey HSD	1	2	0.034	0.0348	0.757	-0.055	0.124	0.007
			3	0.029	0.0337	0.829	-0.058	0.115	
			4	-.176(*)	0.0575	0.012	-0.324	-0.028	
		2	1	-0.034	0.0348	0.757	-0.124	0.055	
			3	-0.006	0.034	0.998	-0.093	0.082	
			4	-.211(*)	0.0577	0.002	-0.359	-0.062	
		3	1	-0.029	0.0337	0.829	-0.115	0.058	
			2	0.006	0.034	0.998	-0.082	0.093	
			4	-.205(*)	0.057	0.002	-0.351	-0.058	
		4	1	.176(*)	0.0575	0.012	0.028	0.324	
			2	.211(*)	0.0577	0.002	0.062	0.359	
			3	.205(*)	0.057	0.002	0.058	0.351	
	Tamhane	1	2	0.034	0.0345	0.9	-0.056	0.125	
			3	0.029	0.0356	0.962	-0.065	0.123	
			4	-.176(*)	0.0528	0.006	-0.316	-0.036	
		2	1	-0.034	0.0345	0.9	-0.125	0.056	
			3	-0.006	0.0327	1	-0.092	0.08	
			4	-.211(*)	0.0509	0	-0.346	-0.075	
		3	1	-0.029	0.0356	0.962	-0.123	0.065	
			2	0.006	0.0327	1	-0.08	0.092	

Dependent Variable		(I) YEAR	(J) YEAR	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound	Partial Eta Sq
			4	-.205(*)	0.0517	0.001	-0.342	-0.068	
		4	1	.176(*)	0.0528	0.006	0.036	0.316	
			2	.211(*)	0.0509	0	0.075	0.346	
			3	.205(*)	0.0517	0.001	0.068	0.342	
STIMED	Tukey HSD	1	2	.110(*)	0.0349	0.009	0.02	0.2	0.009
			3	.131(*)	0.0337	0.001	0.044	0.217	
			4	0.138	0.0576	0.077	-0.01	0.286	
		2	1	-.110(*)	0.0349	0.009	-0.2	-0.02	
			3	0.021	0.034	0.929	-0.067	0.108	
			4	0.028	0.0578	0.961	-0.12	0.177	
		3	1	-.131(*)	0.0337	0.001	-0.217	-0.044	
			2	-0.021	0.034	0.929	-0.108	0.067	
			4	0.008	0.0571	0.999	-0.139	0.154	
		4	1	-0.138	0.0576	0.077	-0.286	0.01	
			2	-0.028	0.0578	0.961	-0.177	0.12	
			3	-0.008	0.0571	0.999	-0.154	0.139	
	Tamhane	1	2	.110(*)	0.0351	0.011	0.018	0.202	
			3	.131(*)	0.034	0.001	0.041	0.22	
			4	0.138	0.0568	0.09	-0.012	0.289	
		2	1	-.110(*)	0.0351	0.011	-0.202	-0.018	
			3	0.021	0.0337	0.99	-0.068	0.11	
			4	0.028	0.0566	0.997	-0.122	0.179	
		3	1	-.131(*)	0.034	0.001	-0.22	-0.041	
			2	-0.021	0.0337	0.99	-0.11	0.068	
			4	0.008	0.056	1	-0.141	0.156	
		4	1	-0.138	0.0568	0.09	-0.289	0.012	
			2	-0.028	0.0566	0.997	-0.179	0.122	
			3	-0.008	0.056	1	-0.156	0.141	
COOPER	Tukey HSD	1	2	0.054	0.0439	0.609	-0.059	0.167	0.015
			3	-.109(*)	0.0424	0.049	-0.218	0	
			4	.255(*)	0.0725	0.002	0.069	0.441	
		2	1	-0.054	0.0439	0.609	-0.167	0.059	
			3	-.163(*)	0.0428	0.001	-0.273	-0.053	
			4	.201(*)	0.0727	0.029	0.014	0.388	
		3	1	.109(*)	0.0424	0.049	0	0.218	
			2	.163(*)	0.0428	0.001	0.053	0.273	
			4	.365(*)	0.0718	0	0.18	0.549	
		4	1	-.255(*)	0.0725	0.002	-0.441	-0.069	
			2	-.201(*)	0.0727	0.029	-0.388	-0.014	
			3	-.365(*)	0.0718	0	-0.549	-0.18	
	Tamhane	1	2	0.054	0.0459	0.808	-0.067	0.175	
			3	-0.109	0.0426	0.061	-0.222	0.003	
			4	.255(*)	0.0708	0.002	0.067	0.443	
		2	1	-0.054	0.0459	0.808	-0.175	0.067	
			3	-.163(*)	0.0416	0.001	-0.273	-0.054	
			4	.201(*)	0.0702	0.027	0.015	0.388	
		3	1	0.109	0.0426	0.061	-0.003	0.222	
			2	.163(*)	0.0416	0.001	0.054	0.273	
			4	.365(*)	0.0682	0	0.183	0.546	
		4	1	-.255(*)	0.0708	0.002	-0.443	-0.067	
			2	-.201(*)	0.0702	0.027	-0.388	-0.015	
			3	-.365(*)	0.0682	0	-0.546	-0.183	

* The mean difference is significant at the .05 level.

Table A.4

Kaiser-Meyer-Olkin measure of sampling frequency and Barlett's test of sphericity for each year group

Year		Year 1	Year 2	Year 3	Professionals
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.834	0.878	0.863	0.792
Bartlett's Test of Sphericity	**Approx. Chi-Square**	10267.824	6619.222	8188.629	1336.139
	df	190	190	190	190
	Sig.	0	0	0	0

Table A.5.1

Correlation between the 20 ILS sub-scale items for Year 1 data

Correlation Matrix(a)

		SSDEEP1	SSDEEP2	SSSTEP1	SSSTEP2	CONCRETE	SSSELFR1	SSSELFR2	SSEXTER1	SSEXTER2	LACKREG	INTEREST	CERTIFIC	SELFTEST	VOCATION	AMBIVALE	CONSTRUC	INTAKE	USEKNOW	STIMED	COOPER
Correlation	SSDEEP1	1	0.621	0.583	0.662	0.631	0.728	0.708	0.542	0.637	0.344	0.371	0.06	0.168	0.205	0.047	0.553	0.095	0.297	0.413	0.113
	SSDEEP2	0.621	1	0.417	0.615	0.733	0.727	0.688	0.274	0.382	0.621	0.372	-0.015	0.136	0.187	0.336	0.412	-0.134	0.041	0.308	0.16
	SSSTEP1	0.583	0.417	1	0.585	0.365	0.539	0.46	0.494	0.503	0.448	0.358	0.195	0.185	0.153	0.224	0.286	0.353	0.39	0.224	0.317
	SSSTEP2	0.662	0.615	0.585	1	0.606	0.699	0.64	0.631	0.627	0.442	0.351	0.204	0.145	0.166	0.267	0.471	0.317	0.343	0.446	0.115
	CONCRETE	0.631	0.733	0.365	0.606	1	0.747	0.58	0.293	0.476	0.45	0.423	0.111	0.217	0.294	0.29	0.44	0.001	0.269	0.351	0.262
	SSSELFR1	0.728	0.727	0.539	0.699	0.747	1	0.757	0.458	0.601	0.39	0.38	0.091	0.216	0.195	0.218	0.539	0.121	0.242	0.345	0.187
	SSSELFR2	0.708	0.688	0.46	0.64	0.58	0.757	1	0.51	0.47	0.413	0.392	-0.024	-0.01	-0.012	0.2	0.482	-0.002	0.159	0.327	0.112
	SSEXTER1	0.542	0.274	0.494	0.631	0.293	0.458	0.51	1	0.607	0.278	0.33	0.273	0.092	0.044	0.237	0.376	0.355	0.342	0.292	0.153
	SSEXTER2	0.637	0.382	0.503	0.627	0.476	0.601	0.47	0.607	1	0.354	0.408	0.208	0.46	0.419	0.151	0.535	0.408	0.518	0.41	0.187
	LACKREG	0.344	0.621	0.448	0.442	0.45	0.39	0.413	0.278	0.354	1	0.479	0.153	0.06	0.16	0.555	0.109	0.137	0.205	0.214	0.307
	INTEREST	0.371	0.372	0.358	0.351	0.423	0.38	0.392	0.33	0.408	0.479	1	0.446	0.421	0.444	0.257	0.481	0.407	0.601	0.53	0.46
	CERTIFIC	0.06	-0.015	0.195	0.204	0.111	0.091	-0.024	0.273	0.208	0.153	0.446	1	0.365	0.412	0.371	0.31	0.661	0.499	0.289	0.352
	SELFTEST	0.168	0.136	0.185	0.145	0.217	0.216	-0.01	0.092	0.46	0.06	0.421	0.365	1	0.808	0.002	0.524	0.456	0.502	0.59	0.184
	VOCATION	0.205	0.187	0.153	0.166	0.294	0.195	-0.012	0.044	0.419	0.16	0.444	0.412	0.808	1	0.092	0.441	0.401	0.541	0.538	0.228
	AMBIVALE	0.047	0.336	0.224	0.267	0.29	0.218	0.2	0.237	0.151	0.555	0.257	0.371	0.002	0.092	1	0.145	0.236	0.23	0.044	0.326
	CONSTRUC	0.553	0.412	0.286	0.471	0.44	0.539	0.482	0.376	0.535	0.109	0.481	0.31	0.524	0.441	0.145	1	0.366	0.591	0.659	0.19
	INTAKE	0.095	-0.134	0.353	0.317	0.001	0.121	-0.002	0.355	0.408	0.137	0.407	0.661	0.456	0.401	0.236	0.366	1	0.707	0.431	0.373
	USEKNOW	0.297	0.041	0.39	0.343	0.269	0.242	0.159	0.342	0.518	0.205	0.601	0.499	0.502	0.541	0.23	0.591	0.707	1	0.536	0.451
	STIMED	0.413	0.308	0.224	0.446	0.351	0.345	0.327	0.292	0.41	0.214	0.53	0.289	0.59	0.538	0.044	0.659	0.431	0.536	1	0.148
	COOPER	0.113	0.16	0.317	0.115	0.262	0.187	0.112	0.153	0.187	0.307	0.46	0.352	0.184	0.228	0.326	0.19	0.373	0.451	0.148	1

