



Towards coherent practice in capstone courses for IS majors

by

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From Our Father's Heart

As you work through those things that are placed in front of you,
remember that there is a much larger picture that is unfolding,

Your world is groaning as if in birth.

My plan is unfolding at My rate of speed,
on My terms,

In response to My command,

Soon, what seems very large in front of you will pass away,

Everything is about to change,

When you are with Me, your darkest fear

Will not even be a memory.

There is only one constant in your life.

His name is Jesus.

He is with you now.

He will be with you for eternity,

Embrace Him.

Embrace His ways.

The pattern that He has set for your life.

Towards coherent practice in capstone courses for IS majors

Abstract

Information and communication technologies (ICTs) are used to support almost all areas of human activity, and information systems play an increasingly important role in organisations and in society as a whole. At the same time, continuous and dramatic changes in the field of Information Systems (IS) and its context pose serious challenges to educators preparing students for professional practice. This study is therefore about the search to design, develop and implement a framework for constructing a capstone course that will be both flexible and efficient, while simultaneously embracing the interdisciplinary character of the IS field. A capstone course can be viewed as a man-made artefact intended to meet the needs of the world we live in and the activity of building theory in such a world is embedded in the sciences of the artificial. The research paradigm for this environment thus comprised a combination of the behavioural science and design science paradigms.

The evolution of a capstone course at the University of Cape Town commenced in 2001 and led to the development of a conceptual framework for a coherent practice. During 2010 and 2011 the conceptual framework acted as a bridge enabling the researcher to develop, refine and evaluate a design science theory. This was done through a series of themed action experiments each consisting of several interventions, to create a synthesis of theory and practice for preparing thoughtful practitioners. The theory includes prescriptive statements of actions leading to specific outcomes that provided evidence of how a reflective practice nurtures deep involvement of students in their learning experience. It further demonstrated how accompanying theories within this framework can be utilised either to underpin or to make sense of the different activities within this practice. These meaning-making activities initiated the reconstruction of interventions and actions to promote transcendence and embodied cognition, nurturing competence and lifelong learning. Ultimately, the intention of the theory is to extend the boundaries of the capabilities of IS majors (or students of other exit level courses) to such an extent that they become empowered to cope with the complex and changing demands of the real world.

Table of Contents

1	Introduction	1
1.1	Introduction	1
1.2	Background to the Research Problem	2
1.3	Research Problem	7
1.4	The Purpose of the Research	9
1.5	Research Objectives and Questions	11
1.6	The Research Process	12
1.7	Importance of the Research	14
1.8	Research Context	15
1.9	Definition of Terms	15
1.10	Organisation of the Thesis	17
2	Building a Theoretical Foundation	20
2.1	Introduction	20
2.2	Theory and the Role of Theory	20
2.2.1	Theories of Action	22
2.2.2	Theories of Practice	26
2.2.3	Competence Development in the Context of Theories of Practice	29
2.3	Establishing a Pedagogical Foundation	37
2.3.1	Teaching	37

2.3.2	Approaches to Learning	41
2.3.3	Assessment.....	51
2.4	Summary	54
3	Merging Theory and Practice.....	56
3.1	Introduction	56
3.2	Core Characteristics of the Information Systems Discipline.....	57
3.3	Industry Expectations and Curriculum Design.....	61
3.3.1	Industry Needs and Expectations.....	61
3.3.2	Curriculum Design to Meet Industry Expectations	64
3.3.3	Model Curricula.....	66
3.4	Integrated Environment of Capstone Courses	69
3.4.1	Opportunities and Benefits	71
3.4.2	Project Management.....	73
3.4.3	The People as the Project Stakeholders.....	76
3.4.4	Developing the Project.....	78
3.4.5	Learning and Teaching in this Environment.....	83
3.4.6	Assessment Approaches	84
3.5	Theory and Practice in Capstone Courses	84
3.6	Summary and Critique	87

4	Stages of Evolution: The Case of the Capstone	91
4.1	Introduction	91
4.2	A Historical Perspective	93
4.2.1	The Baseline Phase (2000)	95
4.2.2	The Grounding of Skills Phase (2001 – 2004).....	98
4.2.3	The Emergent Phase (2005 – 2009)	114
4.3	Summary and Anticipating the Next Phase	127
5	The Science of Design.....	129
5.1	Introduction	129
5.2	Building Theory in the Sciences of the Artificial	129
5.2.1	Design Science as Research Paradigm	131
5.2.2	Design Research in Education	133
5.2.3	Humanities Enriched Design Science Research	133
5.2.4	Design Science Theory.....	137
5.3	Building Theory for a Capstone Course	141
5.3.1	Framing the Research.....	141
5.3.2	The Research Process for Developing Theory in the Capstone Course	142
5.3.3	Theory Development for a Capstone Course.....	144
5.4	Design Evaluation Methods	151
5.5	The Making of Data.....	153

5.6	Data Analysis.....	156
5.7	Summary of the Research Methodology.....	159
6	Themed Action Experiments	161
6.1	Introduction	161
6.2	The Plan.....	163
6.3	Intervention Themes Executed as Action Experiments.....	168
6.3.1	Interventions for Assessing and Becoming Aware of the Self	169
6.3.2	Interventions to Address the IS Management and Project Phenomena	177
6.3.3	Interventions and the Integration of IS and Business Foundations.....	186
6.3.4	Interventions for a Sound Technological Foundation.....	190
6.3.5	Interventions for a Reflective Practice.....	199
6.3.6	Interventions to Provide a Real-World Perspective.....	207
6.3.7	Interventions to Culminate the Capstone Experience.....	210
6.4	Summary.....	214
7	Conclusion	216
7.1	Introduction	216
7.2	The Claim for Relevance	217
7.3	The Claim for Rigour	220
7.4	Justification of the Theory – Design Cycle	221
7.5	Contributions	225

7.6	Limitations.....	227
7.7	Conclusion.....	228
8	References	230
	Appendices	249
	Appendix 1 – Profile Excerpts 2010	249
	Appendix 2 – Profile Excerpts 2011	253
	Appendix 3 – PGDIP – BASA 2011 Course Outline.....	258
	Appendix 4 – PGDIP – BASA 2011 Student Stories	259
	Appendix 5 – Table of Contents for Analysis Documentation.....	260

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List of Figures

Figure 1.1: The Dualistic Character of IS in a DSR Approach for a Capstone Course	13
Figure 1.2: The First Part of the Roadmap to the Thesis – Towards Coherent Practice	18
Figure 1.3: The Second Part of the Roadmap to the Thesis – Towards Coherent Practice	19
Figure 2.1: Theories of Action	26
Figure 2.2: Knowledge-Experience and Theory-Practice Cycle.....	27
Figure 2.3: A Theory of Intervention in the Context of a Theory of Action	28
Figure 3.1: Key Characteristic of the IS Discipline	60
Figure 3.2: Characteristics of the Real World	63
Figure 3.3: Characteristics of the IS Curriculum (IS2010)	69
Figure 3.4: The Act of Programming	80
Figure 4.1: The Baseline Phase 2000.....	97
Figure 4.2: The Grounding of Skills Phase 2001 - 2004.....	113
Figure 4.3: Curriculum Design at UCT (2005 – 2009).....	117
Figure 4.4: Interventions Exhibiting a 3-Phased Structure	120
Figure 4.5: The Emergent Phase 2005 - 2009	123
Figure 4.6: The Opportunities Provided by the Emergent Phase	125
Figure 5.1: The Reasoning in the DSR Cycles of the Capstone Course.....	135
Figure 5.2: Theories, Conceptual Framework, Design Theory and the Design Process.....	138
Figure 5.3: Research Framework for Developing Theory in a Capstone Course.....	142
Figure 5.4: Intended Outcomes embedded in the Capstone Course	146
Figure 5.5: Kernel theories of the Conceptual Framework for a Coherent Practice	148
Figure 5.6: Conceptual Framework for a Coherent Practice (No Kernel theories shown)	148
Figure 6.1: Themes for a Coherent Practice.....	166
Figure 6.2: The Life Cycle of an Intervention	169
Figure 6.3: Expectations and Contribution for Delivery Cycles of 2010 and 2011	174
Figure 6.4: Team Issues emphasised in Peer Evaluations (2006 – 2011).....	185
Figure 6.5: Interventions and Intervention Themes	215

List of Tables

Table 2.1: Stages of Skills Acquisition	33
Table 3.1: Aligning Concepts	86
Table 4.1: Project Phases and Corresponding Milestone Deliverables	103
Table 4.2: Assessment Instruments	108
Table 4.3: Research Studies to Underpin the Grounding of Skills Phase	111
Table 4.4: Publications to Underpin the Grounding of Skills Phase	112
Table 4.5: The Evolution of the Grounding of Skills Phase	114
Table 4.6: Schedule and Teaching Methods	121
Table 4.7: Assessment Strategy	122
Table 4.8: Research Studies to Underpin the Emergent Phase	126
Table 4.9: Publications to Underpin the Emergent Phase	126
Table 4.10: Kernel Theories Identified During the Emergent Phase (see section 2.2.3)	127
Table 5.1: Components of an Initial Design Theory for a Capstone Course	150
Table 5.2: Data Making Method	154
Table 5.3: Historical Data Items and Data Items of the Cycles of 2010 and 2011	155
Table 5.4: Data Recoding Techniques and Tools for Analysis	158
Table 5.5: Summary of Research Methodology	160
Table 6.1: Action Elements of the Action Experiments	168
Table 6.2: Top 8 Core Values	175
Table 6.3: Positive Aspects of the Course: Communication and Real-world Experience	182
Table 6.4: Intervention Streams in a 3-Phased Approach	188
Table 6.5: Average Marks for Documentation Deliverables in 2010 and 2011	189
Table 6.6: The Different Phases and Stages of the Programming Interventions	194
Table 6.7: The Different Phases and Marks for Coding Deliverables	197
Table 6.8: Excerpts from Student Profiles of 2010	202
Table 6.9: Excerpts from Student Profiles of 2011	203
Table 6.10: Theories of Action to Facilitate Embodied Cognition	206
Table 7.1: Student Profile Excerpts - Comments on Relevance	218
Table 7.2: Alumni (2006 – 2009) - Third Year Experience	219
Table 7.3: Research Questions, Theory Propositions and Themes	222
Table 7.4: The Theory of Coherent Practice	223

Table 7.5: The Theory of Coherent Practice (continued)..... 224

1 Introduction

A journey of a thousand miles begins with a single step...

(Chinese proverb)

1.1 Introduction

This thesis describes the development and refinement of a design theory in the form of a course development framework for the construction of capstone courses in Information Systems (IS). It further argues that capstone courses developed in this way will equip students with the competencies and lifelong learning skills that are needed to fulfil their roles effectively in the real world.

Information systems have become ubiquitous and make a significant contribution to the running of organisations, governments and communities; as a result, the provision of information systems has become a priority for organisations and for society as a whole. However, such systems have often failed to meet the expectations of their stakeholders, and academic institutions are continuously challenged to equip students for the demanding roles needed to successfully conceptualise, analyse, design, develop, implement, enhance and maintain these systems. Walsham (2012, p. 90) claims that “we need a broader ethical agenda of making a better world and we must embrace new technologies and new settings where information and communication technologies (ICTs) are important”. In order to meet new needs and address the difficulties that are experienced, IS has had to embrace a more socio-technical approach and “work closely with other disciplines and be interdisciplinary” (p. 91). During this transition, institutional roles have also changed and sourcing strategies have had to be aligned with the dynamics of supply and demand. The quality and quantity of IS skills that are available to support the emergence and maturity of IS provision roles has emerged as a key concern that needs to be addressed.

It is widely accepted that there is a shortage of highly skilled professionals to design, develop and manage the technical, organisational and strategic aspects of these information

systems. Much has been written on the skills gap and what graduate attributes and capabilities should be developed to prepare IS graduates to cope with the challenges of the real world (Richards, Marrone, & Vatanasakdakul, 2011; McMurtrey, Downey, Zeltmann, & Friedman, 2008; Beard, Schwieger, & Surendran, 2007; Gallivan, TruexIII, & Kvasny, 2004). The dilemma, however, is not only to identify *what* needs to be done (Beard et al., 2007), but also *how* it should be done. An in-depth review of the literature reveals that very little research has sufficiently addressed the *how* aspect of professional development, which relies on deep understanding of *why* particular processes and methods deliver better results than others. In the quest to address the *how* questions it is necessary to understand the root causes of the problems and demands created by a complex socio-technical environment.

This chapter will give a brief overview of the research problem, the purpose of the research, research objectives and questions and the process followed. The importance of the research and the context in which it was conducted will be highlighted. The chapter will conclude with definitions of commonly used terms and a roadmap to show how the various parts of the thesis fit together and inform one another.

1.2 Background to the Research Problem

IS practitioners and academics require lifelong learning skills in order to cope with the messy and ill-defined problems that are created by continuously changing workplace demands (Kroeze et al., 2011; Checkland, 1972). Rapidly advancing information and communication technologies (ICTs) have become inextricably intertwined with business strategy and processes (Chao & Shih, 2005; Peppard & Ward, 2004). This has not only generated a variety of career opportunities (Chao & Shih, 2005), but also demands increasingly diverse skills from current and new employees (Gallivan et al., 2004; Smits, McLean, & Tanner, 1997). As a result of all these factors, the challenge of “making reliable forecasts for supply and demand for ICT skills should not be underestimated” (Lotriet, Matthee, & Alexander, 2010, p. 44). People are important resources in any organisation; and because organisations depend so heavily on information technology, the competitive ability of an organisation is optimised when Information Systems(IS) and Information Technology (IT) competence is widely dispersed in the organisation (Peppard & Ward, 2004). The concept

of IS competence reflects the ongoing organisational capability to derive business value from IT investments, based on the skills and resilience of people in the organisation. This involves the suggestion, selection and implementation of appropriate business changes and innovations, whether they are product/service innovation, new business models, or process changes (Peppard & Ward, 2004). White (2004, p. 14) contends that business really wants IT/IS professionals to “deliver IT without fuss, get involved in business improvement and give us [them] appropriate leadership”. This is not easy to do given the increasing complexity of real-world practice where situations of instability, uniqueness, uncertainty and value-conflict often prevail (Schön, 1983). Few tasks are more challenging to the IS executive than recruiting, training, motivating and retaining high-calibre professional staff (Smits et al., 1997).

In light of the above, institutions of tertiary education face the challenge of producing graduates who are sufficiently prepared for professional practice when they commence their careers. Several researchers have explored the existing skills gap. For example, Gallivan et al. (2004) found ongoing evidence of a recruitment gap: despite the “emphasis on hiring well-rounded employees with good business knowledge and soft skills, the recruitment staff continue to focus on hard skills as these are easier to screen” (Gallivan et al., 2004, p. 83). In a survey of employer satisfaction conducted in Australia in 2001, 30% of respondents felt that universities should provide students with more work experience, including real-life projects (Hagan, 2004). This study concludes that universities should encourage closer links with industry representatives, and should aim to develop students who can demonstrate flexibility based on broad knowledge and understanding, instead of only focusing on specific skills and applications. Other researchers have investigated the critical skills needed for entry or advanced level IS/IT professionals (McMurtrey et al., 2008) as well as the job skills demanded by the internet era (Hardin, Joshi, & Li, 2002).

There is thus consensus in the literature that producing well-rounded IS/IT graduates in a world of complex requirements places stringent demands on IS educators (Richards et al., 2011; Byrne & Lotriet, 2007), who must continuously revise and change programmes and curricula so as to better equip students for the marketplace (Kumar, 2006; Dawson & Newman, 2002; Noll & Wilkins, 2002; Tuttle, 2000). Over the past decade only two major

academic attempts have been made to address IS curricular issues, with IS2010 (Topi et al., 2010) being the most recent update to the IS curriculum.

A key responsibility of the IS professional is to determine the requirements for an organisation's information systems and to play an active role in the specification, design and implementation thereof (ComputingCurricula, 2005, 2004); which extends beyond the mere provision of a suitable system and its subsequent support. IS2010 (Topi et al., 2010) suggested significant changes to the previous curriculum, bearing in mind that IS professionals must keep up with rapid changes in technology, business and IS functions (Gupta & Wachter, 1998). The main changes included restructuring the curriculum to have a broader focus, re-evaluating topics relating to high-level IS capabilities, and categorising these into three knowledge and skills areas. The curriculum was also separated into core and non-core (elective) topics to ensure that it provided sufficient flexibility for a variety of educational systems. Although the extensive curriculum update was necessary and welcomed, a serious cause of concern is that application development was identified as no longer being core to the IS curriculum (Kroeze et al., 2011). In addition, the benefit realisation role, which is ongoing and tied to the life of any system (Peppard & Ward, 2004), was neither addressed in previous versions of the curriculum nor sufficiently covered in the new IS2010 version.

It is evident that the development of a comprehensive and coherent pedagogy needs careful consideration. Byrne and Lotriet (2007) argue that since the main aim of education is to facilitate a change in learners' knowledge, educators should convey to their learners a critical awareness of the different conceptualisations of the discipline and link this to the role of the IS actor as a potential IS practitioner (p. 2). They also note that it is important to create spaces and opportunities for students to become co-constructors of this body of knowledge. White (2004) contends that focus should be directed on three types of IS/IT roles within organisations: maintaining business momentum (MBM), improving business results (IBR) and providing appropriate technology leadership (TL) (see Chapter 3). In preparing the IS graduate for these roles, a capstone experience is globally accepted as being a possible vehicle for delivering the desired outcomes (Lynch, Heinze, & Scott, 2007; Kumar, 2006; Clear, Goldweber, Young, Leidig, & Scott, 2001; Gupta & Wachter, 1998).

In a collaborative paper representing three institutions from different continents, Lynch et al. (2007, p. 1) state that a capstone course provides “a quintessential experience for students in their program of study and is a critical component of an information systems curriculum”. In many faculties the design of the capstone course is intended to integrate the body of knowledge obtained in other undergraduate courses, an objective which is relevant to the IS domain. This practice is also seen as an effective way to address the curriculum challenges at the end of an IS academic programme (Novitzki, 2001; Tuttle, 2000; Gupta & Wachter, 1998). According to Moore (2006), the design of a capstone course should include ample opportunities to assess cognitive, affective and psychomotor competency in both a student-centred and student-directed way. Cognitive competency refers to the ability of students to recall, understand and apply knowledge, whereas affective learning refers to changes in their feelings, values and attitudes. Psychomotor learning in contrast is an ongoing refinement process that depends on the application and performance of skills (Moore, 2006).

In many cases the learning that occurs in capstone courses, and particularly so for IS and IT, happens through a team project used as a major deliverable (Novitzki, 2001). IS capstone courses typically include project management and a systems development project as core components. Often these activities are aligned with the *best practice* approaches of industry. Cicmil (2006, p. 28) suggests that best practice in management focuses “on planning, organizing, coordinating, and controlling, but does not fully reflect organizational reality as messy, ambiguous, fragmented and political in character”. Although such a team project requires careful design, coordination, monitoring and evaluation, the value for students of a *near real life* educational experience is recognised by many universities around the world (Lynch et al., 2007).

Despite widespread consensus about the benefits of capstone courses (Kumar, 2006; Brandon, Pruet, & Wade, 2002; Clear et al., 2001; Tuttle, 2000; Gupta & Wachter, 1998), they are also known to be resource intensive. Furthermore, although team projects are intended to encourage *deep approaches* to learning (Entwistle, 2000) and to provide a lived experience of the real world, the usual duration of one semester is often not sufficient to incorporate the comprehensive range of activities that may occur during the full development cycle. Lack of time while doing a project may keep students from seeing the

bigger picture, which would be detrimental to processes of integration and convergence that are needed for students to extend their knowledge through analysis, synthesis and application. In addition, adequate time should be available for implementing recursive processes to facilitate not only problem solving, but also for problem definition and for the reflection needed to nurture the internalising of knowing and understanding (Schön, 1983). Solving a real-life problem often involves a search and the possibility of exploring “several tentative paths” (Simon, 1969, p. 69). Failing to address these issues sufficiently might result in a capstone course failing to live up to the expectations of such a culminating experience. It can be argued that learning can just as well be enhanced through repetition and more exercises in individual courses. However, a well-planned capstone course has unique benefits of integrating topics of various classes, implementing real world concepts and emphasising core principles of a particular discipline very effectively (Reinicke, Janicki, & Gebauer, 2012).

The business environment for which IS graduates must be prepared, has undergone numerous changes since the 1980s, evolving from functional organisation to being process driven, through to being task-based, to what is currently referred to as a project-driven environment (Crawford, Morris, Thomas, & Winter, 2006). In Winter and Szczepanek’s (2009) opinion, formal project management knowledge is less important than a willingness to be challenged and an openness to new ideas and ways of thinking. In the complex environment of fast changing market conditions, these abilities are essential in order for project practitioners to make appropriate decisions quickly and in the best interest of the organisation. This not only calls for a closer investigation of how specific courses are used to implement the IS curriculum, but also to encourage a better alignment and an awareness of new research in related areas of software development practices and project management practices (Cicmil, 2006; Cicmil, Williams, Thomas, & Hodgson, 2006). One of the main objectives mentioned for a proposed capstone course in the IS2010 curriculum is to explore the issues and approaches in managing the information systems function in organisations. This could refer to IT management, the structuring of IS management within organisations and managing IS professionals within the firm (Topi et al., 2010).

If the capstone environment is *interactive and integrated* it has the potential to provide a unique opportunity to “enact” meaning-making activities towards constructing and

internalising knowledge (Barrett & Walsham, 2004). It is in such a process that students can be groomed to practise innovative ways that will enhance their capabilities and better prepare them to face industry challenges. To date very little mention is made in the literature on capstone courses of how theory can be used to underpin the pedagogy of such courses and facilitate the design of the interventions incorporated into a curriculum in such a way that it will foster deep approaches to learning. LeMaster (2005, p. 1) argues that some authors only focus on the way students learn rather than the cognitive learning process, or what was actually learned. This thesis is thus driven to articulate the *how* and the *what* of a theory that will assist to grow competence and empower IS graduates to meet the demands of practice.

The background as described above creates an acute awareness of a persistent and relevant problem that exists in IS education. The next section defines the problem more explicitly and emphasises the main reasons for the particular situation of concern. Section 1.4 motivates the purpose of the research and section 1.5 states the research questions and lists the main objectives. This is followed by an introduction to the research process and further sections explaining the value of this research and describing the context in which it has been conducted. The chapter concludes with a set of definitions of terms that form part of the discourse of the study and a brief outline of the thesis.

1.3 Research Problem

The problem of *how best to empower IS students to perform their roles with competence in their future work environments* is clearly a multifaceted and complex one. Six core issues are briefly highlighted below, some of which have already been alluded to in the previous section. Firstly, the *dynamic nature* of the IS profession, caused primarily as a result of the ever-changing IS/IT technology environment (Janicki, Lenox, Logan, & Woratschek, 2008; Chao & Shih, 2005; Ebert & DeMan, 2005; Hagan, 2004; Hardin et al., 2002; Benamati & Lederer, 2001; Cappel, 2001) and the ongoing evidence of a *skills and/or recruitment gap* between industry and higher education (McMurtrey et al., 2008; Gallivan et al., 2004; Hagan, 2004; Todd, McKeen, & Gallupe, 1995; Trauth, Farwell, & Lee, 1993), provide serious reasons for concern to both industry and academia as attempts to improve the alignment

between what industries expect from new employees and how higher education prepares students for professional practice, remain a challenge.

Secondly, there is a *need for diversity*. Several reasons can be given for this need, since IS is an interdisciplinary field that develops and maintains systems across different disciplines (Walsham, 2012). As a result, IS embraces not only technological and organisational systems, but is also interested in the problems and solutions (phenomena) which emerge when the two interact (Lee, 2000). IS is thus concerned with the developing of artefacts (objects like plans, systems, concepts, etc.) “that are brought about or caused|| by human agency” (Kroeze et al., 2011, p. 382). The dualistic character of IS further creates a need for collaborative industry and research projects and Hevner, March and Park (2004) argue that design science research should be aligned to the real-world production experience, while the behavioural science research component should address validation of organisational issues. This need for diversity is also reflected in Gallivan et al.’s (2004) study on the changing patterns of the IT/IS skills set from 1998 to 2003;,, this diversity was confirmed in a more recent study by McMurtrey et al. (2008) who listed 42 potentially important skills, and indicated that this number was continuously increasing.

In the third place, *value needs to be added* through programmes and projects (Winter & Szczepanek, 2009; Winter, 2004). Peppard and Ward (2004, p. 170) contend that organisations face a “serious challenge” of improving their IS capability. This refers to the sustainability of the IT-based competitive advantage that organisations may have achieved. The inability of organisations to make effective use of their IS/IT resources is as much a result of inadequate competencies among those resources as it is a lack of proper business leadership and organising (Peppard & Ward, 2004).

A fourth complexity has been created by *globalisation*, as the skills of IS/IT graduates must now be transferable to suit the needs of different continents (Lee, 2005). High job turnover among IS professionals is a serious reason for concern (Niederman & Sumner, 2001) and may be related to the different sets of skills possessed by entry level and advanced level practitioners in industry; as such lifelong learning becomes a vital attribute of potential employees (Lee, 2005). Often the specification of skills needed for specific positions is

vague, resulting in the wrong people applying for certain positions (Chao & Shih, 2005) and further contributing to high job turnover rates.

A fifth issue, and perhaps the most important, is the question of *relevance to practice*. The focus of organisational management has shifted from being task-oriented to being project-driven (Sewchurran, 2008), but the complexity of real-world projects is often absent from undergraduate curricula. As a result, training frequently exhibits a lack of relevance to practice, as the emphasis remains predominantly on the best practice approach of planning, organising, coordinating and control (Cicmil, 2006; Cicmil et al., 2006) with the prime focus on just the project manager instead of all the stakeholders.

The sixth and last issue is the profound and persistent challenge encountered by educators all over the world *to align and update the IS Curriculum*. It will be shown in this study that while capstone courses themselves can be challenging, they provide a truly unique learning experience. Reinicke et al. (2012, p. 1) hold that “a well-planned and integrated curriculum can utilise a capstone as an opportunity to refresh students on key discipline topics immediately preceding graduation”.

It is unavoidable that the issues and challenges raised above provide opportunities to find a more explicit and plausible way to encourage deep approaches to learning among IS students. In addition they can guide the design of a well-planned capstone course, direct the objectives of the study and impact the research questions asked.

1.4 The Purpose of the Research

The main purpose of this research is therefore *to develop and refine a theory that reflects the pedagogy of how to implement a capstone programme capable of empowering IS majors to sustain competence across dynamic and evolving IS roles*. The exemplar of the capstone course provided here can also guide academics through the detailed planning and execution of a program that will produce more effective IS graduates. These mechanisms will aid the construction and reconstruction of knowledge and the shaping of thoughts and actions of both academics and students.

As has been mentioned, a capstone course characteristically offers an integrated and interactive environment which can provide students with unique opportunities for learning to cope in complex environments of the real world (Lynch et al., 2007; Lynch, 2007; Kumar, 2006). Through this research we seek to attain a coherent and clear understanding of how and why the capstone processes and procedures enable certain practices and experiences to be successful. First, this research explores and establishes ways to exploit the value of this *integrated environment* so as to fuse practical experiences with theoretical concepts and grow competence through an *as-lived* project experience. Secondly, this research emphasises how the *interactive environment* positively influences students towards acquiring a vocabulary that focuses on doing, explaining, understanding, believing and being. It endeavours to show how this vocabulary equips students to use specific concepts more effectively, not only to negotiate, relate and articulate their learning experiences, but also to stimulate reflection. Reflection is synonymous with higher-order mental processes that individuals apply to explore their experiences in order to derive new understanding and appreciation (Mezirow, 1990). Reflection always accompanies an experience, often unexpectedly (Merleau-Ponty, 1962) and we need “to develop more subtle methodologies and tools of reflective practice that can integrate the various dimensions of human consciousness” to facilitate integrated experiential learning (Jordi, 2010, p. 13). Finally, this research investigates how best to *encourage deep approaches to learning* that will enable students to become context-driven and competent through an action learning approach. This approach initially guides students to perform activities in a step-by-step and controlled manner. As students gain more experience and confidence, tasks are performed in a more independent manner, albeit still in a secure environment until they reach the following stage where they are expected to perform tasks more autonomously. We argue that such an approach may help to avoid a descent into chaos and set students on a path of controlled quality, gradually developing creative abilities and leading towards crafted quality and competence.

The next section lists the research questions and defines a set of high level objectives that must be met in order to achieve the purpose of this research.

1.5 Research Objectives and Questions

The main objective for this study is to provide an exemplar underpinned by theory of how to put into practice a capstone programme capable of empowering IS majors to perform the diverse, dynamic and evolving roles associated with IS competence. In order to achieve this overarching objective it is incumbent to also:

- understand the desired outcomes to establish IS competence;
- understand, investigate and describe how to nurture IS competence;
- understand the related interventions that are necessary to encourage the acquisition of competencies;
- understand the related interventions that are necessary to facilitate deep approaches to learning;
- gain deeper insights into experiences of applying and testing these interventions and efforts to encourage deep approaches to learning;
- understand how these experiences contribute to student participation, learning, sense-making and coping in the real world;
- understand how these experiences can initiate lifelong learning that will assist in sustaining motivation, commitment and business improvement.

Considering the above objectives, the fundamental question underlying this research is therefore to uncover *what pedagogy should underpin the capstone course within the IS major to empower graduates to meet the dynamic and evolving roles related to IS competence and lifelong learning in the context of the IS profession*. There is no simple explanation for this phenomenon of empowering students, which leads us to define three further sub-questions so as to explore in more depth how the dynamic interactive environment of the capstone course could provide a context to develop this understanding. These are:

- what interventions are necessary to create an integrated environment that will fuse practical experiences with theoretical concepts?

- how can this set of carefully structured interventions be used to grow competence through an as-lived project experience, where the growing of competence involves the encouraging of deep approaches to learning and the nurturing of transcendence?
- how can a reflective practice nurture an interactive environment that will influence students towards acquiring a vocabulary that focuses on doing, explaining, understanding, believing and being, and helps them to make sense of their experiences?

The researcher's formulation of the above objectives is the culminating result of the evolution of the capstone course and the driving force behind a continuous search for ways to improve the capstone through a process of progressive elaboration. The task of improving a capstone course in this way is undeniably a matter of design.

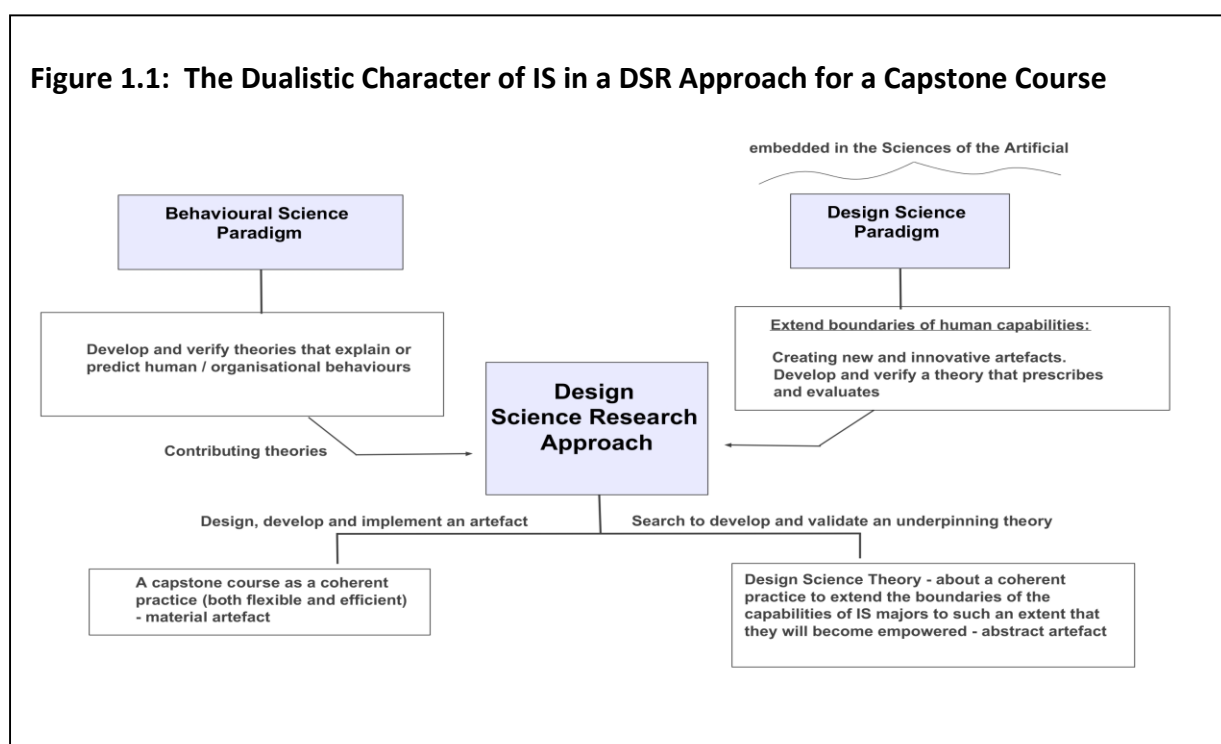
1.6 The Research Process

A Design Science Research (DSR) approach was therefore adopted for this study as it was deemed the most suitable. This choice is congruent with the arguments of Kelly, Lesh and Baek (2008, p. xiii) in the Handbook of Design Research Methods in Education that "successful design research uses design processes, grounded in context of use, to inform and to be informed by the practice of research methods in order to develop principles, heuristics, models and theories about design in learning and teaching settings". According to Baskerville (2008, p. 441) an interest in DSR leads to an engagement in a discourse of discovery, an "arena that encompasses terms like design science, design research, science of design and design theory". In education it is common that design research is often designated to aid the development of curricular products, intervention strategies or software tools (Middleton, Gorard, Taylor, & Bannan-Ritland, 2008).