a Only cases for which YEAR = 1 are used in the analysis phase.

Table A.5.2

Correlation between the 20 ILS sub-scale items for Year 2 data

Correlation Matrix(a)

		SSDEEP1	SSDEEP2	SSSTEP1	SSSTEP2	CONCRETE	SSSELFR1	SSSELFR2	SSEXTER1	SSEXTER2	LACKREG	INTEREST	CERTIFIC	SELFTEST	VOCATION	AMBIVALE	CONSTRUC	INTAKE	USEKNOW	STIMED	COOPER
Correlation	SSDEEP1	1	0.59	0.477	0.616	0.655	0.743	0.652	0.392	0.563	0.333	0.305	0.116	0.234	0.293	0.021	0.278	0.064	0.24	0.262	0.066
	SSDEEP2	0.59	1	0.325	0.588	0.572	0.62	0.701	0.334	0.487	0.465	0.3	-0.001	0.201	0.313	-0.032	0.257	-0.021	0.133	0.137	0.073
	SSSTEP1	0.477	0.325	1	0.546	0.448	0.431	0.399	0.568	0.557	0.359	0.113	0.193	0.234	0.14	0.159	0.211	0.211	0.131	0.164	0.11
	SSSTEP2	0.616	0.588	0.546	1	0.678	0.656	0.656	0.496	0.695	0.379	0.266	0.212	0.301	0.403	0.025	0.319	0.276	0.293	0.209	-0.027
	CONCRETE	0.655	0.572	0.448	0.678	1	0.691	0.683	0.435	0.538	0.302	0.295	0.15	0.274	0.433	0.002	0.429	0.19	0.339	0.182	-0.059
	SSSELFR1	0.743	0.62	0.431	0.656	0.691	1	0.711	0.383	0.552	0.341	0.336	0.112	0.279	0.39	-0.038	0.412	0.094	0.284	0.322	0.074
	SSSELFR2	0.652	0.701	0.399	0.656	0.683	0.711	1	0.409	0.559	0.417	0.286	0.135	0.255	0.362	-0.011	0.362	0.04	0.193	0.191	-0.002
	SSEXTER1	0.392	0.334	0.568	0.496	0.435	0.383	0.409	1	0.482	0.279	0.098	0.23	0.278	0.232	0.112	0.162	0.264	0.208	0.259	0.095
	SSEXTER2	0.563	0.487	0.557	0.695	0.538	0.552	0.559	0.482	1	0.282	0.267	0.175	0.432	0.398	-0.062	0.345	0.279	0.339	0.192	0.054
	LACKREG	0.333	0.465	0.359	0.379	0.302	0.341	0.417	0.279	0.282	1	0.108	0.108	0.059	0.098	0.369	0.185	0.144	0.005	0.125	0.058
	INTEREST	0.305	0.3	0.113	0.266	0.295	0.336	0.286	0.098	0.267	0.108	1	0.191	0.531	0.503	-0.048	0.464	0.297	0.337	0.321	0.153
	CERTIFIC	0.116	-0.001	0.193	0.212	0.15	0.112	0.135	0.23	0.175	0.108	0.191	1	0.316	0.202	0.345	0.257	0.459	0.323	0.314	0.309
	SELFTEST	0.234	0.201	0.234	0.301	0.274	0.279	0.255	0.278	0.432	0.059	0.531	0.316	1	0.566	0.03	0.477	0.509	0.495	0.363	0.181
	VOCATION	0.293	0.313	0.14	0.403	0.433	0.39	0.362	0.232	0.398	0.098	0.503	0.202	0.566	1	-0.13	0.446	0.433	0.571	0.326	0.098
	AMBIVALE	0.021	-0.032	0.159	0.025	0.002	-0.038	-0.011	0.112	-0.062	0.369	-0.048	0.345	0.03	-0.13	1	0.147	0.21	0.026	0.14	0.175
	CONSTRUC	0.278	0.257	0.211	0.319	0.429	0.412	0.362	0.162	0.345	0.185	0.464	0.257	0.477	0.446	0.147	1	0.416	0.55	0.439	0.07
	INTAKE	0.064	-0.021	0.211	0.276	0.19	0.094	0.04	0.264	0.279	0.144	0.297	0.459	0.509	0.433	0.21	0.416	1	0.512	0.305	0.345
	USEKNOW	0.24	0.133	0.131	0.293	0.339	0.284	0.193	0.208	0.339	0.005	0.337	0.323	0.495	0.571	0.026	0.55	0.512	1	0.459	0.185
	STIMED	0.262	0.137	0.164	0.209	0.182	0.322	0.191	0.259	0.192	0.125	0.321	0.314	0.363	0.326	0.14	0.439	0.305	0.459	1	0.284
	COOPER	0.066	0.073	0.11	-0.027	-0.059	0.074	-0.002	0.095	0.054	0.058	0.153	0.309	0.181	0.098	0.175	0.07	0.345	0.185	0.284	1

a Only cases for which YEAR = 2 are used in the analysis phase.

Table A.5.3

Correlation between the 20 ILS sub-scale items for Year 3 data

Correlation Matrix(a)																					
		SSDEEP1	SSDEEP2	SSSTEP1	SSSTEP2	CONCRETE	SSSELFR1	SSSELFR2	SSEXTER1	SSEXTER2	LACKREG	INTEREST	CERTIFIC	SELFTEST	VOCATION	AMBIVALE	CONSTRUC	INTAKE	USEKNOW	STIMED	COOPER
Correlation	SSDEEP1	1	0.68	0.416	0.681	0.719	0.726	0.637	0.411	0.561	0.128	0.292	-0.127	0.259	0.38	-0.192	0.549	0.115	0.386	0.369	0.179
	SSDEEP2	0.68	1	0.225	0.647	0.661	0.696	0.607	0.41	0.479	0.219	0.231	-0.012	0.072	0.283	-0.072	0.487	0.145	0.269	0.346	0.202
	SSSTEP1	0.416	0.225	1	0.472	0.363	0.411	0.216	0.549	0.53	0.268	0.213	0.172	0.295	0.252	0.107	0.246	0.313	0.316	0.112	0.111
	SSSTEP2	0.681	0.647	0.472	1	0.58	0.591	0.563	0.527	0.681	0.103	0.202	-0.042	0.248	0.355	-0.107	0.459	0.135	0.292	0.369	0.12
	CONCRETE	0.719	0.661	0.363	0.58	1	0.712	0.637	0.416	0.531	0.262	0.186	-0.138	0.1	0.359	-0.168	0.455	0.145	0.405	0.343	0.15
	SSSELFR1	0.726	0.696	0.411	0.591	0.712	1	0.595	0.434	0.512	0.216	0.272	-0.032	0.19	0.258	-0.038	0.527	0.13	0.301	0.352	0.139
	SSSELFR2	0.637	0.607	0.216	0.563	0.637	0.595	1	0.198	0.425	0.236	0.227	-0.115	0.174	0.257	-0.132	0.358	-0.025	0.2	0.297	-0.005
	SSEXTER1	0.411	0.41	0.549	0.527	0.416	0.434	0.198	1	0.558	0.109	0.143	0.226	0.156	0.25	-0.005	0.359	0.404	0.24	0.337	0.262
	SSEXTER2	0.561	0.479	0.53	0.681	0.531	0.512	0.425	0.558	1	0.156	0.201	0.136	0.319	0.398	-0.023	0.347	0.259	0.306	0.284	0.133
	LACKREG	0.128	0.219	0.268	0.103	0.262	0.216	0.236	0.109	0.156	1	0.037	0.159	-0.1	-0.024	0.3	0.001	-0.016	-0.076	-0.084	0.027
	INTEREST	0.292	0.231	0.213	0.202	0.186	0.272	0.227	0.143	0.201	0.037	1	0.358	0.555	0.618	-0.051	0.487	0.37	0.531	0.281	0.131
	CERTIFIC	-0.127	-0.012	0.172	-0.042	-0.138	-0.032	-0.115	0.226	0.136	0.159	0.358	1	0.32	0.215	0.346	0.054	0.462	0.156	0.133	0.313
	SELFTEST	0.259	0.072	0.295	0.248	0.1	0.19	0.174	0.156	0.319	-0.1	0.555	0.32	1	0.584	-0.152	0.39	0.347	0.424	0.127	-0.071
	VOCATION	0.38	0.283	0.252	0.355	0.359	0.258	0.257	0.25	0.398	-0.024	0.618	0.215	0.584	1	-0.182	0.504	0.426	0.628	0.361	0.166
	AMBIVALE	-0.192	-0.072	0.107	-0.107	-0.168	-0.038	-0.132	-0.005	-0.023	0.3	-0.051	0.346	-0.152	-0.182	1	-0.211	0.098	-0.174	-0.001	0.145
	CONSTRUC	0.549	0.487	0.246	0.459	0.455	0.527	0.358	0.359	0.347	0.001	0.487	0.054	0.39	0.504	-0.211	1	0.375	0.574	0.527	0.258
	INTAKE	0.115	0.145	0.313	0.135	0.145	0.13	-0.025	0.404	0.259	-0.016	0.37	0.462	0.347	0.426	0.098	0.375	1	0.513	0.355	0.403
	USEKNOW	0.386	0.269	0.316	0.292	0.405	0.301	0.2	0.24	0.306	-0.076	0.531	0.156	0.424	0.628	-0.174	0.574	0.513	1	0.438	0.208
	STIMED	0.369	0.346	0.112	0.369	0.343	0.352	0.297	0.337	0.284	-0.084	0.281	0.133	0.127	0.361	-0.001	0.527	0.355	0.438	1	0.433
	COOPER	0.179	0.202	0.111	0.12	0.15	0.139	-0.005	0.262	0.133	0.027	0.131	0.313	-0.071	0.166	0.145	0.258	0.403	0.208	0.433	1

a Only cases for which YEAR = 3 are used in the analysis phase.

Table A.5.4

Correlation between the 20 ILS sub-scale items for Year 4 data

Correlation Matrix(a)																					
		SSDEEP1	**SSDEEP2**	**SSSTEP1**	**SSSTEP2**	**CONCRETE**	**SSSELFR1**	**SSSELFR2**	**SSEXTER1**	**SSEXTER2**	**LACKREG**	**INTEREST**	**CERTIFIC**	**SELFTEST**	**VOCATION**	**AMBIVALE**	**CONSTRUC**	**INTAKE**	**USEKNOW**	**STIMED**	**COOPER**
Correlation	**SSDEEP1**	1	0.656	0.438	0.602	0.63	0.707	0.485	0.316	0.608	0.232	0.333	0.123	0.217	0.146	-0.033	0.32	0.02	0.118	0.187	-0.061
	SSDEEP2	0.656	1	0.269	0.611	0.555	0.694	0.626	0.227	0.552	0.37	0.333	0.155	0.26	0.036	0.13	0.279	-0.061	0.068	0.177	0.083
	SSSTEP1	0.438	0.269	1	0.487	0.195	0.408	0.273	0.498	0.395	0.346	0.12	0.184	0.153	0.076	0.058	0.103	0.182	-0.04	0.144	0.055
	SSSTEP2	0.602	0.611	0.487	1	0.434	0.592	0.594	0.414	0.632	0.37	0.327	0.24	0.183	0.137	0.074	0.321	0.089	0.119	0.188	0.136
	CONCRETE	0.63	0.555	0.195	0.434	1	0.635	0.439	0.227	0.496	0.172	0.209	0.01	0.063	0.275	-0.204	0.267	-0.027	0.406	0.16	-0.031
	SSSELFR1	0.707	0.694	0.408	0.592	0.635	1	0.558	0.234	0.632	0.225	0.35	0.077	0.216	0.09	-0.065	0.322	0.02	0.123	0.194	0.004
	SSSELFR2	0.485	0.626	0.273	0.594	0.439	0.558	1	0.19	0.465	0.331	0.25	0.051	0.141	-0.122	0.089	0.249	-0.139	-0.034	0.201	-0.022
	SSEXTER1	0.316	0.227	0.498	0.414	0.227	0.234	0.19	1	0.346	0.481	0.098	0.23	0.149	0.211	0.095	-0.011	0.262	-0.006	0.193	0.134
	SSEXTER2	0.608	0.552	0.395	0.632	0.496	0.632	0.465	0.346	1	0.296	0.339	0.094	0.34	0.202	-0.095	0.335	0.116	0.22	0.227	-0.016
	LACKREG	0.232	0.37	0.346	0.37	0.172	0.225	0.331	0.481	0.296	1	0.191	0.161	0.035	-0.038	0.388	-0.066	0.163	0.005	0.065	0.142
	INTEREST	0.333	0.333	0.12	0.327	0.209	0.35	0.25	0.098	0.339	0.191	1	0.3	0.429	0.214	0.081	0.449	0.207	0.257	0.311	0.084
	CERTIFIC	0.123	0.155	0.184	0.24	0.01	0.077	0.051	0.23	0.094	0.161	0.3	1	0.436	0.242	0.211	0.174	0.365	0.137	0.128	0.19
	SELFTEST	0.217	0.26	0.153	0.183	0.063	0.216	0.141	0.149	0.34	0.035	0.429	0.436	1	0.313	-0.063	0.283	0.275	0.176	0.208	0.014
	VOCATION	0.146	0.036	0.076	0.137	0.275	0.09	-0.122	0.211	0.202	-0.038	0.214	0.242	0.313	1	-0.176	0.293	0.344	0.438	0.077	0.041
	AMBIVALE	-0.033	0.13	0.058	0.074	-0.204	-0.065	0.089	0.095	-0.095	0.388	0.081	0.211	-0.063	-0.176	1	-0.162	0.108	-0.293	-0.066	0.222
	CONSTRUC	0.32	0.279	0.103	0.321	0.267	0.322	0.249	-0.011	0.335	-0.066	0.449	0.174	0.283	0.293	-0.162	1	0.381	0.522	0.488	0.015
	INTAKE	0.02	-0.061	0.182	0.089	-0.027	0.02	-0.139	0.262	0.116	0.163	0.207	0.365	0.275	0.344	0.108	0.381	1	0.496	0.447	0.435
	USEKNOW	0.118	0.068	-0.04	0.119	0.406	0.123	-0.034	-0.006	0.22	0.005	0.257	0.137	0.176	0.438	-0.293	0.522	0.496	1	0.34	0.086
	STIMED	0.187	0.177	0.144	0.188	0.16	0.194	0.201	0.193	0.227	0.065	0.311	0.128	0.208	0.077	-0.066	0.488	0.447	0.34	1	0.349
	COOPER	-0.061	0.083	0.055	0.136	-0.031	0.004	-0.022	0.134	-0.016	0.142	0.084	0.19	0.014	0.041	0.222	0.015	0.435	0.086	0.349	1

a Only cases for which YEAR = 4 are used in the analysis phase.