Real problems must be properly conceptualised and represented, appropriate techniques for their solution must be constructed, and solutions must be implemented and evaluated using appropriate criteria (March & Smith, 1995). Design science research is fundamentally a problem-solving paradigm (Hevner et al., 2004) which is directed towards a better

understanding and towards improving the search for potential components to aid the construction of an artefact (Baskerville, 2008; Simon, 1969).

Figure 1.1 depicts the research process for this study. It indicates how the design science paradigm can be used to conduct a DSR study to develop a theory as an abstract artefact that in turn guides the design of a capstone course as a concrete (physical) artefact. In this research endeavour, contributing theories from the behavioural science paradigm enrich the process and assist to explain and make sense of design activities as well as the changes in student behaviour and student attributes during the process. The utilisation of these theories serves to exhibit the dualistic character of the IS discipline as referred to by Hevner et al. (2004). Bannan-Ritland and Baek (2008, p. 315) concur that although “the most difficult part of design is to locate, frame, and describe the design problem fully” it is “complicated further by involving a team of people”.



Source: Researcher’s own construct informed by the literature on capstone courses (see section 3.4) and the literature on DSR (For example, Kelly et al., 2008; Hevner et al., 2004)

As a first step this study implements the research framework of Hevner et al. (2004) to define the problem space where the phenomena of interest reside, the research process,

and the knowledge base that defines the methodologies and the foundational knowledge that this study depends on.

The second step is concerned with executing the research as a 5-step process, which includes an awareness of the problem, a search and suggestions for solving this problem, development of the theory and the building of the artefact, the evaluation and justification, and the conclusion (Kuechler & Vaishnavi, 2008). The development of the theory is exploratory in nature, interpretive and qualitative, and comprises two phases. In the first phase an inductive approach was followed to develop a conceptual framework. The empirical observations over the period 2001 – 2009 and specific theoretical lenses applied in the capstone course towards the end of this period elucidated several concepts and relationships. This facilitated the emergence of a conceptual model as a theoretical framework for the study. The second phase comprised a deductive approach. The theoretical framework for coherent practice developed in phase one provided an initial theory for this step to be further refined, validated and tested during sets of consecutive action experiments in 2010 and 2011 to produce a highly prescriptive design theory.

1.7 Importance of the Research

Both the research literature and industry portray an *acute awareness* “that technology in itself has no inherent value and that IT alone is unlikely to be a source of sustainable competitive advantage” (Peppard & Ward, 2004, p. 169). People are indispensable resources within an organisation, and are required to communicate, coordinate, apply and integrate their business and technical knowledge, skills and experiences. This research can serve as a valuable contribution towards preparing students for the different IS roles and equipping them with the relevant competencies demanded in practice. This research can also provide a valuable contribution by proposing an additional dimension to the IS curriculum aimed at addressing the *benefit realisation role* which is ongoing, tied to the life of organisational systems and is currently not explicitly addressed.

It is thus valid to argue that the challenge of curriculum design in IS is very significant considering how quickly the technologies evolve and also because of the growth of the field

in terms of the impact on individuals, groups, and society. This thesis represents a committed effort in addressing this challenge.

1.8 Research Context

This research initiative is based upon and associated with a single case study and is motivated by a desire to contribute to an ongoing and evolving education process that extends beyond the teaching of specific tools, techniques and best practices. Flyvbjerg (2006) argues that a case study produces invaluable concrete and context dependent knowledge that is at the core of research on learning. He further argues that, when developing theory, “one can generalise on the basis of a single case”, since the “force by example cannot be underestimated” (p. 228).

This case study refers to the capstone course of the IS major at the University of Cape Town (UCT). The course subscribes to an approach that is intended to promote lifelong learning and create a critical awareness of the IS roles through an as-lived project experience. The capstone course in this case study has been structured around three main areas: project management, project phenomena, and software application analysis, design, development and implementation, so as to incorporate the guidelines provided by the Joint Task Force for Computing Curricula (Topi et al., 2010; ComputingCurricula, 2005, 2004; Gorgone et al., 2002). It provides a platform for a coherent practice where the theoretical and practical components and the assessment strategies of the course are merged into a cohesive whole. Since the inception of the course in 2005, numerous interventions have been undertaken and reflected upon in an attempt to facilitate the transcendence of students through the different competency levels of adult learning as described by Dreyfus and Dreyfus (1986).

Although continuous research has been conducted based on similar programmes, a holistic and coherent theory that describes the design of the capstone course in pedagogical terms has not previously been developed to the best of the researcher’s knowledge.

1.9 Definition of Terms

The following terms are used repeatedly throughout this thesis and are therefore defined in terms of the context in which they are used for this study.

As-lived project experience: In the context of this study, the term project refers to the development of a comprehensive web-based software system for a sponsor in industry. An as-lived project experience allows students to experience the entire project context as realistically as possible.

Capstone course: A capstone course represents a complex interactive environment, integrating learning from different courses in the major with courses from previous academic experience in a student-centred and student-directed way (Moore, 2006). It is project-based and thus affords students a real-world experience through intensive teamwork and collaboration with other stakeholders. This environment includes theoretical and practical components and encourages students to learn professional practice and behaviour.

Pedagogy and related terminology: The Concise Oxford English Dictionary (11th Edition) define pedagogy as the science of teaching. Alexander (2003) argues that for us to appreciate and conceive the meaning of education and the kind of inquiry that can effectively inform its practice, we need to conceive of pedagogy in aesthetic terms. This deeper level of understanding questions “distinctions between thinking and feeling, and between truth, beauty and goodness” and takes us beyond self-interest to compassion (Alexander, 2003, p. 2). In this study we concur with Alexander that such insight will empower “teachers and learners to respond meaningfully to the new realities they face each day” (p. 15).

This kind of pedagogy underpins the design of the capstone course as an exit level course in the IS curriculum at UCT. The activities and the deliverables of the course, are mostly referred to as interventions in the latter part of the thesis. The structure of the course and the structure of these interventions depend on the way in which they were conceptualised, designed and constructed, i.e. the theory that influenced these designs. It also refers to the different components that they include and how these components are related and how they will interact with one another. Groups of these interventions formed the themes of the action experiments, discussed in more depth in Chapter 6.

IS competence: IS competence comprises the ability to consistently carry out tasks to a designated standard that demonstrates knowledge, experience and skills in a way that will be adequate to meet the changing profile of organisations. It refers to explicit and tacit knowledge; the resilience people can show to derive business value from IT investments, as well as the ability to exhibit leadership characteristics in a specific business area. These concepts will be revisited in Chapter 2.

Lifelong learning: Lifelong learning refers to an ability to take control of one's own overall learning endeavours in an independent and self-motivated pursuit of knowledge (Candy, 1991). The lifelong learner demonstrates sustained commitment and enthusiasm towards continuing professional learning and development. This learning and development should reflect an ability to acquire new skills and the agility to redefine existing skills.

Empowerment: Empowerment encompasses and symbolises the final stages of competence (Sewchurran, 2008; Björklund, 2007; Cicmil, 2006) where the thinking, knowing and doing of the expert becomes intuitive and embodied practices. In the context of this study it provides a holistic term, not political in nature, to epitomise the state of an IS major that characterises deep understanding and knowledge about the artefacts produced by human agency, closely linked to technological systems and the impact they will have on social systems.

1.10 Organisation of the Thesis

This thesis is organised into seven chapters. Figures 1.2 and 1.3 will serve as a roadmap to guide the reader through the thesis and to provide a concise, but high level understanding of how the context of a specific chapter fits into the holistic view of the study. Chapter 2 provides a theoretical foundation for the study, while Chapter 3 focuses on the IS discipline as a background to industry expectations and curriculum design. This is followed by a detailed and comprehensive literature review of the integrated environment of a capstone course as it is implemented globally. All the related components of this environment are reviewed and analysed. An account of the three-phased evolution of the capstone course at UCT follows in Chapter 4, which prepares the scene for the discussion on the research methodology in Chapter 5. In Chapter 5 the research methodology is presented with

reference to the research paradigm, method, and data collection and analysis techniques. The themed action experiments during 2010 and 2011 to evaluate the artefacts together with the resulting reflections and learning are discussed in Chapter 6. In Chapter 7 I argue in support of the relevance and rigour of this research study, provide a synthesis and justification for the theory, and state the explicit contribution of the research endeavour.

Figure 1.2: The First Part of the Roadmap to the Thesis – Towards Coherent Practice

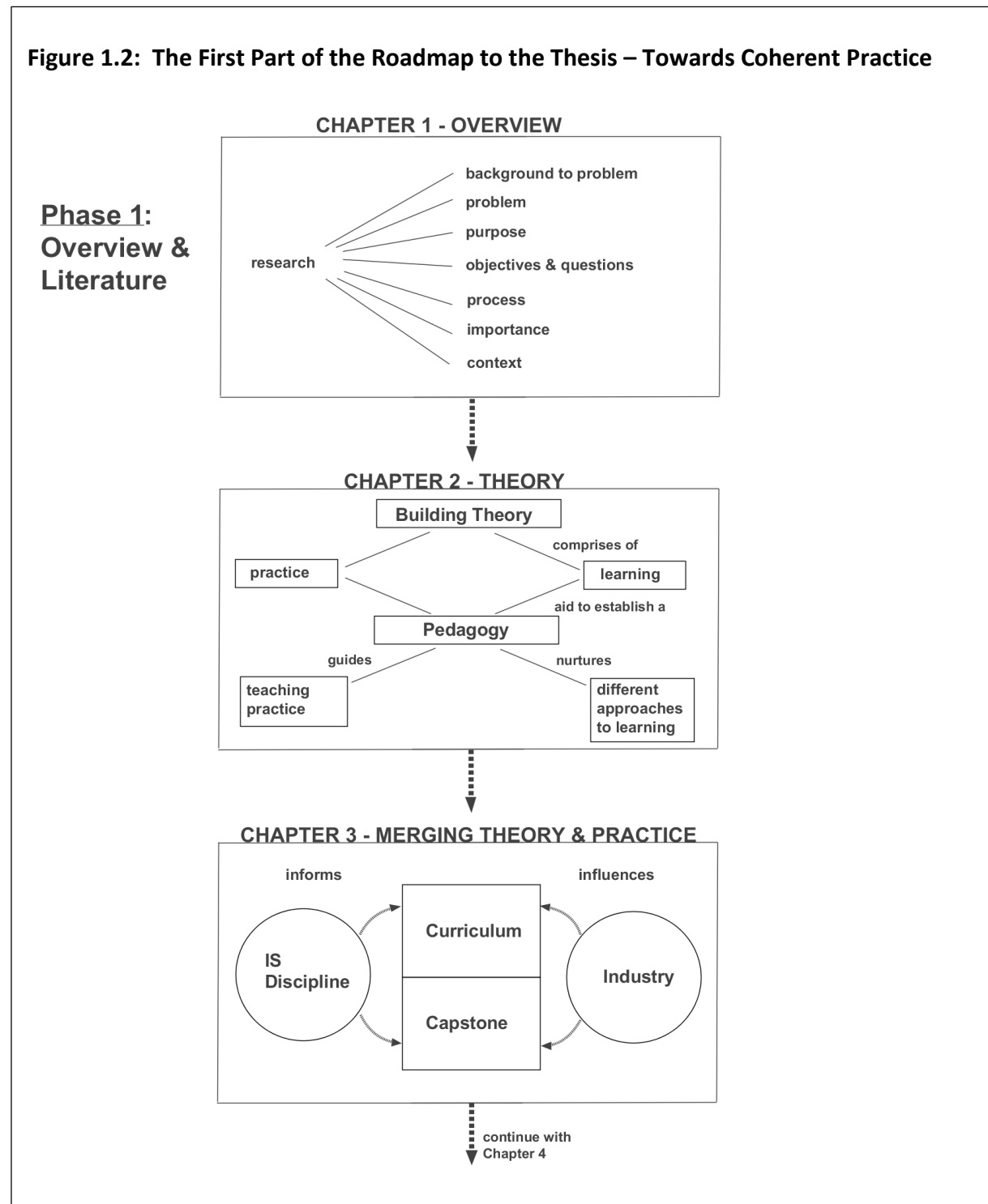
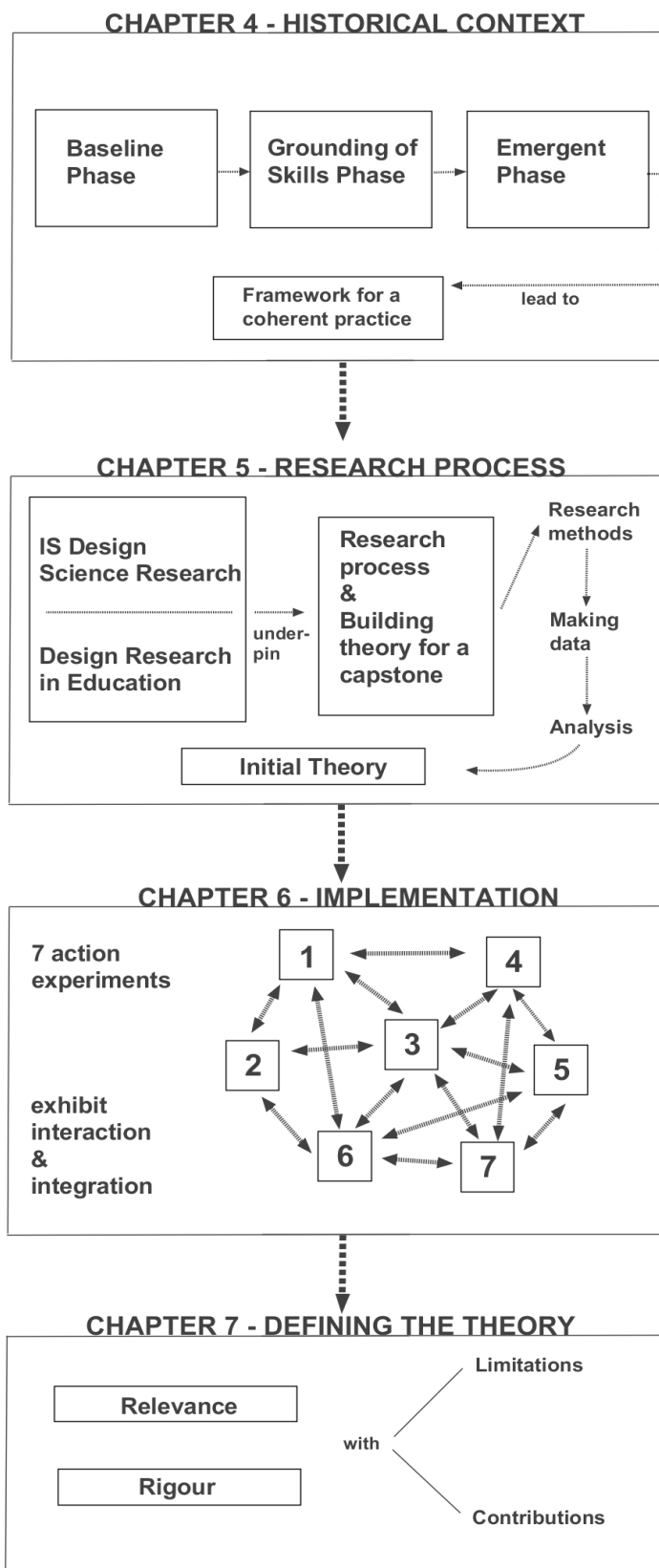


Figure 1.3: The Second Part of the Roadmap to the Thesis – Towards Coherent Practice

**Phase 2:
Context,
Design &
Implementation**



2 Building a Theoretical Foundation

...in the separation of science and philosophy we deny ourselves the possibility of fully reflecting on the fundamentals of what we do, either because as scientists we think that such reflection is irrelevant because all that matters are facts, or because as philosophers we think that what we need is ultimate truths, and not the pragmatics of material events.