Table A.6.1

Anti-image Correlation Matrix for Year 1

Anti-image Matrices(b)

		SSDEEP1	SSDEEP2	SSSTEP1	SSSTEP2	CONCRETE	SSSELFR1	SSSELFR2	SSEXTER1	SSEXTER2	LACKREG	INTEREST	CERTIFIC	SELFTEST	VOCATION	AMBIVALE	CONSTRUC	INTAKE	USEKNOW	STIMED	COOPER
Anti-image Correlation	SSDEEP1	.873(a)	-0.103	-0.381	9.21E-02	-0.21	-4.64E-02	-0.151	-0.154	-0.277	1.18E-02	4.87E-02	-7.95E-02	0.282	-0.143	0.294	-0.212	9.71E-02	2.93E-02	-0.149	7.94E-02
	SSDEEP2	-0.103	.825(a)	-4.43E-02	-0.314	-0.204	-0.165	-0.17	0.141	0.186	-0.464	-3.37E-02	5.23E-02	-0.117	-0.135	-9.99E-02	-0.296	0.235	0.32	6.23E-02	-0.118
	SSSTEP1	-0.381	-4.43E-02	.830(a)	-0.223	0.236	-0.177	6.30E-03	-7.44E-02	0.159	-0.168	4.72E-02	5.52E-02	-0.253	0.133	1.17E-02	0.214	-8.86E-02	-0.23	0.211	-0.167
	SSSTEP2	9.21E-02	-0.314	-0.223	.871(a)	-0.229	-6.74E-02	-2.18E-02	-0.275	-0.215	6.75E-02	0.135	-4.19E-02	0.261	9.41E-04	4.29E-02	5.38E-02	-0.276	-1.91E-02	-0.275	0.242
	CONCRETE	-0.21	-0.204	0.236	-0.229	.858(a)	-0.392	0.11	0.122	-4.18E-03	4.41E-02	-5.11E-02	-8.80E-02	-5.34E-02	-1.91E-02	-0.133	0.18	0.291	-0.244	-3.46E-02	-0.175
	SSSELFR1	-4.64E-02	-0.165	-0.177	-6.74E-02	-0.392	.901(a)	-0.352	7.08E-02	-0.173	0.15	3.70E-03	2.45E-02	-6.61E-02	3.96E-02	3.70E-04	-0.123	-0.169	0.162	0.129	-1.11E-02
	SSSELFR2	-0.151	-0.17	6.30E-03	-2.18E-02	0.11	-0.352	.912(a)	-0.159	-1.01E-02	9.54E-03	-0.231	0.12	0.178	0.105	-3.82E-02	-0.135	4.13E-02	2.19E-02	-0.102	3.47E-02
	SSEXTER1	-0.154	0.141	-7.44E-02	-0.275	0.122	7.08E-02	-0.159	.877(a)	-0.332	7.38E-02	-9.48E-02	-0.167	3.09E-03	0.166	-0.168	1.70E-02	3.37E-02	6.16E-02	-4.93E-02	-3.68E-02
	SSEXTER2	-0.277	0.186	0.159	-0.215	-4.18E-03	-0.173	-1.01E-02	-0.332	.855(a)	-0.266	7.14E-02	0.215	-0.326	-9.40E-02	6.22E-02	-5.71E-02	-9.07E-02	-0.147	0.299	2.42E-02
	LACKREG	1.18E-02	-0.464	-0.168	6.75E-02	4.41E-02	0.15	9.54E-03	7.38E-02	-0.266	.748(a)	-0.315	7.73E-02	0.133	1.69E-03	-0.422	0.364	-9.33E-02	-2.71E-02	-0.169	2.25E-02
	INTEREST	4.87E-02	-3.37E-02	4.72E-02	0.135	-5.11E-02	3.70E-03	-0.231	-9.48E-02	7.14E-02	-0.315	.877(a)	-0.276	-0.107	1.93E-02	0.205	2.12E-02	9.70E-02	-0.296	-0.149	-0.186
	CERTIFIC	-7.95E-02	5.23E-02	5.52E-02	-4.19E-02	-8.80E-02	2.45E-02	0.12	-0.167	0.215	7.73E-02	-0.276	.763(a)	2.16E-02	-0.217	-0.256	-0.119	-0.459	0.155	0.164	-1.47E-02
	SELFTEST	0.282	-0.117	-0.253	0.261	-5.34E-02	-6.61E-02	0.178	3.09E-03	-0.326	0.133	-0.107	2.16E-02	.720(a)	-0.589	9.97E-02	-0.242	-0.17	0.204	-0.284	6.81E-02
	VOCATION	-0.143	-0.135	0.133	9.41E-04	-1.91E-02	3.96E-02	0.105	0.166	-9.40E-02	1.69E-03	1.93E-02	-0.217	-0.589	.794(a)	-2.76E-02	0.193	0.119	-0.281	-9.43E-02	1.65E-02
	AMBIVALE	0.294	-9.99E-02	1.17E-02	4.29E-02	-0.133	3.70E-04	-3.82E-02	-0.168	6.22E-02	-0.422	0.205	-0.256	9.97E-02	-2.76E-02	.708(a)	-0.182	-3.98E-02	-8.39E-02	0.143	-6.75E-02
	CONSTRUC	-0.212	-0.296	0.214	5.38E-02	0.18	-0.123	-0.135	1.70E-02	-5.71E-02	0.364	2.12E-02	-0.119	-0.242	0.193	-0.182	.822(a)	7.03E-02	-0.435	-0.283	4.30E-02
	INTAKE	9.71E-02	0.235	-8.86E-02	-0.276	0.291	-0.169	4.13E-02	3.37E-02	-9.07E-02	-9.33E-02	9.70E-02	-0.459	-0.17	0.119	-3.98E-02	7.03E-02	.777(a)	-0.348	-0.183	-0.17
	USEKNOW	2.93E-02	0.32	-0.23	-1.91E-02	-0.244	0.162	2.19E-02	6.16E-02	-0.147	-2.71E-02	-0.296	0.155	0.204	-0.281	-8.39E-02	-0.435	-0.348	.805(a)	-2.87E-02	-0.161
	STIMED	-0.149	6.23E-02	0.211	-0.275	-3.46E-02	0.129	-0.102	-4.93E-02	0.299	-0.169	-0.149	0.164	-0.284	-9.43E-02	0.143	-0.283	-0.183	-2.87E-02	.844(a)	6.58E-02
	COOPER	7.94E-02	-0.118	-0.167	0.242	-0.175	-1.11E-02	3.47E-02	-3.68E-02	2.42E-02	2.25E-02	-0.186	-1.47E-02	6.81E-02	1.65E-02	-6.75E-02	4.30E-02	-0.17	-0.161	6.58E-02	.846(a)

a Measures of Sampling Adequacy(MSA)

b Only cases for which YEAR = 1 are used in the analysis phase.

Table A.6.2

Anti-image Correlation Matrix for Year 2

Anti-image Matrices(b)