(Maturana & Poerksen, 2004, p. 22)

Theories are theories regardless of their origin: there are practical, common-sense theories as well as academic or scientific theories.

(Argyris & Schön, 1974, p. 4)

2.1 Introduction

This chapter uses different perspectives on theory and the role of theory to build a theoretical foundation for understanding and explaining competence development, for prescribing how best to prepare students for professional practice, and for designing a capstone course that will become a plausible vehicle for achieving this.

The aim of this chapter is therefore to first establish the theoretical underpinnings for such an endeavour, and then to proceed to explore principles of teaching and deep approaches to learning that will facilitate the desired outcome.

2.2 Theory and the Role of Theory

Although many definitions of theory exist, the definitions provided by Argyris and Schön (1974) and Gregor (Gregor, 2009; Gregor & Jones, 2007; Gregor, 2006) underpin the core thinking behind this study. In addition, the practice of using theory to understand theory is inherent in the process of theory building, and will be applied extensively throughout this study.

Argyris and Schön (1974, p. 4) define a theory as “a set of interconnected propositions that have the same referent – the subject of the theory” where “their interconnectedness is reflected in the logic of relationships among propositions...”. They claim that this definition stands, irrespective of whether the origin of the theory is practical, academic or scientific. Similarly, Gregor (2009) defines theory “as a generalized body of knowledge, with a set of connected statements expressing general relationships among constructs that refer to entities of different types, both real world and theoretical”.

In Argyris and Schön’s (1974, p. 5) words, theories can be used as

vehicles for explanation, prediction and control. An explanatory theory explains events by setting forth propositions from which these events may be inferred, a predictive theory sets forth propositions from which inferences about the future event may be made, and a theory of control describes the conditions under which events of a certain kind may be made to occur. In each case the theory has an ‘if ...then ...’ form.

Gregor (2009) also recognises that different types of theory may be distinguished depending on whether the primary focus of the theory is to analyse, explain, predict or provide a prescription for design and action, although views on the type of theory itself may differ.

On a more practical note Llewelyn (2003, p. 667) argues that theories are “for working and doing as well as reflection”. A theory can thus either be used to support a specific argument and articulate how something should be done in practice, or it can be used as a theoretical lens to make sense of phenomena (Gregor, 2006). Theory forms an integral part of the intended outcome of this study and guides both the thinking and the actions taken. Despite the fact that “integrating thought with action [has] effectively plagued philosophers, frustrated social scientists, and eluded professional practitioners for years” (Argyris & Schön, 1974, p. 3), all human beings have to become competent in taking action while also reflecting upon this action in order to learn from it. Mezirow (1990) refers to this as thoughtful action with reflection, which often allows the individual to pause for a split second to re-assess the situation, while Argyris and Schön (1974) focus on theories of action

as manifestations of patterns of human action, where human action can be seen as human behaviour that can be corrected or negotiated.

Argyris and Schön (1974, p. 4) propose that theories of professional practice are special cases of theories of action, in the sense that they comprise a set of theories of action that determine “all deliberate behaviour”. Theories of practice provide an important entry point for this study by forming key constructs for packaging the ideas around a capstone course, especially when it comes to making sense of behaviour in a team context. As such, theories of action as a *parent* concept of theories of practice thus warrant an in-depth discussion. Figure 2.3 provides a conceptual representation of theories of action and theories of practice and how they relate to one another.

2.2.1 Theories of Action

“The root metaphor of the theory of action approach is practical knowledge as a kind of theory” (Putnam, 1999, p. 178). Since this study is concerned with practical knowledge applied within a practical course, the epistemology of the theory of action promises to be a good fit to provide backing and support for further discussions in subsequent chapters. This section will therefore give distinct focus to the concepts, principles and characteristics of Argyris and Schön’s (1974) theories of action. The text starts with an explanation of the different types of theories of action, and then highlights the similarities between skills and theories-in-use as a type of theory of action and the role these theories can play in providing strategies to govern human action. It must be noted that the construction of theory, especially a theory of human action, is never a static or finite process; it involves ongoing learning and modification. Finally, theories of action are embedded in the sciences of the artificial, since as far as a theory is constructed by human agency it can be seen as a theory of the artificial (Argyris & Schön, 1974).

Argyris and Schön (1974) propose two types of theories of action: espoused theory and theory-in-use. An espoused theory projects the image that one ‘wills’ for oneself. It is that theory which, people would claim, guide their actions in a particular situation. However, this espoused theory may be completely different to and not even compatible with the theory that actually governs that person’s behaviours and actions. Argyris and Schön (1974) refer to this theory as someone’s theory-in-use. Individual theories-in-use are learnt and we

are socialised into a particular pattern of behaviour which is influenced by culture and is interdependent with the behavioural world in which we live. People can honestly believe that they are behaving consistently with their espoused theory although their real behaviour will often indicate that this is not the case. A lack of congruence between an espoused theory and a theory-in-use creates a need to find ways of modifying either of these theories to better integrate doing and believing.

Argyris and Schön (1974) created two models to account for our theories-in-use and also to assist in the formulation and the reconstruction of our theories-in-use. Model I theories-in-use depict unilateral control and persuasiveness (claiming ownership) accompanied by unilateral protection of oneself and others. The consequences for the behavioural world are that actors operating within Model I are perceived as defensive, inconsistent and controlling, and allowing little freedom of choice. In this *world* issues are not discussed or resolved and commitment remains low. Winograd and Flores (1987, p. 106) contend that “an essential part of being human is the ability to enter into commitments and to be responsible for the courses of action that they anticipate”. Learning will be constrained within an environment that is characterised by behaviours like low commitment and the avoidance of issues that need to be uncovered and resolved. Model II behaviour typically includes the designing of environments that encourage joint control and a joint enterprise of striving for growth in different aspects. Most people espouse Model II behaviour and are shocked and often taken by surprise when they learn that they are acting and behaving within Model I (Putnam, 1999). Model II theories-in-use can reduce the negative consequences of the Model I theories-in-use by developing new behavioural competence. A transition from Model I to Model II behaviour is possible, although not easily attainable, and becomes a task of progressive elaboration whereby someone can continuously work at reconstructing his/her theories-in-use in an attempt to make them more accurate and to guard against inconsistencies and irregularities (see Figure 2.1). Model II behaviour can be encouraged in a capstone course by developing self-awareness within interpersonal relationships and group dynamics.

It is not an easy task to construct one’s theory-in-use as “we know more than we can tell and more than our behaviour consistently shows” (Argyris & Schön, 1974, p. 10). Polanyi (1967) refers to this concept as implicit or tacit knowledge. The act then of formulating

one's theory-in-use means making explicit what one already knows tacitly. In theory it is possible to test this explicit knowledge against one's tacit knowledge; but in practice it is not all that easy. An alternative approach is learning to put an espoused theory to use, in which case one must internalise the theory by making the 'explicit' espoused theory tacit and thus changing it to become a theory-in-use. These activities seem similar to improving a skill by practising that particular skill consistently.

Learning and practising a skill are often perceived as completely different processes. For example, learning a skill like diving not only depends on a person's ability to understand theory about what the practice of diving involves, but it also depends on the physical performance of the act of diving. Someone will not be regarded as an expert in diving, if he/she consistently fails to meet a particular standard during a diving session. Explicit and detailed programmes may already exist or can be developed to capture the theory relating to diving activities. Learning the skills however means putting the programmes into practice. In the capstone course this analogy can also be applied to the act of programming. No matter how many manuals you peruse, you have to physically practise coding (and practise a lot) to acquire the skill and to become competent. As such, learning a skill and learning a theory of action to become competent in professional practice involve similar processes. A professional practitioner cannot claim to have learnt a theory of action until it is effectively put into practice. "Making one's theory-in-use explicit is like making explicit the program manifested by a skill" (Argyris & Schön, 1974, p. 12). Preparing students for professional practice should therefore include opportunities where they can test their concrete behaviour and start constructing theories-in-use that will assist them to address real-world problems more effectively.

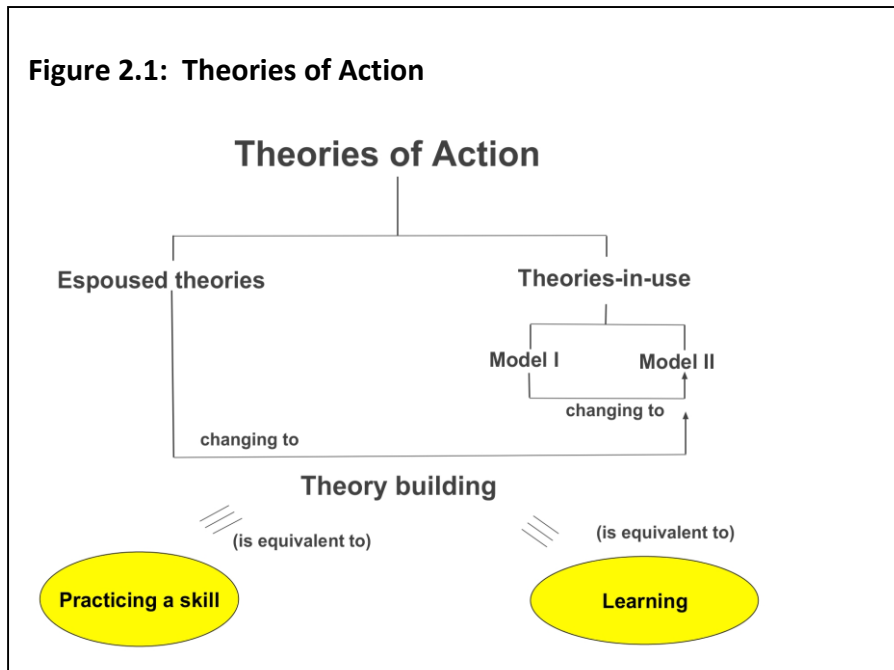
Theories-in-use can play different roles: These different roles provide ways in which a person can get what he/she wants. They can also assist to maintain "certain kinds of constancy" (Argyris & Schön, 1974, p. 15). A person's theories-in-use specify the governing variables that matter to him/her and provide the programmes by which these variables are managed, manipulated and kept within an acceptable range where possible. Formulating and choosing appropriate actions that will influence the governing variables and the world-picture of the theory-in-use, constitute a design problem; in this sense the design refers to the construction of a specific pattern of human behaviour and this construction of new

patterns of behaviour implies learning. Likewise, reflection in a capstone course can help students get a deeper understanding of their own and their team mates' behaviour, thus influencing them to change their ways.

Theories-in-use as theories of the artificial: Simon (1969) refers to theories of the behavioural world as theories of the artificial. These theories are concerned with design in order to build artefacts for a particular purpose. The way in which Design Science Research draws on theories of the artificial will be discussed in Chapter 5. For Gregor (2009, p. 5), theories embedded in the sciences of the artificial can either provide statements on how “artefacts can be designed, developed and brought into being”, or they can aim to analyse, describe and predict what happens when these artefacts are used. In this sense, one's behavioural world is an artefact of one's theories-in-use, where this behavioural world is created through the interactions of one's own behaviours with those of others. This means that every person's behaviour world is artificial, constructed through human activity. It not only comprises artefacts that we as humans construct, it is also shaped and influenced by our own actions and “by one's theories of the behaviour world as they influence action” (Argyris & Schön, 1974, p. 17). There is an ongoing process of *being-in-the-world* where our theories-in-use guide us to understand the behaviour world and determine our actions. This in turn influences our behaviour world and consequently also our theories-in-use by progressively constructing more effective theories-in-use. In a sense, it becomes an ongoing process of theory building: not only reconstructing theories-in-use, but also continuously constructing new theories-in-use and internalising espoused theories to make them tacit. This process of theory building is depicted in Figure 2.1.

This phenomenon has profound implications for this research as theories of action can provide a powerful mechanism for the reconstruction of knowledge. According to Bain (2004) this reconstruction of knowledge cannot happen without reflection. Thoughtful action in reflection (Mezirow, 1990) further shapes the thoughts and actions of both the researcher and students that helps practical decision-making and guides actions in different situations. Lewin (1945) confirms this notion by stating that “nothing is so practical as a good theory”. Gregor (2006) concurs since theories guide us to accumulate knowledge in a systematic manner that in turn informs professional practice. The society in which we live is dependent on specially trained professionals to conduct its principal business in areas like

schools, hospitals, courts of law, government, engineering and architecture. Through these actions that we collectively refer to as professional practice, the ‘professionals’ will typically seek to enable social progress by defining and solving societal problems and addressing areas of concern (Schön, 1983).



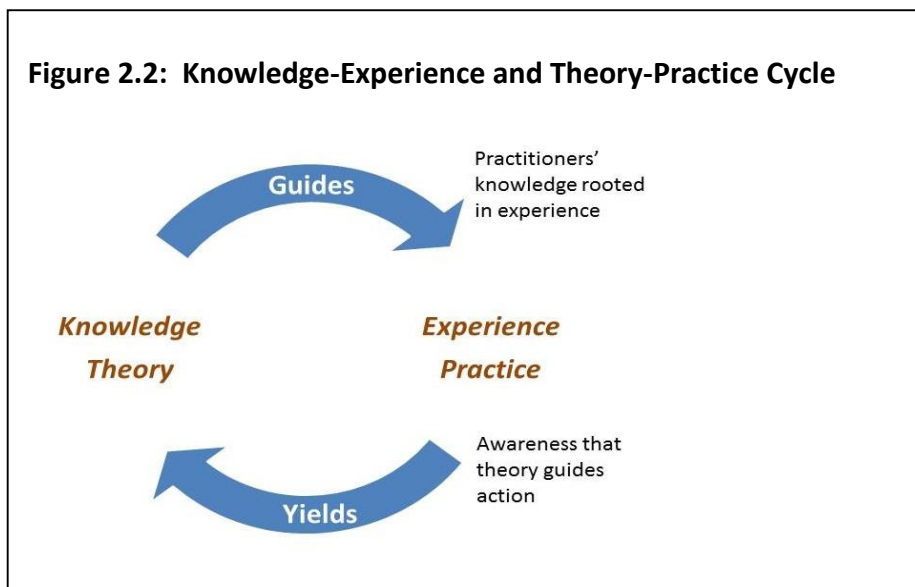
Source: Researcher’s own construct (Informed by Putnam, 1999; Argyris & Schön, 1974)

2.2.2 Theories of Practice

Argyris and Schön (1974) argue that theories of professional practice are just special cases of theories of action used to explain purposeful human action and behaviour. They state that a theory of practice therefore “consists of a set of interrelated theories of action that specify for the situations of the practice the actions that will, under the relevant assumptions yield the intended consequences” (Argyris & Schön, 1974, p. 6) as Figure 2.3 also shows.