		SSDEEP1	SSDEEP2	SSSTEP1	SSSTEP2	CONCRETE	SSSELFR1	SSSELFR2	SSEXTER1	SSEXTER2	LACKREG	INTEREST	CERTIFIC	SELFTEST	VOCATION	AMBIVALE	CONSTRUC	INTAKE	USEKNOW	STIMED	COOPER
Anti-image Correlation	SSDEEP1	.915(a)	-8.33E-02	-0.125	-7.82E-03	-0.202	-0.36	-9.73E-02	3.69E-02	-0.15	1.64E-02	-0.141	1.78E-02	3.00E-02	9.35E-02	-8.15E-02	0.177	6.71E-02	-8.40E-02	-0.1	-1.97E-02
	SSDEEP2	-8.33E-02	.886(a)	0.125	-0.187	-9.00E-02	-4.05E-02	-0.266	-5.46E-02	-3.83E-02	-0.301	-0.103	0.132	-4.77E-02	-4.39E-02	6.41E-02	-1.86E-02	0.217	1.00E-02	7.04E-02	-0.231
	SSSTEP1	-0.125	0.125	.882(a)	-0.155	-8.48E-02	-1.58E-02	7.96E-02	-0.333	-0.227	-0.14	3.25E-02	-1.01E-03	-5.82E-02	0.109	-5.39E-02	-6.48E-02	2.88E-02	9.33E-02	3.93E-02	-0.118
	SSSTEP2	-7.82E-03	-0.187	-0.155	.908(a)	-0.163	-0.168	-0.119	-2.97E-02	-0.323	4.02E-04	-1.41E-02	-9.26E-02	0.114	-5.54E-02	-2.88E-02	0.145	-0.242	-2.13E-03	-3.54E-02	0.236
	CONCRETE	-0.202	-9.00E-02	-8.48E-02	-0.163	.926(a)	-0.176	-0.185	-0.117	8.49E-02	8.60E-02	1.63E-02	-1.53E-02	9.55E-02	-0.125	-2.12E-02	-0.167	-6.97E-02	-9.82E-02	0.166	0.154
	SSSELFR1	-0.36	-4.05E-02	-1.58E-02	-0.168	-0.176	.924(a)	-0.179	1.91E-02	8.16E-03	-3.79E-02	3.58E-03	4.75E-02	3.49E-03	-5.15E-02	9.93E-02	-0.158	0.117	3.30E-02	-0.148	-0.126
	SSSELFR2	-9.73E-02	-0.266	7.96E-02	-0.119	-0.185	-0.179	.925(a)	-8.98E-02	-7.46E-02	-0.135	4.27E-02	-0.142	-4.33E-02	-7.10E-02	5.73E-02	-0.144	0.179	0.1	4.35E-02	-4.02E-03
	SSEXTER1	3.69E-02	-5.46E-02	-0.333	-2.97E-02	-0.117	1.91E-02	-8.98E-02	.894(a)	-8.72E-02	6.98E-03	0.104	-3.58E-02	-7.77E-02	3.84E-03	-3.12E-02	0.177	-0.114	2.19E-03	-0.189	3.96E-02
	SSEXTER2	-0.15	-3.83E-02	-0.227	-0.323	8.49E-02	8.16E-03	-7.46E-02	-8.72E-02	.915(a)	-1.85E-02	8.45E-02	1.38E-02	-0.223	-7.59E-03	0.167	-7.81E-02	-1.83E-02	-9.00E-02	0.116	-2.03E-02
	LACKREG	1.64E-02	-0.301	-0.14	4.02E-04	8.60E-02	-3.79E-02	-0.135	6.98E-03	-1.85E-02	.788(a)	-1.47E-02	7.40E-02	0.133	-2.95E-02	-0.385	2.89E-03	-0.191	0.121	-5.03E-02	8.94E-02
	INTEREST	-0.141	-0.103	3.25E-02	-1.41E-02	1.63E-02	3.58E-03	4.27E-02	0.104	8.45E-02	-1.47E-02	.869(a)	-4.84E-02	-0.296	-0.209	9.67E-02	-0.219	-8.30E-03	0.119	-5.90E-02	-6.31E-02
	CERTIFIC	1.78E-02	0.132	-1.01E-03	-9.26E-02	-1.53E-02	4.75E-02	-0.142	-3.58E-02	1.38E-02	7.40E-02	-4.84E-02	.841(a)	-5.89E-02	3.75E-02	-0.269	4.10E-02	-0.18	-7.32E-02	-0.1	-0.159
	SELFTEST	3.00E-02	-4.77E-02	-5.82E-02	0.114	9.55E-02	3.49E-03	-4.33E-02	-7.77E-02	-0.223	0.133	-0.296	-5.89E-02	.884(a)	-0.222	-5.28E-02	-7.97E-02	-0.209	-5.54E-02	-5.84E-02	5.08E-02
	VOCATION	9.35E-02	-4.39E-02	0.109	-5.54E-02	-0.125	-5.15E-02	-7.10E-02	3.84E-03	-7.59E-03	-2.95E-02	-0.209	3.75E-02	-0.222	.899(a)	0.161	5.79E-02	-0.153	-0.288	-3.17E-02	3.55E-02
	AMBIVALE	-8.15E-02	6.41E-02	-5.39E-02	-2.88E-02	-2.12E-02	9.93E-02	5.73E-02	-3.12E-02	0.167	-0.385	9.67E-02	-0.269	-5.28E-02	0.161	.554(a)	-0.17	-2.82E-02	1.92E-02	-2.13E-02	-8.08E-02
	CONSTRUC	0.177	-1.86E-02	-6.48E-02	0.145	-0.167	-0.158	-0.144	0.177	-7.81E-02	2.89E-03	-0.219	4.10E-02	-7.97E-02	5.79E-02	-0.17	.843(a)	-0.182	-0.267	-0.217	0.175
	INTAKE	6.71E-02	0.217	2.88E-02	-0.242	-6.97E-02	0.117	0.179	-0.114	-1.83E-02	-0.191	-8.30E-03	-0.18	-0.209	-0.153	-2.82E-02	-0.182	.786(a)	-0.168	8.91E-02	-0.319
	USEKNOW	-8.40E-02	1.00E-02	9.33E-02	-2.13E-03	-9.82E-02	3.30E-02	0.1	2.19E-03	-9.00E-02	0.121	0.119	-7.32E-02	-5.54E-02	-0.288	1.92E-02	-0.267	-0.168	.874(a)	-0.213	-3.73E-02
	STIMED	-0.1	7.04E-02	3.93E-02	-3.54E-02	0.166	-0.148	4.35E-02	-0.189	0.116	-5.03E-02	-5.90E-02	-0.1	-5.84E-02	-3.17E-02	-2.13E-02	-0.217	8.91E-02	-0.213	.847(a)	-0.17
	COOPER	-1.97E-02	-0.231	-0.118	0.236	0.154	-0.126	-4.02E-03	3.96E-02	-2.03E-02	8.94E-02	-6.31E-02	-0.159	5.08E-02	3.55E-02	-8.08E-02	0.175	-0.319	-3.73E-02	-0.17	.559(a)

a Measures of Sampling Adequacy(MSA)

b Only cases for which YEAR = 2 are used in the analysis phase.

Table A.6.3

Anti-image Correlation Table for Year 3

Anti-image Matrices(b)																					
		SSDEEP1	SSDEEP2	SSSTEP1	SSSTEP2	CONCRETE	SSSELFR1	SSSELFR2	SSEXTER1	SSEXTER2	LACKREG	INTEREST	CERTIFIC	SELFTEST	VOCATION	AMBIVALE	CONSTRUC	INTAKE	USEKNOW	STIMED	COOPER
Anti-image Correlation	SSDEEP1	.932(a)	-0.173	-0.146	-0.128	-0.18	-0.2	-0.159	8.41E-03	-7.36E-02	5.77E-02	-5.54E-02	0.175	-0.129	7.25E-03	6.13E-02	-8.56E-02	0.132	-4.29E-02	6.68E-03	-0.194
	SSDEEP2	-0.173	.890(a)	0.286	-0.304	-9.82E-02	-0.269	-0.152	-8.54E-02	1.43E-02	-8.89E-02	-4.05E-02	-9.88E-02	0.196	-2.97E-02	-1.49E-02	-0.101	-8.92E-02	9.51E-03	0.112	-3.29E-02
	SSSTEP1	-0.146	0.286	.795(a)	-0.208	2.46E-02	-0.156	4.56E-02	-0.334	-0.127	-0.247	-2.74E-02	5.46E-02	-0.116	8.86E-02	-0.134	0.102	-0.103	-0.212	0.189	-2.40E-02
	SSSTEP2	-0.128	-0.304	-0.208	.902(a)	5.39E-02	7.09E-02	-0.159	-0.154	-0.33	0.103	5.88E-02	9.08E-02	-5.91E-02	-5.96E-02	-2.60E-02	-7.24E-02	0.129	4.38E-02	-0.12	2.91E-02
	CONCRETE	-0.18	-9.82E-02	2.46E-02	5.39E-02	.890(a)	-0.306	-0.249	-0.114	-0.106	-0.22	0.141	0.136	0.151	-0.166	0.118	7.53E-02	-2.97E-02	-0.253	1.60E-02	-3.11E-02
	SSSELFR1	-0.2	-0.269	-0.156	7.09E-02	-0.306	.907(a)	-6.15E-02	-4.44E-02	-3.89E-02	4.56E-02	-0.105	1.52E-03	-7.91E-02	0.178	-0.137	-0.198	7.06E-02	8.53E-02	-6.19E-02	5.48E-02
	SSSELFR2	-0.159	-0.152	4.56E-02	-0.159	-0.249	-6.15E-02	.898(a)	0.189	-2.46E-02	-0.142	-9.98E-02	-5.91E-03	-9.48E-02	4.42E-02	5.67E-02	6.98E-02	4.36E-02	0.116	-0.188	0.136
	SSEXTER1	8.41E-03	-8.54E-02	-0.334	-0.154	-0.114	-4.44E-02	0.189	.849(a)	-0.168	6.86E-02	5.83E-02	-0.189	0.12	9.62E-03	0.141	-8.76E-02	-0.223	0.194	-0.137	3.46E-02
	SSEXTER2	-7.36E-02	1.43E-02	-0.127	-0.33	-0.106	-3.89E-02	-2.46E-02	-0.168	.925(a)	-4.91E-03	0.131	-0.109	-0.103	-0.151	-3.52E-02	8.98E-02	-2.65E-02	1.91E-02	6.67E-03	2.85E-02
	LACKREG	5.77E-02	-8.89E-02	-0.247	0.103	-0.22	4.56E-02	-0.142	6.86E-02	-4.91E-03	.597(a)	-4.50E-02	-0.186	0.158	-3.71E-02	-0.236	-9.70E-02	6.40E-02	0.137	0.154	3.68E-02
	INTEREST	-5.54E-02	-4.05E-02	-2.74E-02	5.88E-02	0.141	-0.105	-9.98E-02	5.83E-02	0.131	-4.50E-02	.865(a)	-0.238	-0.161	-0.325	-1.40E-02	-0.156	2.55E-02	-0.168	1.65E-02	3.22E-02
	CERTIFIC	0.175	-9.88E-02	5.46E-02	9.08E-02	0.136	1.52E-03	-5.91E-03	-0.189	-0.109	-0.186	-0.238	.660(a)	-0.296	5.21E-02	-0.235	0.152	-0.177	-1.12E-02	-2.86E-02	-0.263
	SELFTEST	-0.129	0.196	-0.116	-5.91E-02	0.151	-7.91E-02	-9.48E-02	0.12	-0.103	0.158	-0.161	-0.296	.764(a)	-0.307	0.12	-0.173	-0.126	2.60E-02	0.127	0.273
	VOCATION	7.25E-03	-2.97E-02	8.86E-02	-5.96E-02	-0.166	0.178	4.42E-02	9.62E-03	-0.151	-3.71E-02	-0.325	5.21E-02	-0.307	.879(a)	6.31E-02	-2.83E-03	-6.19E-02	-0.228	-7.04E-02	-6.24E-02
	AMBIVALE	6.13E-02	-1.49E-02	-0.134	-2.60E-02	0.118	-0.137	5.67E-02	0.141	-3.52E-02	-0.236	-1.40E-02	-0.235	0.12	6.31E-02	.648(a)	0.137	-9.16E-02	7.68E-02	-0.147	-2.88E-02
	CONSTRUC	-8.56E-02	-0.101	0.102	-7.24E-02	7.53E-02	-0.198	6.98E-02	-8.76E-02	8.98E-02	-9.70E-02	-0.156	0.152	-0.173	-2.83E-03	0.137	.909(a)	-0.1	-0.203	-0.239	-8.47E-02
	INTAKE	0.132	-8.92E-02	-0.103	0.129	-2.97E-02	7.06E-02	4.36E-02	-0.223	-2.65E-02	6.40E-02	2.55E-02	-0.177	-0.126	-6.19E-02	-9.16E-02	-0.1	.852(a)	-0.27	-4.41E-02	-0.219
	USEKNOW	-4.29E-02	9.51E-03	-0.212	4.38E-02	-0.253	8.53E-02	0.116	0.194	1.91E-02	0.137	-0.168	-1.12E-02	2.60E-02	-0.228	7.68E-02	-0.203	-0.27	.858(a)	-0.175	8.36E-02
	STIMED	6.68E-03	0.112	0.189	-0.12	1.60E-02	-6.19E-02	-0.188	-0.137	6.67E-03	0.154	1.65E-02	-2.86E-02	0.127	-7.04E-02	-0.147	-0.239	-4.41E-02	-0.175	.849(a)	-0.267
	COOPER	-0.194	-3.29E-02	-2.40E-02	2.91E-02	-3.11E-02	5.48E-02	0.136	3.46E-02	2.85E-02	3.68E-02	3.22E-02	-0.263	0.273	-6.24E-02	-2.88E-02	-8.47E-02	-0.219	8.36E-02	-0.267	.710(a)