“Effective action requires the generation of knowledge that crosses the traditional disciplines of knowledge – with as much competence and rigour as each discipline usually demands” (Argyris & Schön, 1974, p. 3). In a fast changing world professional practice is rife with value conflicts, complexities and uncertainties; and the inherent instability of situations in practice creates a “dilemma of rigour or relevance” (Schön, 1983, p. 42). Because

professional knowledge is not always adequate to meet the demands of professional practice, effective action is not always easy in real-world situations. Contrary to the perspective of technical rationality which holds that professional practice is about solving well-formed instrumental problems, problems need to be constructed from fuzzy, uncertain or ill-defined situations. In essence “practice is a knowledge affair” (Waks, 2001, p. 40). The practitioner is required to make sense of difficult situations, often while dealing with those situations and often without being able to say what it is that he/she knows. Although a practitioner will often think before acting, the skilful action of *thinking on your feet* and bringing to the fore that which was tacit suggests that “the know-how is *in* the action” (Schön, 1983, p. 50). Schön (1983) refers to this concept as *knowing-in-action* and argues that it is similar to the way in which know-how is exhibited when a tight-rope walker traverses his rope. Although one often intuitively *knows* when acting spontaneously, Schön (1983, p. 54) argues that as questions arise in one’s mind while one is busy doing something, one also usually “thinks about something while doing it”. He refers to this concept as *reflection-in-action* and deems it “critically important” to develop an epistemology of practice that will address the dilemma of rigour and relevance more effectively (Schön, 1983, p. 55).

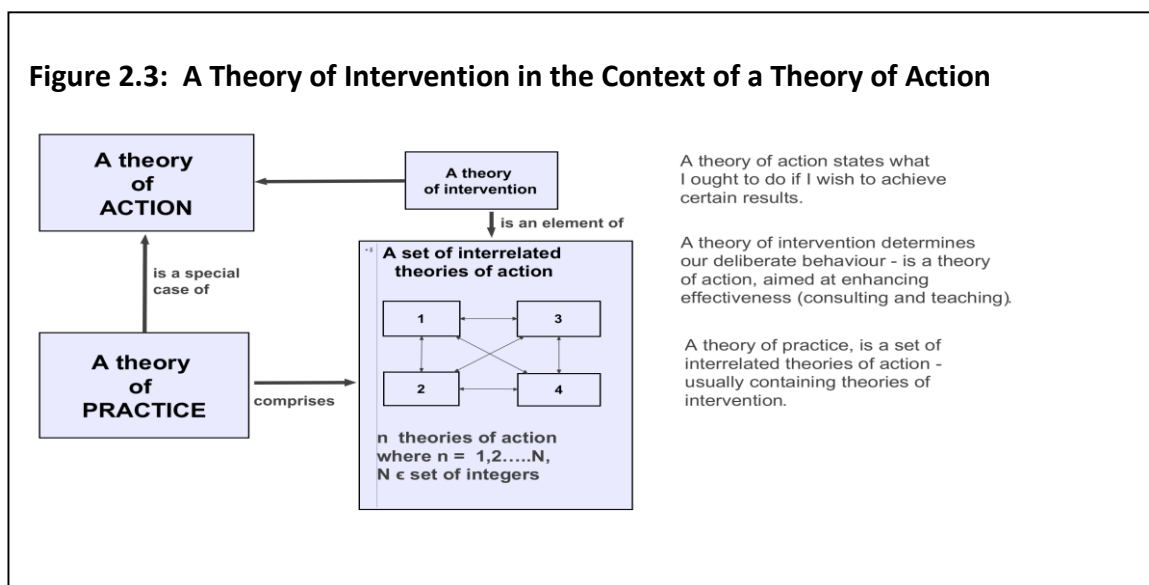


(Adapted from Winter & Szczepanek, 2009; Checkland & Holwell, 1998)

For Merleau-Ponty (1962, p. 49) “reflection is not absolutely transparent for itself, it is always given to itself in an experience ... it always springs up without itself knowing whence

it springs and offers itself to me [him] as a gift of nature”. If reflection ‘is given to itself in experience’ and reflection-in-action plays an important role in the life of a practitioner, how is it possible to create opportunities for reflection in the special case of a capstone course for students? In this study reflective practice was perceived as important by both the students and the lecturer as will be shown in a later section of this thesis.

Figure 2.2 illustrates that “practitioners’ knowledge is rooted in their experience of the world and their experience in the world is guided by their own personal knowledge” (Winter & Szczepanek, 2009, p. 2). Expert practitioners have a wealth of experience and tacit knowledge that manifests very appropriately when they are faced with the ‘messy’ and uncertain issues of the real world. For this reason preparing students for professional practice poses severe challenges to educators and teachers. However, as seen in section 2.3.2, theory building is part of the learning process and carefully planned interventions may help to reconstruct or build new theories of action, making tacit what was explicit. “Theory is not preordained, but constituted as a living construction to capture the useful ingredients of the performance” (Raelin, 2007, p. 500). Argyris and Schön (1974, p. 6) confirm this point by stating that “theories of practice usually contain theories of intervention — that is, theories of action aimed at enhancing effectiveness; — these may be differentiated according to the roles in which intervention is attempted – consulting and teaching”. This point of view is illustrated in Figure 2.3.



Source: Researcher’s own construct (Informed by Argyris & Schön, 1974, pp. 4, 6)

An alternative epistemology of practice may exist that could be used to underpin this study, other than the theory of action approach. Putnam (1999) argues that it is highly likely that other such approaches would resemble the theory of action in many aspects. However, being theories of practice they will have to draw from theoretical sources and practice traditions, have a strong prescriptive component, and reflect on practice. For the environment of a capstone course, the implications of the concepts depicted in Figures 2.1, 2.2 and 2.3 are profound. On the one hand this study is about the development of a theory practice that will describe the pedagogy of an IS capstone course. On the other hand, however it is also necessary to use theory to understand the learning process taking place within a student, itself a theory building process. The way in which students internalise knowledge is thus inextricably intertwined with the notion of the use of theory to explain the pedagogy of a capstone course.

A logical progression from practice then is competence development (expert practitioners have a wealth of experience as well as tacit knowledge). Since theories of practice are *special cases of theories of action that determine all deliberate behaviour* (Figure 2.3), one can argue that theories used to explain purposeful behaviour leading to competence development also fall in this category as theories of practice. Such theories can play a cardinal role in both the development of the interventions of the capstone course and in the understanding, explaining and the determining of student behaviour.

2.2.3 Competence Development in the Context of Theories of Practice

A number of theories that speak to the development of competence appear to have characteristics that resonate with theories of practice, as they provide a means to explain behaviour. In this section three theories which explain the development of competence in students as ‘would-be practitioners’ are described. These theories are used as theoretical lenses that act as sensitising devices to understand and give meaning to phenomena. A theoretical lens guides the researcher, student or teacher as to what issues and people are important to investigate; and “becomes an advocacy perspective that shapes the types of questions asked, informs how data are collected and analysed and provides a call for action or change” (Creswell, 2009, p. 62).

The first lens speaks to the changes of behaviour observed in students as they master new skills in the IS discipline as defined by Cockburn (2002). The second lens encapsulates the acquisition of skills in terms of Dreyfus' taxonomy of skills acquisition and Merleau-Ponty's concept of the *intentional arc*. The third lens of embodied cognition (Maturana & Varela, 1987) exhibits the fact that mind and body are inexplicably intertwined; a unity that has far-reaching consequences for obtaining competence, or as Merleau-Ponty calls it, for gaining *maximal grip* (Merleau-Ponty, 1962).

Before focussing in detail on the theories that play a role in understanding the development of competence, it is important to first define the concept of competence.

What is competence? The notion of an expert practitioner with a wealth of experience and tacit knowledge has already been alluded to as characteristic of competence. The Concise Oxford English Dictionary (11th Edition) defines competence as "the ability to do something successfully or efficiently [that is] the quality or extent of being competent: A person's subconscious knowledge of the rules governing the formation of speech in their first language. Often contrasted with performance" ("Competence," n.d.). From this definition it is evident that the concept of competence comprises different meanings – referring to competence as either action or knowledge. The mentioning of performance can also cause confusion as these terms are sometimes used interchangeably. Bassellier, Reich and Benbasat (2001) concur that the concept of competence is used in many different areas of research, often highlighting different meanings, depending on the context in which it is used - sometimes "as a synonym for performance, or other times as a skill or a personal trait". They distil the meaning of the concept into three main areas: "competence as a skill, competence as a personal trait and competence as knowledge" (Bassellier et al., 2001, p. 162). In the skills-based approach the idea of competence is often discipline-specific and refers to the development of skills used to perform a particular task effectively. When competence is a personal trait, it refers to "generic knowledge, motive, trait, social role or skill of a person linked to a superior performance on the job" (Haynes, 1979, p. 3). Bassellier et al. (2001) argue that the knowledge dimension of the concept of competence makes it dynamic and interactive. It is therefore more likely that desired goals will be achieved when human knowledge based on true beliefs informs the actions taken (Owen, 1997). Knowledge is generated and accumulated through action; knowledge is subsequently used

to create works, and works are evaluated to build knowledge. In the acts of both doing and judging, questions are asked, answers are obtained and decisions are made (Winter & Szczepanek, 2009).

For an individual to perform well on an organisational level, both explicit and tacit knowledge are necessary. Explicit IT knowledge refers to formal knowledge that can be taught, read or explained and includes areas like technology, applications and systems development (Bassellier et al., 2001). Tacit IT knowledge refers to the *know-how* gained through experience and practice that equips the IT manager with vision and acumen (Bassellier et al., 2001). As such, “knowledge building and knowledge use are the key design activities leading to discovery and invention” (Baskerville, Kaul, & Storey, 2011, p. 2).

The strategy of reducing a complex concept into its isolated parts, highlighting different aspects and characteristics, can be a useful approach for obtaining in-depth understanding. However, in real-life we often have to deal with *things* in a holistic way and it becomes necessary to resort to the concept of the *hermeneutic circle* that relates the whole to the part and the part to the whole. When referring to the preparation of students for professional practice, this study refers to the concept of competence in a holistic way.

Stages of behaviour: Preparing students for professional practice often involves moving them out of their comfort zones into new areas of expertise. In this sort of situation they typically need detailed and explicit instructions to perform a task. Cockburn’s (2002) theory of different stages of behaviour explains how people transcend from one stage to the next, whilst learning and mastering new skills in the software development arena. This theory depicts practitioners in three different stages of expertise and incorporates the concepts of *following, detaching and fluency*.

In this study Cockburn’s (2002) theory not only acts as a theoretical lens to understand or explain student behaviour, but it was also used to guide the design of software development interventions and to structure project management related interventions within the learning environment. People (students) in the *following* stage need extensive and detailed instructions to perform a task. Interventions that are structured to meet the demands of the following stage may include rote learning in order to acquire the

foundational knowledge of project management, or may implement step-by-step procedures to guide students in creating a framework to support their systems development processes. In the *detaching* stage people (students) can be encouraged to transcend by applying the foundational project management knowledge or the coding framework that was previously provided to different situations, or to find and use alternative methods and approaches in similar situations. This stage brings the realisation that no single methodology is suitable for every kind of problem, and a certain degree of experience is needed to either design a new method or to select a particular method or a combination of methods that will be more appropriate when designing a better solution within a specific context (Introna & Whitley, 1997). The *fluency* stage challenges people (students) to *think out of the box*, and to act independently by finding the best suited approach for the current, specific situation of concern, where a situation of concern can refer to different contexts and scenarios.

This process facilitates the continuous construction and reconstruction of knowledge in the knowledge-experience cycle (see Figure 2.2). According to Cockburn (2002) we *parse* our experiences, that is, we divide them into separate, meaningful chunks as we live through them for retrieval at a later stage. Many different parsing patterns can exist, depending on the context of the situation or other influences. Parsing patterns can leave unresolved gaps in the result which may then cause an incomplete and distorted result when the pieces are put together again. Furthermore, different people have different parsing patterns which in turn can influence one another and add to our as-lived experiences and shared experiences. The concept of shared experience plays an important role in the capstone environment, which is heavily dependent on teamwork. In addition, the continuous process of gaining understanding and acquiring competence, in the sense that competence is knowledge, facilitates transcendence (Cockburn, 2002). Transcendence in turn defines an evolving education that moves from unconscious incompetence to conscious incompetence through to conscious competence until unconscious competency is finally reached (unknown). Hubert Dreyfus and Stuart Dreyfus (1986) encapsulate the process of transcendence in their theory of skills acquisition.

Stages of skills acquisition: Hubert Dreyfus and Stuart Dreyfus (1986) define five stages of skill development: *novice, advanced beginner, competence, proficiency* and *expertise*. This

taxonomy provides a lens that can assist the researcher in making sense of how a learner learns and what the different kinds of learning are like (McPherson, 2005). Firstly, it reveals how the learning of *new skills*, a *higher level of skills* or *composite skills* can be broken down into simpler stages as shown in Table 2.1. The definition of these stages also helps to clarify the different kinds of situation where the corresponding skills are applicable, for example novices are given simple rules of how to react in a simple situation and what aspects to consider. Secondly, it *encourages increasing coordination and integration* and thirdly, it reflects the learner's *stage of being-in-the-world* - the way in which he can evaluate, recognise and think about situations. McPherson (2005) refers to this as a phenomenology of learning.

In the capstone course the various skills of an individual student need not all be at the same level. For example, some students, although proficient in their practical skills, could still be advanced beginners in terms of their interpersonal or team skills or vice versa.

Table 2.1: Stages of Skills Acquisition

(Adapted from Dreyfus & Dreyfus, 1986)

Stage	Description
Novice	Students learn to recognise concepts and features by following procedures through repetition and practice (context free).
Advanced beginner	Students begin to understand the relevant context of subject material and recognise recurrent and meaningful patterns as they gain experience. These students begin to cope with real situations.
Competence	In this stage the student is able to use analytical principles to deal with the vast amount of information that has been gained through practice. The student has holistic views of situations and can handle similar situations from different perspectives.
Proficiency	The proficient performer exhibits embodied experience. Rules and principles have been gradually replaced by situational discriminations and associated responses. The proficient performer may know how to act, but has not yet gained sufficient experience to react automatically.
Expertise	In this stage the student has reached the final stage in this step-wise process towards mental maturity. The extensive experience of the expert aided by reflection allows the expert to utilise his/her vast repertoire of experience intuitively to act appropriately in specific context dependent situations.

Dreyfus (1999) contends that “involvement and mattering are essential to the acquisition of skills” and demonstrates what skills are and how they can be acquired through the five stages of skills acquisition (Dreyfus, 2004; Dreyfus & Dreyfus, 1986). Heidegger’s (1962) explanation of understanding can be used to shed some light on the inference that skill acquisition is dependent on *mattering*. Heidegger argues that when we are drawn to phenomena in reflection, it allows for specific phenomena to become highlighted and emphasised while other phenomena are de-emphasised or dimmed down (Guignon, 1997; Haugeland, 1997). During such events phenomena become known and tied to practical activity like the acquisition of a competence. In his phenomenology of skilful coping Merleau-Ponty emphasises the principle of an involved agent. What the agent learns through experience is not stored as a representation in his/her mind, but the agent perceives it as an increasingly refined situation that causes him/her to respond in a particular way (Dreyfus, 2002). Where a response does not produce the expected or satisfactory result, the agent is led to further refine his perceptions. For example, when a novice plays tennis for the first time, his actions on the court will be governed by a conscious adherence to the rules of the game in order to meet the conditions of satisfaction. On the contrary, a seasoned player, absorbed in the game, will experience spontaneous responses and act unconsciously, depending on specific situations to gain control over the game. “The life of consciousness – cognitive life, the life of desire or perpetual life - is subtended by an intentional arc which projects round about us our past, our future, [and], our human setting...” (Merleau-Ponty, 1962, p. 157). As this intentional arc is steadily refined and enriched, the agent gradually moves towards a state of maximal grip in a particular situation (Dreyfus, 2002). It means that this unique unity of body and mind allows action to happen outside the realm of conscious representation.

The challenge is now, as Pellegrino, Chudowsky and Glaser (2001) put it: “to know what students know ... how much they know and how well they know it”. In response to this challenge it seems relevant to investigate how Dreyfus and Dreyfus’s (1986) 5 stages of skills acquisition (summarised in Table 2.1) can serve to illuminate how learning and teaching as manifested in projects can facilitate skilful coping to nurture a student’s transcendence through different stages of skills acquisition.

Embodied cognition: Mingers (1991) refers to the process of acquiring and using knowledge, as cognition. This process is not a once-off clinical and objective endeavour. Maturana and Varela (1987, p. 239) explain the phenomenon of cognition as a circular approach that illustrates “the beginning is also the end” and then contend that “the theory of knowledge ought to show how knowing generates the explanation of knowing”. It is thus reasonable to argue that the construction and reconstruction of knowledge as a meaning-making activity (Barrett & Walsham, 2004) is an ongoing and interactive process where intentional and unintentional interventions within different contexts are merged as fields of influence. These influences continue to shape and mould past and present perceptions, thoughts and actions of the researcher and students as agents to internalise competencies below the threshold of their consciousness (Crossley, 2001) and towards maximal grip (Merleau-Ponty, 1962). It seems necessary to explore in the first place how students can become involved in an action learning cycle of meaning-making activities towards constructing and internalising knowledge throughout the duration of the capstone course. Secondly, one can ask what interventions can be enacted not only to emphasise the application of knowledge, but also to engage students in their own learning about the application of this knowledge.

From what has been said before, it is evident that these activities do not only happen in the mind. Positivists make two claims that significantly contradict Maturana and Varela’s (1987) belief about cognition. Firstly, they claim that a human is by nature rational, reflective and disengaged (Sewchurran & Scott, 2009). Cognition is thus seen as a separate process that allows a human to use the correct knowledge and act according to it in a specific situation. Their second claim states that the role of cognition is to recover pre-given assumptions and properties of the world (Sewchurran & Scott, 2009).

Maturana and Varela (1987) propose an alternate view advocating that cognition is occurring all the time and is an inherent part of our existence. They say that since “*all doing is knowing and all knowing is doing*” (p. 27), action and experience are inseparable. As human beings, we are often oblivious of the fact that very simple cognitive actions require an infinite amount of knowledge (Varela, Thompson, & Rosch, 1993). What we often refer to as common sense cannot be obtained by the application of sophisticated rules, but is in fact context dependent know-how and the “very essence of creative cognition” (Varela et

al., 1993, p. 148). Knowledge depends on the *unity* of being in a world that is one with our bodies, language and social environment, and culture and it is created by a continuous process of interpretation based on how we understand this world. This process of *enaction* or bringing forth meaning is one with our existence and our understanding and results in *embodied cognition* (Varela et al., 1993). Maturana and Varela (1987) explain the phenomenon of *unity* as referring to any object or entity that can be identified by an act of distinction from its background. For Merleau-Ponty (1962, p. 157) the “unity of the senses, of intelligence, of sensibility and motility subtends our life of consciousness” like an intentional arc. As we acquire more skills these are *stored* not as representations in the mind, but they are paired with particular responses which create a tighter connection of being-in-the-world and dealing with situations that may occur.

Maturana and Varela’s (1987) theory on the explicit nature of living systems explains how we distinguish living systems from those systems or entities that are complex, but cannot be referred to as living (Mingers, 1989). They claim that living systems are *auto-poetic*, meaning that these systems are self-producing and self-organising. Following on from this they developed fundamental ideas about the nervous system, perception, language and cognition (Mingers, 1989) which are of particular interest to this study. In using these theories as lenses to assist in understanding the nature of cognition and knowledge and how perceptions occur through the operation of the nervous system, the researcher hopes to obtain valuable insights into how students acquire and use knowledge. This could then further aid in supporting the re-structuring of interventions. In the action learning cycles of a capstone activity Maturana and Varela’s (1987, p. 27) phrase of “all doing is knowing and all knowing is doing”, comes into being to optimise competence and nurture lifelong learning. Mingers (1991, p. 336) concludes that Maturana “... generates a radical view of cognition in which the world we experience is a subject-dependent creation constrained by our own basic *auto-poesis* and our structural couplings. Language ... cannot describe an independent and objective world. We construct the objects of our discourse in our discourse.” In the capstone course it may prove significant to focus on getting students to see how language is embodied and how communication can be utilised to aid transformation instead of just being used to convey information. Mezirow (1997) argues

that because transformative learning depends on one's own interpretations rather than on those of others, it develops autonomous thinking.

From this section it became evident that theory building is in essence also a learning process that involves the construction of understanding and knowledge united as one process in mind and body. In the next section concepts of learning and teaching will be synthesised to provide a pedagogical foundation for this study.

2.3 Establishing a Pedagogical Foundation

In any pedagogical endeavour the roles of the teacher, students and their unique, multi-faceted interactions with one another, should not be underestimated. The section below highlights basic principles of teaching that form a foundation for approaches that may vary in different disciplines and underpin the teaching practice in general. Some learning strategies for implementing these principles that are significant to this study, are explored next. The section ends with a discussion of assessment that forms an integral part in any educational endeavour. Different elements of a comprehensive assessment strategy are investigated as part of a pedagogical foundation.

2.3.1 Teaching

How does one define excellence in teaching? How should an educator approach his/her task to make a profound difference that will not only nurture students to learn deeply, but also encourage them to embark on the exciting journey of lifelong learning? What indeed can serve as evidence that transcendence has happened? Educators and students have been grappling with questions like these for years in a world where education always seems incomplete. Biggs and Tang (2011) argue that it is all about how we think about teaching, it is the theories we hold that deeply affect the learning environment we create. They maintain that "good teaching is that which supports the appropriate learning activities and discourages the inappropriate ones" (p. 16).

Key principles for effective teaching: In independent efforts, Ken Bain (2004) and Paul Ramsden (2003) propose six similar key principles they deem necessary, and in some cases necessary and sufficient, for effective teaching in higher education. The concepts contained

in these principles can be synthesised to guide constructive thinking about education with implications to synthesise thinking about teaching. In Bain's (2004) case the principles emerged from a study of about seventy renowned teachers in neighbouring universities.

In the first place, teachers are faced with the challenge of knowing their subject extremely well (Bain, 2004) which enables them to stimulate students' interest (Ramsden, 2003). However, the significant changes both in technology and industry practices, including the globalisation of IS development processes pose several challenges for teachers in this respect. Ramsden (2003) suggests that these changes necessitate new ways of teaching that will for example focus on solving problems, are sensitive to customers' needs, strive for quality and quantity, but which are also invigorated by the easy accessibility of extensive volumes of information over the internet. In this thesis we extend the concept of problem solving to include the concept of problem setting (Schön, 1983).

Secondly, Bain (2004) argues that teaching must be regarded as a serious intellectual endeavour and according to Ramsden (2003), teachers should set clear goals and provide students with an intellectual challenge – “expect more and you will get it” (Chickering & Gamson, 1987). This is easier said than done. Teaching can be improved by studying the students' learning and then by attempting to change their understanding. This, Ramsden believes can be done by focussing on “the way in which students apprehend and discern phenomena related to the subject, rather than what they know about them and how they manipulate them” (Ramsden, 2003, p. 6). Students' understanding must further be altered to foster the conceptualisation of these phenomena and ideas (Ramsden, 2003). In this study we agree to the importance of conceptualisation. However, an approach that will nurture those capabilities that will enable students to contextualise and implement what they have learnt, is of the utmost importance and must be investigated (Entwistle & Peterson, 2004).

The third, fourth and fifth principles highlight important aspects of the relationship between teacher, student and the teaching and learning activities. Ramsden (2003, p. 98) holds the opinion that “learning from students” is a necessary and a sufficient principle for good teaching. Teachers should be aware of the impact of different types of instruction on their students and should continuously adapt and modify their practices. In this respect, the

importance of a reflective and inquiring approach as a necessary condition for good teaching cannot be over-emphasised. A good teacher should constantly explore practices and thinking that will stimulate high achievement and produce excellent learning results (Bain, 2004). This means that good teachers will utilise the fact that “teaching and learning in higher education are inextricably and elaborately linked” (Ramsden, 2003, p. 8) to the advantage of both learner and teacher. Good teaching should further subscribe to providing students with independence, control and engagement (Ramsden, 2003). A student-centred approach leads to students being more engaged, creating the perception that they have some control over their learning, while it also stimulates interest and an imaginative spirit. The literature refers to the concept of a student-centred approach as that which will foster flexible, self-directed or experiential learning (O’Neill & McMahon, 2005). The concept of a student-centred learning approach is not new; Hayward has been credited with using it as far back as 1905, as have others like Dewey and Piaget. This approach emphasises a paradigm shift away from a traditional teacher-centred approach and has been acclaimed for preventing students from becoming passive, bored and apathetic (O’Neill & McMahon, 2005). Bain (2004, p. 18) argues for a “natural critical learning environment” that will also challenge students “to grapple with ideas and rethink their assumptions and examine their mental models of reality”. Both the aforementioned principles seem to allude to student reflection and the reconstruction of knowledge being mechanisms to enhance learning. This study is particularly interested in exploring how a reflective and inquiring approach can enhance effective learning for both student and teacher.

The principle of sincere concern and respect for students and student learning is not just desirable, it is mandatory and is widely supported by many researchers in education (Ramsden, 2003). Sincere concern from faculty enhances students’ commitment and encourages them to reflect on their own values and future plans (Chickering & Gamson, 1987). Entwistle and Tait (1990) regard consideration and respect as vitally important in effective university teaching. Bain (2004) holds the view that an expert teacher’s attitude should reflect a strong trust in the students. Other concepts that add value and also contribute to a comprehensive description of this principle are: benevolence and humility, an attitude of generosity towards knowledge, honesty and interest in teaching, versatility in teaching skills, as well as availability to students (Ramsden, 2003).

The last of the six principles is concerned with assessment. The significance of timely and quality feedback cannot be denied. Setting appropriate assessment tasks is “a difficult but crucial skill” (Ramsden, 2003, p. 96) and should flow from primary learning objectives (Bain, 2004). Aspects of assessment will be covered in more depth in section 2.3.3.

Strategies for good teaching: It seems evident that principles of teaching help to synthesise thinking about teaching and assist in developing effective strategies for good teaching. Aligned with his constructivist view, Biggs (1999b, p. 60) believes that education is about “conceptual change, not just the acquisition of information”. Entwistle (2000) and Entwistle and Petersen (2004) illustrate this point effectively with a hierarchical concept map which shows the link between conceptions of teaching (teacher-focused, content-driven versus student-focused, learning-oriented) and levels of understanding (limited grasp versus thorough acquisition). The map further exhibits how specific approaches to teaching influence students’ approaches that will in turn impact the learning outcomes.

Learning is a way of interacting with the world and a student-focused (student-centred) approach to learning can change the ways in which the student understands the world. However, since learning is “generally a gradual process of shaping understanding” (Entwistle & Peterson, 2004, p. 410), the crux of the matter is how this change should be brought about. Entwistle (2000) argues that it is very likely that a deep approach to studying will result in a high level of understanding and the conception of learning (outcome) will be transformative. Biggs (1999b) claims that this can only be effective when the objectives of a task are clearly stated and both the student and the teacher have a clear vision of these, when the students become motivated through the teaching, when the students start to engage spontaneously and actively in the task, and when students find themselves in a collaborative environment where they can communicate with peers and the teacher. Collaborative dialogue can progressively elaborate, shape and deepen students’ understanding.

Such a strategy can be implemented through a “*constructive alignment network*” where teaching and learning activities (TLA) are aligned with the objectives of the curriculum, which are then also carefully aligned with the assessment practices (Biggs, 1999b, p. 64).

The objectives of such a strategy dictate the *'what'* and the *'how'* of the teaching activity as well as how best to know to what extent the students achieved the learning objectives.

If the objectives of a curriculum can determine *how* a teaching activity is performed, it will most probably also indicate what roles a teacher should fulfil to achieve the best results. Often a teacher will have to take on the role of a teacher, coach, mentor or facilitator. In a learning orientation that is student-focused, active learning can be directed by facilitating understanding (facilitator) or by encouraging conceptual change (mentor) (Entwistle & Peterson, 2004; Entwistle, 2000). According to Raelin (2006, p. 83) the root definition of facilitation is "to make easy". The main goal of a facilitator is therefore to guide participants of a group/team to achieve its purpose through constructive and productive dialogue with as little conflict as possible. To be an effective coach and mentor, a teacher needs to imbue trust and earn respect from their students (Bain, 2004). Although the student-centred approach is of cardinal importance, a teacher-focused approach, where a teacher simply imparts information or transmits structured knowledge, may in some situations be of much value, depending on the objectives and the context.

In using effective and efficient teaching practices to transform information and knowledge, learning becomes a key construct. According to Biggs (1999a, p. 70) it is "learning that brings knowledge to life". Similarly, Argyris and Schön (1974) in their thinking about theories of action (practice) regarded learning as a key construct, significant not only for the conceptualisation of an idea or a design, but also for its contextualising and its implementation.

The question of what strategies we can implement to encourage effective learning while also influencing the ways in which students are prepared for professional practice, will be dealt with in the next section.

2.3.2 Approaches to Learning

The intention of this section is not to enter into a deep philosophical debate to validate and compare the effectiveness of different learning theories. The discussion is rather a critical investigation and a reflection on a selection of those theories that are used as strategies for learning within adult education and are frequently mentioned in the context of capstone

courses. “All human beings do philosophical reflections when they ask about fundamentals of their beliefs or of what they think they know” – even when they are not professional philosophers (Maturana & Poerksen, 2004, p. 15). Through this investigation I hope to gain a better understanding and a deeper insight into how the concepts embedded in a range of theories can contribute to achieving the intended learning outcomes of capstone courses. Further investigation into other theories that have not yet been exploited to their full potential can aid in the facilitation of a holistic learning process. As an introduction to this section, a discussion of surface and deep approaches demonstrates how students will typically go about learning and studying. A critical investigation of some theories of learning then follows: experiential learning, action learning, project-based learning, reflective learning, single- and double-loop learning, and other theories of adult learning. The section ends with a brief discussion on lifelong learning as one of the intended learning outcomes of the capstone course.

Deep and surface approaches to learning: Over the past 20 years the notion of *deep and surface approaches* to learning have received much prominence in research and theory as well as in practice in higher education (Webb, 1997). Biggs (1993) refers to deep and surface learning approaches as dynamic and particularly sensitive to the context in which learning is negotiated. A surface approach is about rote learning and exhibits the satisficing principle, where the task at hand requires minimal effort, sufficient just to meet perceived requirements (Biggs, 1993). A surface approach is usually accompanied by negative feelings and emotions about a task, and students may try to hide their anxiety and inability to understand specific concepts at a deeper level by being cynical (Biggs & Tang, 2011). Students practice the surface approach if they find the learning activity boring and try to get the task out of the way without any appreciation for the meaning and structure of what is taught (Biggs & Tang, 2011). The deep approach, however, is about how a student relates to a task, it is context sensitive, closely based on the intrinsic interest in the subject/task, and with the intention to maximise understanding of the underlying meanings by being properly engaged in the task (Biggs, 1993). This approach is accompanied by positive feelings where learning becomes a pleasure and the feeling of need-to-know is exhilarating and important (Biggs & Tang, 2011). This links closely to the approaches that Björklund and

Cicmil perceive expert practitioners to follow when going about their daily tasks as discussed in section 3.4.2 (Björklund, 2007; Cicmil, 2006; Cicmil et al., 2006).

The deep and surface approach is not concerned only with student factors, since both the teacher and the student are inextricably linked within the learning process (Biggs & Tang, 2011). Desirable student learning depends as much on the student's abilities and responsibilities as on those of the teacher. This is echoed by the principles of good teaching briefly discussed in the previous section (Bain, 2004; Ramsden, 2003; Chickering & Gamson, 1987). Deep and surface approaches to learning can be implemented in different ways. This can for example, refer to an orientation towards learning, or a predisposition to adopt certain processes, as is posited by Entwistle and Waterston's (1988) study where students report how they usually go about learning. In this approach a specific strategy is involved which is intentional and produces active learning processes that not only relate ideas and search for patterns and principles, but also try to provide evidence and examine the logic of an argument (Entwistle & Peterson, 2004; Entwistle, 2000).

According to Haggis (2003), paradoxes and problems emerge if one conceptualises learning in this way, and more difficult questions regarding task interactions and the complexities of location and context need to be investigated. Research has shown that misconceptions about surface and deep learning exist (Biggs & Tang, 2011) and students often memorise in ways that can lead to understanding that is typical of a deep approach (Haggis, 2003; Webb, 1997).