a Measures of Sampling Adequacy(MSA)

b Only cases for which YEAR = 3 are used in the analysis phase.

Table A.6.4

Anti-image Correlation Table for Professionals

Anti-image Matrices(b)

		SSDEEP1	SSDEEP2	SSSTEP1	SSSTEP2	CONCRETE	SSSELFR1	SSSELFR2	SSEXTER1	SSEXTER2	LACKREG	INTEREST	CERTIFIC	SELFTEST	VOCATION	AMBIVALE	CONSTRUC	INTAKE	USEKNOW	STIMED	COOPER
Anti-image Correlation	SSDEEP1	.894(a)	-0.23	-0.188	-0.138	-0.336	-0.14	9.82E-02	-2.95E-02	-0.113	9.43E-02	-9.86E-02	-9.50E-04	8.84E-03	2.94E-02	-2.12E-02	-6.57E-02	-8.32E-02	0.171	-3.26E-02	0.176
	SSDEEP2	-0.23	.865(a)	0.164	-0.124	-0.116	-0.288	-0.158	4.26E-02	-1.58E-02	-0.223	8.54E-02	-3.89E-02	-0.223	3.68E-02	-0.167	-0.124	0.218	-4.63E-03	-6.67E-03	-0.185
	SSSTEP1	-0.188	0.164	.850(a)	-0.197	9.70E-02	-0.2	2.06E-02	-0.223	-1.08E-02	-0.137	0.108	-4.17E-02	-3.40E-02	1.99E-02	4.80E-02	-1.50E-03	-9.02E-02	9.39E-02	-2.52E-02	4.32E-02
	SSSTEP2	-0.138	-0.124	-0.197	.855(a)	0.135	-4.40E-02	-0.317	-0.185	-0.297	7.25E-03	-4.66E-02	-0.179	0.186	-7.17E-02	-3.25E-03	-0.136	0.119	-0.1	0.146	-0.221
	CONCRETE	-0.336	-0.116	9.70E-02	0.135	.754(a)	-0.313	-0.202	-0.164	-2.49E-02	1.25E-02	7.44E-02	-1.89E-02	0.19	-0.23	6.47E-02	0.133	0.25	-0.49	-5.75E-03	-8.20E-02
	SSSELFR1	-0.14	-0.288	-0.2	-4.40E-02	-0.313	.881(a)	-7.93E-02	0.109	-0.195	9.17E-02	-0.158	5.70E-02	2.37E-02	8.44E-02	0.103	-2.14E-02	-0.166	0.175	4.90E-02	2.07E-02
	SSSELFR2	9.82E-02	-0.158	2.06E-02	-0.317	-0.202	-7.93E-02	.858(a)	6.98E-02	4.71E-03	-0.162	3.54E-02	3.54E-02	-0.107	0.188	-4.59E-02	-0.141	0.103	0.154	-0.166	9.71E-02
	SSEXTER1	-2.95E-02	4.26E-02	-0.223	-0.185	-0.164	0.109	6.98E-02	.739(a)	-6.09E-02	-0.332	6.04E-02	-6.73E-02	-1.31E-02	-0.188	0.105	0.161	-0.193	0.245	-0.199	8.26E-02
	SSEXTER2	-0.113	-1.58E-02	-1.08E-02	-0.297	-2.49E-02	-0.195	4.71E-03	-6.09E-02	.913(a)	-0.108	-5.97E-04	0.183	-0.247	-2.74E-02	7.16E-02	-5.40E-03	-2.42E-02	-5.52E-02	-3.42E-02	8.14E-02
	LACKREG	9.43E-02	-0.223	-0.137	7.25E-03	1.25E-02	9.17E-02	-0.162	-0.332	-0.108	.719(a)	-0.177	3.13E-02	0.127	0.11	-0.294	0.216	-0.123	-0.162	8.27E-02	5.08E-02
	INTEREST	-9.86E-02	8.54E-02	0.108	-4.66E-02	7.44E-02	-0.158	3.54E-02	6.04E-02	-5.97E-04	-0.177	.829(a)	-9.97E-02	-0.271	-6.67E-02	-0.136	-0.229	0.152	-8.14E-02	-0.124	-5.11E-02
	CERTIFIC	-9.50E-04	-3.89E-02	-4.17E-02	-0.179	-1.89E-02	5.70E-02	3.54E-02	-6.73E-02	0.183	3.13E-02	-9.97E-02	.763(a)	-0.34	-4.48E-02	-0.159	5.48E-03	-0.155	-1.02E-02	7.46E-02	-2.31E-02
	SELFTEST	8.84E-03	-0.223	-3.40E-02	0.186	0.19	2.37E-02	-0.107	-1.31E-02	-0.247	0.127	-0.271	-0.34	.686(a)	-0.193	0.155	7.61E-02	-0.133	2.94E-02	-3.09E-02	0.107
	VOCATION	2.94E-02	3.68E-02	1.99E-02	-7.17E-02	-0.23	8.44E-02	0.188	-0.188	-2.74E-02	0.11	-6.67E-02	-4.48E-02	-0.193	.758(a)	3.40E-02	-0.121	-0.117	-0.116	0.2	-8.32E-03
	AMBIVALE	-2.12E-02	-0.167	4.80E-02	-3.25E-03	6.47E-02	0.103	-4.59E-02	0.105	7.16E-02	-0.294	-0.136	-0.159	0.155	3.40E-02	.589(a)	3.43E-02	-0.226	0.27	9.25E-02	-7.10E-02
	CONSTRUC	-6.57E-02	-0.124	-1.50E-03	-0.136	0.133	-2.14E-02	-0.141	0.161	-5.40E-03	0.216	-0.229	5.48E-03	7.61E-02	-0.121	3.43E-02	.781(a)	-0.219	-0.242	-0.308	0.245
	INTAKE	-8.32E-02	0.218	-9.02E-02	0.119	0.25	-0.166	0.103	-0.193	-2.42E-02	-0.123	0.152	-0.155	-0.133	-0.117	-0.226	-0.219	.634(a)	-0.437	-0.164	-0.383
	USEKNOW	0.171	-4.63E-03	9.39E-02	-0.1	-0.49	0.175	0.154	0.245	-5.52E-02	-0.162	-8.14E-02	-1.02E-02	2.94E-02	-0.116	0.27	-0.242	-0.437	.621(a)	-6.59E-02	0.119
	STIMED	-3.26E-02	-6.67E-03	-2.52E-02	0.146	-5.75E-03	4.90E-02	-0.166	-0.199	-3.42E-02	8.27E-02	-0.124	7.46E-02	-3.09E-02	0.2	9.25E-02	-0.308	-0.164	-6.59E-02	.747(a)	-0.31
	COOPER	0.176	-0.185	4.32E-02	-0.221	-8.20E-02	2.07E-02	9.71E-02	8.26E-02	8.14E-02	5.08E-02	-5.11E-02	-2.31E-02	0.107	-8.32E-03	-7.10E-02	0.245	-0.383	0.119	-0.31	.500(a)

a Measures of Sampling Adequacy(MSA)

b Only cases for which YEAR = 4 are used in the analysis phase.

Table A.7.1

Communalities for Year 1

Communalities[a]		
	Initial	**Extraction**
SSDEEP1	1	0.794
SSDEEP2	1	0.883
SSSTEP1	1	0.578
SSSTEP2	1	0.758
CONCRETE	1	0.741
SSSELFR1	1	0.793
SSSELFR2	1	0.761
SSEXTER1	1	0.745
SSEXTER2	1	0.681
LACKREG	1	0.713
INTEREST	1	0.618
CERTIFIC	1	0.63
SELFTEST	1	0.802
VOCATION	1	0.786
AMBIVALE	1	0.662
CONSTRUC	1	0.682
INTAKE	1	0.836
USEKNOW	1	0.755
STIMED	1	0.657
COOPER	1	0.504
Extraction Method: Principal Component Analysis.		
a Only cases for which YEAR = 1 are used in the analysis phase.		

Table A.7.2

Communalities for Year 2

Communalities[a]		
	Initial	**Extraction**
SSDEEP1	1	0.677
SSDEEP2	1	0.708
SSSTEP1	1	0.684
SSSTEP2	1	0.744
CONCRETE	1	0.688
SSSELFR1	1	0.747
SSSELFR2	1	0.755
SSEXTER1	1	0.646
SSEXTER2	1	0.705
LACKREG	1	0.618
INTEREST	1	0.571
CERTIFIC	1	0.53
SELFTEST	1	0.627
VOCATION	1	0.664
AMBIVALE	1	0.707
CONSTRUC	1	0.59
INTAKE	1	0.688
USEKNOW	1	0.631
STIMED	1	0.449
COOPER	1	0.328
Extraction Method: Principal Component Analysis.		
a Only cases for which YEAR = 2 are used in the analysis phase.		

Table A.7.3

Communalities for Year 3

Communalities[a]		
	Initial	**Extraction**
SSDEEP1	1	0.781
SSDEEP2	1	0.725
SSSTEP1	1	0.718
SSSTEP2	1	0.728
CONCRETE	1	0.741
SSSELFR1	1	0.726
SSSELFR2	1	0.708
SSEXTER1	1	0.752
SSEXTER2	1	0.706
LACKREG	1	0.694
INTEREST	1	0.752
CERTIFIC	1	0.706
SELFTEST	1	0.763
VOCATION	1	0.709
AMBIVALE	1	0.649
CONSTRUC	1	0.673
INTAKE	1	0.685
USEKNOW	1	0.653
STIMED	1	0.671
COOPER	1	0.709
Extraction Method: Principal Component Analysis.		
a Only cases for which YEAR = 3 are used in the analysis phase.		

Table A.7.4

Communalities for Professionals

Communalities(a)		
	Initial	**Extraction**
SSDEEP1	1	0.712
SSDEEP2	1	0.743
SSSTEP1	1	0.556
SSSTEP2	1	0.679
CONCRETE	1	0.689
SSSELFR1	1	0.739
SSSELFR2	1	0.679
SSEXTER1	1	0.723
SSEXTER2	1	0.646
LACKREG	1	0.575
INTEREST	1	0.603
CERTIFIC	1	0.632
SELFTEST	1	0.689
VOCATION	1	0.639
AMBIVALE	1	0.636
CONSTRUC	1	0.681
INTAKE	1	0.789
USEKNOW	1	0.704
STIMED	1	0.644
COOPER	1	0.599
Extraction Method: Principal Component Analysis.		
a Only cases for which YEAR = 4 are used in the analysis phase.		

Total Variance Explained and Scree Plots

Table A.8.1: Total Variance Explained & Scree Plots for Year 1

Total Variance Explained[a]						
	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	**Total**	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**
1	7.992	39.958	39.958	7.992	39.958	39.958
2	3.198	15.99	55.947	3.198	15.99	55.947
3	1.789	8.944	64.892	1.789	8.944	64.892
4	1.402	7.011	71.902	1.402	7.011	71.902
5	0.818	4.091	75.994			
6	0.782	3.909	79.903			
7	0.643	3.217	83.12			
8	0.505	2.527	85.648			
9	0.478	2.391	88.039			
10	0.405	2.026	90.065			
11	0.377	1.885	91.95			
12	0.318	1.591	93.541			
13	0.266	1.328	94.869			
14	0.219	1.095	95.964			
15	0.205	1.027	96.99			
16	0.157	0.784	97.775			
17	0.14	0.699	98.473			
18	0.125	0.625	99.099			
19	9.17E-02	0.459	99.557			
20	8.86E-02	0.443	100			
Extraction Method: Principal Component Analysis.						
a Only cases for which YEAR = 1 are used in the analysis phase.						

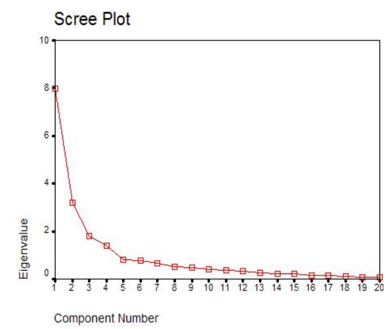


Table A.8.2

Total Variance Explained & Scree Plots for Year 2

Total Variance Explained[a]						
	Initial Eigenvalues			**Extraction Sums of Squared Loadings**		
Component	**Total**	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**
1	7.135	35.677	35.677	7.135	35.677	35.677
2	2.734	13.67	49.347	2.734	13.67	49.347
3	1.757	8.784	58.131	1.757	8.784	58.131
4	1.131	5.657	63.787	1.131	5.657	63.787
5	0.952	4.76	68.548			
6	0.826	4.132	72.679			
7	0.7	3.502	76.182			
8	0.645	3.226	79.408			
9	0.57	2.852	82.26			
10	0.472	2.362	84.622			
11	0.446	2.232	86.854			
12	0.437	2.187	89.041			
13	0.363	1.813	90.855			
14	0.347	1.735	92.59			
15	0.328	1.639	94.229			
16	0.284	1.418	95.647			
17	0.237	1.185	96.832			
18	0.233	1.163	97.995			
19	0.225	1.124	99.119			
20	0.176	0.881	100			
Extraction Method: Principal Component Analysis.						
a Only cases for which YEAR = 1 are used in the analysis phase.						

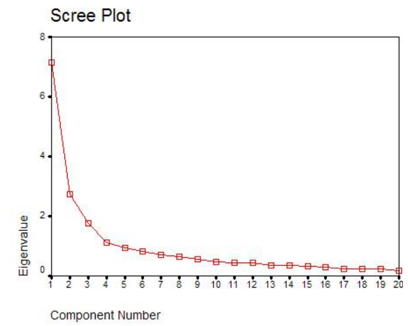


Table A.8.3

Total Variance Explained & Scree Plots for Year 3

Total Variance Explained[a]						
	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	**Total**	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**
1	7.056	35.278	35.278	7.056	35.278	35.278
2	2.693	13.465	48.744	2.693	13.465	48.744
3	1.926	9.631	58.374	1.926	9.631	58.374
4	1.424	7.119	65.493	1.424	7.119	65.493
5	1.151	5.753	71.247	1.151	5.753	71.247
6	0.751	3.753	75			
7	0.619	3.095	78.094			
8	0.563	2.813	80.907			
9	0.508	2.54	83.447			
10	0.488	2.438	85.885			
11	0.433	2.166	88.051			
12	0.393	1.965	90.015			
13	0.351	1.754	91.769			
14	0.33	1.65	93.419			
15	0.281	1.407	94.826			
16	0.249	1.243	96.069			
17	0.223	1.114	97.184			
18	0.201	1.004	98.188			
19	0.192	0.96	99.148			
20	0.17	0.852	100			
Extraction Method: Principal Component Analysis.						
a Only cases for which YEAR = 1 are used in the analysis phase.						