Webb (1997) contends that the hermeneutic principle better describes the constant search for understanding. This underpins an approach, as mentioned before, that can be applied to work back and forth from surface to deep understanding, illuminating the essence of true understanding more precisely.

Experiential learning: Despite the fact that teaching and learning form an integral part of our everyday activities, they "are elusive concepts, very difficult to pin down" (Fox, 1983, p. 151). In recent years there has been a move away from teaching methods and strategies and the focus has shifted to learning, learning experiences (Fox, 1983) and sense making (Sewchurran & Scott, 2009). This process has been referred to as *experiential learning*

(Bruce et al., 2004; Marsick & O'Neil, 1999; Kolb, 1984) with the emphasis on the act of exploring feelings, attitudes and issues in addition to the intellectual activity of understanding (Fox, 1983) and sense making. This approach is not new; Dewey (2001, p. 403) in his century old document of 1902 (reprinted in 2001) on the educational situation of the United States, alludes to the need of turning theory into practice and the drive to utilise the “opportunity of planning our work on the basis of a coherent philosophy of experience” – a philosophy that also acknowledges the role of society in this experience.

Kolb and Kolb (2005) argue that experiential learning is fundamentally a theory and not just a set of tools and techniques to provide learners with experience. It is based on six propositions and grounded in the work of 20th century scholars like Dewey, Kurt Lewin, Jean Piaget and others. These propositions briefly state that learning is in the first instance a dynamic process of engaging students to improve their learning efforts, it is continuously refined, it is concerned with the resolution of conflict between opposing concepts, it is also a holistic process of adapting to the world, it creates synergy between the person and his environment, and lastly it involves the construction and reconstruction of knowledge. From these propositions Kolb and Kolb (2005, p. 194; Kolb, 1984) define the experiential learning theory as “the process whereby knowledge is created through the transformation of experience”. The theory can be illustrated by an experiential learning model comprising a cycle of 4 steps, namely: concrete experience, observations and reflections, formations of abstract concepts, and generalisations and the testing of implications of concepts in new situations (Kolb, 1984).

Kolb's experiential learning theory has been widely criticised as being highly problematic and not generalisable and seems to present a misinterpretation of Dewey's anti-dualistic conception of experience (Miettinen, 2000). Some of these concerns will be addressed more fully in the later section on reflective learning.

Action learning: Action learning is difficult to define: “There is no single definition of action learning...and each action learning program is distinctive” (Zuber-Skerritt, 2002, p. 114); “defining action learning is not easy to do ... can take a variety of forms” (Dilworth, 1998, p. 29). Although the absence of a well-defined framework may hinder some, others find the flexibility of action learning very attractive. Action learning is often confused with

experiential learning although the two do share philosophical assumptions (Zuber-Skerritt, 2002). Further evidence of the ‘many faces’ of action learning is a study by Marsick and O’Neil (1999) that identifies three different theoretical schools of action learning namely, a scientific, experiential and critical reflection school.

Reginald Revans (1982), who is regarded as the father of action learning, bases his arguments on a learning equation of $L = P + Q$, where learning (L) is programmed knowledge (P) plus questioning (Q) insight. In the real world, Q is the field of action learning and P is the programmed knowledge already present in the community (books and expert practitioners). In a fast changing world it becomes obvious that imbalances will occur, making it unavoidable to adapt variables if equilibrium is to be regained.

At its core, however, action learning is about “action-oriented learning in organisations, learning to solve real, not simulated problems, and cooperative learning with work and business partners in the concrete work context/environment” (Zuber-Skerritt, 2002, p. 118). It relies on committed participants (and organisations as a whole) pooling their intellectual capital in a focused effort in an attempt to keep abreast of changes (Dilworth, 1998). The true power of action learning is “that it does not isolate any dimension from the context in which managers [participants] work” (Marquardt, 2000, p. 233).

According to Dilworth (1998) one can summarise the fundamentals of action learning as follows: The action always starts with the questioning of insight and the focus is always on a real problem, which may be strategic or tactical. In this environment learning is the primary goal; it is strategic and facilitated and reflection is equally important to the action. Decisions are always made in terms of what should happen, what will hinder the process and what can be done. Although performance is indirectly improved in programmes and interventions where learning is key, preference is given to fostering the value of individual and team learning rather than project outcomes (Raelin, 2007).

Project-based learning: Mendoza and Ellis (2003) argue that the incorporation of real-world projects in a curriculum as a teaching and learning strategy, allows students to develop the required mix of technical and managerial skills needed to face the challenges of the business environment.

Thomas (2000) describes project-based learning as a teaching and learning model that focuses on the central concepts and principles of a discipline, involves students in problem-solving and other meaningful tasks, allows students to work autonomously to construct their own learning, and culminates in realistic, student-generated products. According to van Rooij (2009, p. 210) “project-based learning is grounded in general theories of knowledge such as situated learning, which states that knowledge must be presented in an authentic context, using settings and applications that would normally involve that knowledge, and includes social interaction and collaboration to solve complex problems”.

Project-based learning is thus a model which distinguishes itself from traditional teaching by emphasising the learner and the project, rather than the teacher and the curriculum (Thomas, 2000). In the project-based approach the teacher is a facilitator and guide rather than an instructor and decision-maker. The focus is not on the content, as in traditional teaching, but rather on the way that information is processed and used. Students become actively engaged, mastering the art of inquiry, linking theory to its practical application, integrating new information to prior knowledge, and applying this in real-life situations (Van der Merwe, Scott, & Weimann, 2010). This further leads to the enhancement of their critical thinking ability as well as their ability to apply the information to new situations and to new contexts. Students discover that although they do not always have all the knowledge and skills needed to accomplish their tasks, they are able to acquire it along the way, which instils and reinforces the concept of lifelong learning (Scott, Weimann, & van der Merwe, 2011). This active engagement with the learning material also encourages what Entwistle (2000) describes as a deep approach to learning, with the result that students develop core competencies at an individual level, as advocated by Bassellier et al. (2001).

While the learning experience in the traditional teaching approach is often competitive in nature, Gerogiannis and Fitsilis (2006) conclude that the project-based approach emphasises collaboration and the development of effective communication skills. Students working together to reach a common goal must be willing and able to help each other and share ideas, despite the fact that the members of project teams may be geographically dispersed. The reliance of team members on each other, coupled with the adherence to deadlines, requires competency in both time-management and self-management. Furthermore, exposure to the project environment is a vital learning experience for IS

graduates, who will be entering a business environment that since the 1980s has evolved from being functionally organised to being process driven, to being task-based, and to what is currently referred to as a project-driven environment (Crawford et al., 2006).

In addition, since the final goals of project-based learning are to develop and often implement a product by following a process that reflects real-world practices, problems that are encountered during the process will enrich the learning process; as Cavanaugh (2004) rightly points out, the process of producing the product is as valuable as the end result itself.

Reflective learning: Jordi (2010, p. 1) argues that “reflective practices can facilitate a learning dialogue between our implicit embodied experience and conceptual aspects of our consciousness”. In the *constructivist approach* to experiential learning, reflection has been given a cognitive bias and is seen as a meaning-making activity and a process where we “step back” to understand and extract knowledge from our concrete experiences. This approach, based on the fact that “rational thought is epistemologically superior to embodied, interested, experiential knowledge” (Cooper, 2005, p. 42), has given reflection a *narrow up-bringing* and has not explored the “non-cognitive dimensions of human consciousness” (Jordi, 2010, p. 4).

Jordi (2010) suggests that learning could be a much richer process if we allow dissonance to emerge and then reflect in such a way as to get in touch with our feelings, emotions, anxieties, discomforts and intuitions. We experience feelings of dissonance when we find ourselves to be outside our comfort zones. This can happen for example, when it becomes necessary to embrace both positive and negative feelings and emotions, instead of blocking out and ignoring the negative ones; or when Schön’s concept of reflection-in-action is used to make rapid decisions and think on our feet when confronted with difficult situations; or if we experience a sense of incompleteness in an action, and reflection almost happens as an afterthought (Illeris, 2007). These dissonances or conflict situations cause *breakdowns* to happen. Winograd and Flores (1987) however, point out that breakdowns play an important role in our understanding and state that “it is not a negative situation to be avoided, but a situation of non-obviousness, in which the recognition that something is missing” leads to reveal “the nexus of relations necessary for us to accomplish our task” (p. 165).

Since our “thought processes are grounded in our emotions and bodily states” it seems evident that a much broader conceptualisation of reflection can result if our *reflective practices* can “integrate a range of cognitive and non-conceptual elements that make up our experience and consciousness” (Jordi, 2010, p. 2 & 10). Jordi (2010) thus proposes a framework that is intended to encapsulate those characteristics of experiential learning that can be used to reconceptualise reflection in an attempt to resolve situations of dissonance that give rise to detachment and separation - “*embodied experience seeks integration*”. In the neverending knowledge-experience cycle where experience yields knowledge and knowledge guides experience, also referred to as the neverending dance between practice and theory (Checkland & Scholes, 1999; Checkland & Holwell, 1998), experiential learning is a *meaning-making* activity. As much as our consciousness is intentional, we also have to leverage our capacity for innovation and creativity by using our imagination. We need to ‘grab the moment’ so to speak as these experiences may manifest as unique occurrences of the moment. Learning from our experience, however, never happens in isolation. It is a relational process that involves us and others, collectively or individually, in a dynamic process that happens through communication - dialogue and listening.

This study strongly support Jordi’s (2010) belief that the elements mentioned above in the ‘character sketch’ of reflective practice can provide us with crucial tools to create coherence in the complex environment of a capstone course and aid the development of mature and well-rounded practitioners.

Single and double-loop learning: Argyris (1991) argues that although problem-solving is important, learning in organisations involves more than just problem-solving and deep understanding, it often means that managers and employers need to reflect critically on their existing behavioural patterns and change them if necessary.

The continuous process of theory building, comprising the construction and reconstruction of theories-in-use, is a powerful learning process as it drives one to learn “to behave according to a theory-in-use” (Argyris & Schön, 1974, p. 18). Such a learning process can involve the adoption of new strategies to perform specific tasks, or it can result in more significant effects that involve changing or adapting one’s strategies to achieve a desired purpose. Argyris and Schön (1974) refer to this approach as single-loop or double-loop

learning respectively. Single-loop learning manifests in Model I theories-in-use, whereas double-loop learning occurs in Model II theories-in-use.

Single-loop learning strategies are mechanisms for control, claiming ownership of tasks, avoiding conflict and creating rules to direct behaviour; at the same time people learn to comply and thus suppress their feelings. In the normal course of events these strategies are effective. According to Putnam (1999, p. 179), it is just about a “change of tactics within the same overarching theory-in-use”. Highly skilled, committed and often very successful professionals ‘learn’ these strategies in an attempt to attain competitive advantage and succeed in the tough business environment. However, when their single-loop learning strategies fail, they act defensively, blame others for the situation and block out any criticism, since they have never learned how to deal with failure. Double-loop learning is concerned with “the surfacing and resolution of conflict rather than with its suppression” (Argyris & Schön, 1974, p. 19) – a value change. When people engage in double-loop learning it allows them to “reason about their own behaviour more effectively in ways to break down the defences that otherwise would have blocked their learning” (Argyris, 1991).

Lifelong learning: If university teaching can imbue in students the ability to handle “unseen problems in their chosen field of study” (Biggs & Tang, 2011, p. 174) and if this kind of learning can be sustained to facilitate growth and evolution, it constitutes what we commonly refer to as lifelong learning. Lifelong learning is of an emergent nature. It is driven by the context of a situation and a pressing need that requires purposeful action of creating conditions and relationships (amongst others) to address a problem situation. This process is further informed by previous experiences of similar situations and knowledge of related concepts and principles. Biggs and Tang (2011, p. 174) refer to this form of learning where students are tasked to solve novel, non-textbook like and professional problems as a kind of “action learning for life” that requires informed self-direction. For this kind of learning then, students “will need high level reflective skills and an abstract body of theory on which to deploy them” (p. 174). According to Jordi (2010, p. 15) it is possible to “develop a more expansive concept and practice of reflection” if students are socialised into embarking on an embodied orientation of experiential learning that includes important elements to foster “an integration of the range of implicit and cognitive elements of our conscious experiencing”.

Reflexive learning is the term used to refer to the ongoing circuitous and self-revisiting activities that form an integral part of lifelong learning, and that are undertaken with the aim of improving understanding and making that which is tacit explicit, in a complex environment of individuals, communities and cultures (Sewchurran & Scott, 2009).

If lifelong learning is then regarded as “the ultimate aim of university teaching” (Biggs & Tang, 2011, p. 174), how can theory be bootstrapped to elevate students’ reflective skills and increase their experience (enhance their competence) to better deal with ill-defined and novel problems?

Other theories of adult learning: Other adult learning theories that are significant for this study are collaborative learning and transformative learning.

The concept of collaborative learning is often mentioned in connection with computer-supported training (So & Brush, 2008; Alavi, 1994). Illeris (2007) however proposes that collaborative learning occurs when individuals enter into a community in order to learn and develop something together. This kind of learning includes both social and collective aspects, since the individuals who join can be of wide-ranging backgrounds. In the specific context of the capstone course at UCT, this is mostly the case.

Mezirow (1997) argues that transformative learning is the essence of adult learning as it guides the individual to think autonomously. An autonomous learner is able to self-reflect and negotiate his or her own values, meanings and purposes through his or her own interpretations, instead of acting on the judgements or feelings of others. However, “educational interventions are necessary to ensure that the learner acquires the understandings, skills and dispositions essential for transformative learning. Critical reflection ... and participation in discourse become significant elements” that further contribute to all facets of such a learning environment (Mezirow, 1997, p. 11). According to Illeris (2007, p. 47) transformative learning “implies a restructuring of the organisation of the self and thereby also a coherent restructuring and coupling of a great number of mental schemes that lead to change in the individual’s personality”. It is commonly accepted that this kind of learning is very demanding and most often driven by a learner’s own efforts (Illeris, 2007).

In summary: The learning theories that were briefly discussed in the above sections are by no means all-inclusive. There are many other approaches to learning, “all of which have something to contribute that can have different significance for different contexts” (Illeris, 2007, p. 35). The ones mentioned however, are of particular importance in the context of the capstone course at UCT, as well as the development of the theory to underpin such a course.

2.3.3 Assessment

Du Toit et al. (2001) describe assessment as “a comprehensive term which includes the full range of procedures used to gain information about student learning and the formation of value judgements concerning learning progress”. Measurement and evaluation are components of assessment, with measurement being described in Du Toit et al. (2001) as “a qualitative and/or quantitative process of assigning numbers to performance to indicate how much of a characteristic is portrayed by an individual”, whereas evaluation can be seen as a value judgement concerning quality – in essence an interpretation of the results through measurement.

Assessment has powerful effects on student motivation and learning (Pellegrino et al., 2001) and should be used as part of teaching to support and promote the learning process instead of merely acting as a measure for teaching (Shepard, 2000). In this respect, learning can be enhanced if assessment provides quality feedback that will assist to improve students’ understanding (Pellegrino et al., 2001) and serve to encourage a deep approach to learning (Entwistle, 2000). All of the aforementioned factors give important reasons for assessment. The most important purpose for assessment, however, is twofold: firstly, to provide formative feedback (as in formative assessment) and secondly to provide summative grading (as in summative assessment) (Biggs & Tang, 2011).

In formative assessment, feedback is a powerful learning activity. Timely feedback during learning can serve to improve both the teaching and the learning effort. Once issues and mistakes are identified they can be corrected or addressed appropriately; at the same time students are introduced to a method of critically reflecting on their own work in a formative way. Peer and self-assessment can be implemented to effectively train students to reflect on the quality of their work. In this sense, formative assessment compels students to take

responsibility for their own learning and performance and encourages more collaboration between lecturers and students. Students are sensitised to be honest about their own efforts and contributions, as well as to be fair to other students in the group. In summative assessment grading happens at the end of the course. In this kind of assessment the results are final and provide an indication of how effective a student's learning activity was.