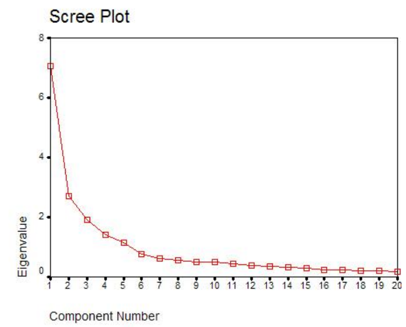
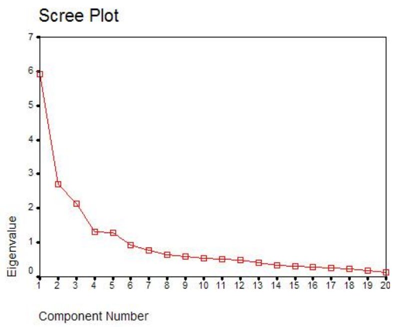


Table A.8.4

Total Variance Explained & Scree Plots for Professionals

Total Variance Explained[a]						
	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	**Total**	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**
1	5.922	29.611	29.611	5.922	29.611	29.611
2	2.696	13.482	43.093	2.696	13.482	43.093
3	2.136	10.682	53.774	2.136	10.682	53.774
4	1.324	6.62	60.394	1.324	6.62	60.394
5	1.279	6.394	66.788	1.279	6.394	66.788
6	0.938	4.692	71.48			
7	0.78	3.901	75.382			
8	0.653	3.263	78.644			
9	0.592	2.962	81.606			
10	0.534	2.668	84.275			
11	0.528	2.638	86.912			
12	0.493	2.466	89.379			
13	0.401	2.003	91.381			
14	0.327	1.634	93.016			
15	0.308	1.54	94.555			
16	0.284	1.418	95.974			
17	0.255	1.274	97.247			
18	0.225	1.123	98.37			
19	0.186	0.931	99.301			
20	0.14	0.699	100			
Extraction Method: Principal Component Analysis.						
a Only cases for which YEAR = 1 are used in the analysis phase.						



APPENDIX B: Interview Guide

Introduction and Instructions

1) Remind participants that they should reflect on their own learning experiences, and that there were no right or wrong answers. Reassure them that everything they said would be used only for the purpose of the study and no names will be mentioned.

2) Tell participants that this interview process would last for about 40 - 60 minutes and they could leave the interview at any point of time if they did not want to continue, no reasons were required.

3) Review the purpose of the research, and outline Vermunt's model - explain the four learning patterns (meaning directed, reproduction directed, application directed and undirected) and the four learning domains (processing strategies, regulation strategies, learning orientations and mental models of learning) to the participants.

Guide Questions:

(i) Please introduce yourselves to each other.

(ii) Let's start with something very fundamental. What comes to your mind when you think of the term, "Learning" - what does learning mean to you?

(iii) What about the term "Understanding" - what does understanding mean to you? Are "learning" and "understanding" the same or different to you?

(iv) Now let's talk about how you go about your learning in general. Think of a recent situation when you had to learn something new. Do you think that you use different learning approaches, like a box of different tools, to learn different things? If so, how do you choose your study approach? What does it depend on? Please give some examples. Is this the same for everyone?
Note: Possible approaches could include:
  - simply memorising all the material so you can reproduce them for an examination
  - reading beyond the textbook and lecture handouts, exploring the topics further on your own
  - asking questions and forming your own ideas
  - thinking about how the knowledge can be applied
  - talking to friends
  - etc.

(v) Now let's be more specific. You take/have taken different types of Engineering modules in your course – do you see yourself using different approaches in handling the different modules? If so, in what way are they different?

(vi) Do you take any non-Engineering modules other than the core modules related to your course? What are these modules?

(vii) Think about how you study for these non-Engineering modules. Do you approach your studies for these modules differently? If so, in what way differently?

(viii) Now try to think about the way you went about learning before you came into the polytechnic and compare that to now. Do you think your approach – the way you study – has changed over the years? If so, how has it changed, and why do you think it has changed? What about between your first year and second year/third year?

Additional for Professionals:

(ix) What has motivated you to come back to school to continue your education for a degree?

(x) Has that influenced the way you approach your studies now? If so, in what way?

Note: Possible responses:

- more driven by specific purpose
- independent, self-directed
- able to know how to apply the knowledge
- etc.

(xi) What do you think are important strategies/learning patterns for professionals like yourselves to be successful in life-long learning? If you had a chance to talk to the polytechnic undergraduates, what you advice them with regards to their learning patterns - meaning directed, reproduction directed, application directed?

APPENDIX C: Cover Letter and Consent Form to Invite Participants for the Quantitative Study

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Study of Learning Patterns of Engineering Students

<u>Participant Information Sheet</u>

Dear Students,

Thank you for picking up this survey!

It is understood that different people approach learning in different ways. This survey seeks to understand the different learning styles adopted by different students in the School of Engineering. I hope that the results of this project would provide some insight for lecturers to reflect on their teaching approaches and understand the factors that may affect the learning styles of the students and thus make changes, if necessary, to enhance the students' learning not only for their current course but also for their future professional development.

I would like to invite you to participate in this study by filling up the attached questionnaire. It will take about 20 mins to complete the whole questionnaire and you need to spend some time to think about how you normally approach your studies - there are no right or wrong answers. After you have finished filling up the questionnaire please drop it off at my office at Block S, Level 4, room S.448. If I am not in my office, you may just slip it under my door. Kindly return it to me by **< day month year >**.

Detailed instructions on how to fill up the questionnaire properly are provided in the Introduction Section of the questionnaire.

Do note that participation is purely voluntary and you will be able to withdraw from this study at any time and without having to give reasons for your withdrawal.

Following proper research procedure, please complete the attached consent form if you agree to participate in this study, and return it together with the questionnaire. If you want to discuss about the study or need further clarifications, please feel free to contact me at Aaron_TAN@nyp.gov.sg or call me at 6550-0568. Thank you!

Yours sincerely,

Aaron Tan
Wireless Technology Centre
School of Engineering (Electronics)
Nanyang Polytechnic

CONSENT FORM

TITLE OF PROJECT

Learning Patterns of Engineering Students in a Singapore Tertiary Education Context and the Implications to Continuing Education in the Field of Engineering

(The participant should complete the whole of this sheet himself/herself)

Please cross out as necessary

Have you read the Participant Information Sheet? YES / NO

Have you had an opportunity to ask questions and to discuss the study? YES / NO

Have you received satisfactory answers to all of your questions? YES / NO

Have you received enough information about the study? YES / NO

Who have you spoken to? Dr/Mr/Mrs/Ms/Prof. ....

Do you consent to participate in the study? YES/NO

Do you understand that you are free to withdraw from the study:

* at any time and
* without having to give a reason for withdrawing and
* without affecting your position in the School? YES / NO

Signed ....………............... **Date** ....

(NAME IN BLOCK LETTERS) ....………........................

APPENDIX D: Professor J.D. Vermunt's Approval Letter

! Attachments can contain viruses that may harm your computer. Attachments may not display correctly.

TAN K.A.A.

From: Vermunt, prof. dr. J.D.H.M. (Jan) [J.D.H.M.Vermunt@ivlos.uu.nl] **Sent:** Thu 01-Sep-05 5:37 PM
To: TAN K.A.A.
Cc:
Subject: RE: Inventory of Learning Styles
Attachments: ILS-HE English.rtf(157KB) ILS-HE English scoring key.rtf(44KB) ILS-HE English 100 items.rtf(145KB) ILS-HE English 100 scoring key.rtf(40KB) Article Vermunt & Vermetten 2004 Ed Psy Rev.pdf(131KB)

Dear Dr. Tan,

Attached you may find our Inventory of Learning Styles (ILS) in both the original 120-item version and a shortened 100-item version, together with the scoing keys of both versions. I also enclosed a recent review article on ILS-related research.

You may use the ILS for your research as you wish. If you have any further questions or remarks, please let me know.

Kind regards,

Jan Vermunt

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http://www.ivlos.uu.nl/deorganisatie/wiewatwaar/medewerkers/vermunt/englishversion/34142main.html

-----Oorspronkelijk bericht-----
Van: k.a.a.tan@durham.ac.uk [mailto:k.a.a.tan@durham.ac.uk]
Verzonden: woensdag 31 augustus 2005 5:05
Aan: Vermunt, prof. dr. J.D.H.M. (Jan)
Onderwerp: Inventory of Learning Styles

Dear Prof. Jan Vermunt,

I am currently reading for a Doctorate of Education under the University of Durham, UK. I am now preparing for my thesis and my interest of study is in the learning styles of 17-20 year old undergraduates of higher learning in a Polytechnic in Singapore where I am currently teaching.

I have read a number of studies based on your ILS which have been mostly done in Europe/UK and I would like to study the learning styles/approaches of students in Singapore.

I am interested to know what are the learning styles adopted by my students and to understand if they have the necessary styles to succeed in future self- regulated life long learning. I would also like to understand if there is any relationship between ethnicity, nationality and gender in learning approaches.

I would like to seek your kind assistance to obtain a copy of the ILS questionnaire and to seek your permission to use it for the purpose of my study.

For your kind consideration, please.

Best Regards,
Aaron Tan