Pellegrino et al. (2001) argue that there is no one-size-fits-all assessment strategy as different assessment types are suited to different purposes. They believe that the use of multiple assessments can provide valuable multiple perspectives on student achievements while supporting a core set of learning goals and identifying three properties essential for an assessment strategy: comprehensiveness, coherence and continuity. Comprehensiveness can be ensured if students are given more than one way to demonstrate competence and if a range of measurement approaches are used to compile a result as evidence. Coherence implies that assessment should be aligned with learning outcomes and teaching and learning goals. For continuity, students' progress should be measured over time and change must be observed, monitored and interpreted. Shepard (2000) also supports the idea of using multiple assessment approaches and suggests strategies like dynamic assessment, assessment of prior knowledge, the use of feedback, teaching for transfer, student self-assessment, and evaluation of teaching to capture important learning goals and processes. Dynamic ongoing assessment implies that the lecturer as facilitator or mentor can provide assistance and guidance as part of the assessment. He indicates that this can be extended to teams, and the practical application thereof in the team projects is valuable as it encourages ongoing improvement. Prior knowledge assessment is essential to establish levels of competency before advancing to the next level of instruction. Transfer means that new concepts and information are not only understood, but they can be applied and used in new situations. Assessment should establish that students can not only master and conceptualise, but are able to apply the underlying concepts to new situations and contexts. Explicit criteria imply that students have an unambiguous understanding of the standards and criteria against which their work will be assessed, ensuring fairness and enabling them to aim for and achieve the highest standards. A reflective approach can serve as self-assessment to enhance learning, improve teaching methods and is more conducive to engaging students within the teaching environment.

An important component of the multiple assessment strategy is the recognition of individual contributions to group performance. When assessing group performance, the focus cannot be on the product alone (Cooke, Drennan, & Drennan, 1997) and some mechanism such as peer evaluation should be implemented to give an indication of the contribution of different group members (Holland & Feigenbaum, 1998). Feigenbaum and Holland (1998) believe that the use of peer evaluations allows group members to voice their perceptions regarding their contributions and those of the other members in the group.

Two very different models, the measurements model and the standards model, underpin the assessment practice. The basis for the measurement model was established centuries ago and adapted by psychologists to create a graduated scale that allows the comparison of individuals against each other and against population norms. Many misconceptions are embedded in this model, such as the perception that knowledge is quantifiable and that assessment is a standalone activity, unrelated to teaching (Biggs & Tang, 2011, p. 204). The standards model is relevant for assessment at a higher education institution and is based on how well an individual meets the criteria that have been set for a particular learning activity as an indication of the effectiveness of his/her learning (Biggs & Tang, 2011). Scoring rubrics are assessment instruments that exhibit the characteristics of this qualitative model where the teacher verbalises the standards expected from the students, as well as how well they are expected to demonstrate them.

Mertler (2001) describes scoring rubrics as rating scales or scoring guides with pre-determined performance criteria. Scoring rubrics comprise a set of guidelines that include all the dimensions that are being tested, and the scale for the assessment as well as descriptions that will guide the user to categorise what is being assessed. The descriptions as to what is expected at each level of the scoring rubric, help students to understand why a specific score was awarded and guide them with regard to what they need to change to elevate their performance to a next level.

Moskal (2000) and Metler (2001) identify two types of scoring rubrics, namely analytic and holistic. An analytic rubric involves the scoring of a number of separate components, the sum of which gives the final score. This kind of formative assessment is effective and provides useful feedback to students on how they fared on various aspect of the task (Biggs

& Tang, 2011). In the case of a holistic rubric, the overall product or process is scored as an entity, with no direct focus on its individual components. Biggs and Tang (2011) argue that a valid and authentic assessment should be on the total performance, providing an indication of the value of the product. A holistic assessment does not ignore the details of the product or process to be assessed, but rather requires a hermeneutic approach where the understanding of the whole is in the light of the parts (Biggs & Tang, 2011). The development of a conceptual framework can aid the effectiveness of the holistic assessment process.

The choice of the most appropriate rubric for a particular situation depends on the intended use of the assessment results, the nature of what is being assessed, the performance criteria, as well as time requirements (Mertler, 2001).

2.4 Summary

In the beginning of this chapter, it was mentioned that the purpose of this chapter was to ground the study in theory and to obtain an in-depth understanding of theory and the role theory plays as a precursor for a theory building process. I argued that theory building is a recursive process of ongoing learning and modification, a process where theory guides action and where practice informs theory (see Figure 2.2). This means that since practice yields theory and the proposed theory for this study will depend on and guide the practice of a capstone course in a tertiary environment, the understanding of theories of action and therefore also theories of practice as a special case of theories of action (see Figure 2.3), further warranted a thorough discussion.

The delivery of a capstone course is also a pedagogical endeavour and the second part of this chapter therefore highlighted crucial teaching principles that underpin such an environment, followed by a discussion of several relevant teaching strategies and learning approaches conducive to the capstone environment.

Raelin (2007, p. 499) cautions that although we realise “that practice, with the aid of reflection, might shape or alter existing theory or create new theory ... practice’s contribution to theory has been downplayed”. Consequently, while this chapter dealt with the theory component, the next chapter will explore the practice component by

investigating the alignment of concepts of the IS discipline, industry and the IS curriculum in order to work towards the effective merging of theory and practice in an attempt to equip students with the means to partake “in structuring and even evaluating their own learning” (Raelin, 2007, p. 513).

3 Merging Theory and Practice

...in merging theory and practice we will end up with better theory, better practice, and better learning that will prepare us for both.

(Raelin, 2007, p. 495)

3.1 Introduction

Concerns that students are not sufficiently prepared for professional practice are often raised in the literature. Since this has been a persistent problem, a fresh approach to address this issue seems necessary. While the previous chapter investigated the crucial role theory can play in this endeavour, this chapter includes an overview of the IS discipline to get a sense of its scope and a clear understanding of the characteristics of the discipline and their significance for a professional grounded in the IS discipline. It is incumbent on the teacher as facilitator and coach to ensure that students in the first place develop a deep understanding and an appreciation for the fragmented and ad-hocratic nature of the IS discipline as it manifests in the real world. Secondly, it is necessary to evaluate the demands and expectations of industry and establish how these factors have influenced previous revisions of IS curricula. Thirdly, the notion of a capstone course as a plausible vehicle for a coherent pedagogy has to be analysed and the phenomena that become apparent in this environment must be investigated. A thorough understanding of how to effectively merge the two pillars of theory and practice into a capstone course needs to be pursued.

This chapter will therefore set out to investigate the three areas mentioned above and will then conclude with a synthesis of the key concepts, aligning and highlighting the important issues that emerged, along with a summary of the key questions that need to be considered when designing a capstone course with a difference.

3.2 Core Characteristics of the Information Systems Discipline

This overview of the IS discipline serves to highlight core characteristics of the IS discipline (see Figure 3.1) that have emerged over the years and which define or confirm the particular identity of the IS professional. Over the past two decades many debates have taken place within the IS community about the undeniable diversity of the field (Frank, 1999) and to determine the extent to which this diversity should be embraced (Benbasat & Weber, 1996).

The IS discipline has been characterised as fragmented adhocracy (Banville & Landry, 1989), a strength when a field needs flexibility to adapt to a changing environment (Baskerville & Myers, 2002).

Diversity can imply that a diversity of problems exist that need to be addressed within the discipline by IS researchers who themselves are from different backgrounds. It can also indicate that the theoretical foundations and reference disciplines we draw from are diverse; and finally, it can refer to the variety of different methods available for collecting, analysing and interpreting data (Benbasat & Weber, 1996). Roode (1993, p. 62) refers to IS as “an interdisciplinary field of scholarly inquiry, where information, information systems and the integration thereof with the organisations is studied in order to benefit the total system (technology, people, organisations and society)”. Hirschheim and Klein (2012; Lee, 2001) argue that by adopting the rich and shared history of the IS field the IS community can bridge the communication gaps that exist within the community themselves.

The quest to define an identity for the IS field characterised the 1980s as a period rife with a number of controversies. One of the initial issues that emerged was the notion of a paradigm. Several arguments have been produced to suggest that the simplistic view of a single paradigm is too restrictive and does not necessarily guarantee progress (Banville & Landry, 1989). Benbasat and Weber (1996, p. 397) argue that we need more than one paradigm not only to provide coherence to the discipline, but also to assist us in characterising phenomena, a factor that will distinguish us from other disciplines and “articulate the core of the discipline”. The recognition of diverse paradigms is a strength unique to the IS discipline and provides excellent opportunities to participate in an

intellectual discourse with other disciplines. However, diversity also allows researchers to choose unrelated topics and use different research methods, despite serious concerns that this might hamper the progress towards maturity of the IS (MIS) field (Banville & Landry, 1989).

Another reason for concern stems from the fact that IS is seen as a field with many reference disciplines given that IS researchers come from varying backgrounds. Benbasat and Weber (1996) believe that the IS field will become more pluralistic by accommodating diverse identities of different reference disciplines, and the benefits of embracing diversity are evident in the increasingly relevant research that is produced. The IS field can boast good examples of substantive research and "...has a distinct subject matter, a distinctive research perspective, and a well-developed communication system that includes respected journals" (Baskerville & Myers, 2002, p. 3). Baskerville and Myers (2002) argue that the conventional view of IS as consuming theories and discoveries from other disciplines with very little research of its own, is outdated. The "IS field has made remarkable progress as a discipline in a relative short period" (Baskerville & Myers, 2002, p. 11). All this provides good reason to believe that a reverse situation has occurred, where IS is now of great value to other disciplines and is subsequently also being referenced by them (Baskerville & Myers, 2002).

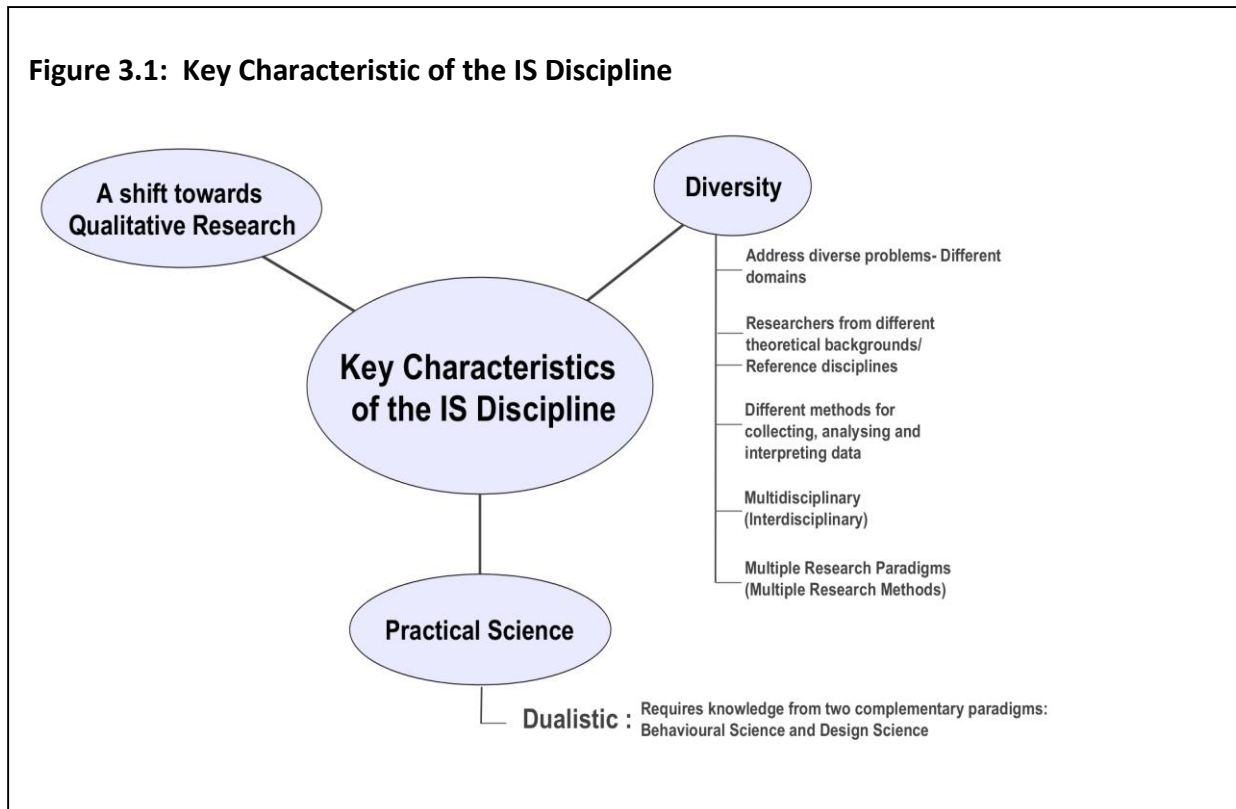
A shift has also been made to intensive qualitative and interpretive studies of IS phenomena (Benbasat & Weber, 1996). Lee (2001) emphasises that IS research not only examines technological and social systems, but also investigates the phenomena that emerge as a result of the interactions between these two systems. He claims that this unique research perspective sets our field apart and the so-called "reference disciplines" should rather be referred to as "contributing disciplines" (Lee, 2001). This provides further evidence of IS as a maturing field and makes IS research more readily accessible to a broad audience of researchers in other disciplines, enforcing the ability to extend and build on prior research (Baskerville & Myers, 2002). As a result the excellent scholarly communications systems nurture collaboration and the creation of knowledge networks throughout the world. The benefits that can be derived from anchoring IS research initiatives in reference discipline theories should be acknowledged. These disciplines can help benchmark quality, contribute

to the development of improved or new theory and even bolster the credibility of IS theorising.

In IS we require specific (useful) knowledge when we want to do things in the world; this can either refer to purposeful action or the construction of artefacts for a particular purpose. Using Simon's (1969) terminology of the sciences of the artificial, we can argue that IS is a science of the artificial, also referred to as a practical science (Niederman, Gregor, Grover, Lyytinen, & Saunders, 2009) as it is concerned with the studying and constructing of artefacts. Examples of artefacts are plans, predictions, prescriptions, and explanations of usefulness and concepts - all objects that arise from human enterprise and require a different kind of reasoning than that which would be used in natural sciences or human sciences (Niederman et al., 2009). Natural sciences are concerned with the occurring of natural phenomena, whereas human sciences focus on human beings as the object of study. As mentioned above, the IS discipline requires students to study not just technological systems and social systems (Lee, 2001), but also the phenomena that emerge when the two interact (Kroeze et al., 2011).

Research should inform practice and vice versa: It is therefore incumbent upon researchers in the IS discipline to generate, support and communicate knowledge that will assist the development and implementation of productive information systems, with the purpose of enhancing efficient and effective management and use of information technology in human organisations (Hevner et al., 2004). Hevner et al. (2004) reason that the quest for useful knowledge to do things requires a dualistic approach. In this approach technology and behaviour are inseparable - two sides of the same coin - and IS is a discipline at the intersection of "knowledge about machines" and "knowledge of human behaviour" (Gregor, 2006, p. 613). It is this "use of artefacts in human machine systems" that gives IS its unique and distinct character and the artefacts are central to theorising (Gregor, 2009; 2006, p. 613). The two complementary but distinct paradigms of behavioural science and design science (alternatively also referred to as sciences of the artificial, design principles or practical sciences) provide an opportunity for researchers to address fundamental issues in the effective application of information technology. This resonates well with Winograd and Flores' (1987, p. xi) viewpoint that "we encounter deep questions of design when we recognise that in designing tools we are designing ways of being", and that "in order to

understand the phenomena surrounding new technology we must open the question of design – the interaction between understanding and creation” (Winograd & Flores, 1987, p. 4). The question of which science is predominant is partially answered in the claim that IS is a social science with technical implications (Kroeze et al., 2011).



Source: Researcher’s own construct (Informed by, amongst others, Walsham, 2012; Hevner et al., 2004; Benbasat & Zmud, 2003; Baskerville & Myers, 2002; Banville & Landry, 1989)

Authors like Hevner et al. (2004) and Peppard and Ward (2004) recognise the disjunction between academic research and its adoption in industry, as well as the need it creates to encourage collaborative industrial and academic research projects. Several authors are in agreement on this point. Angehern in (Land et al., 2009, p. 504) emphasises that the key to good design and the ability to address a “real-world demand” with the design of relevant artefacts often depends on cooperation with partners who come from practice. Gill in (Myers, Baskerville, Gill, & Ramiller, 2011) recommends that practice-informing activities should be encouraged if research is to inform practice, and vice versa.

3.3 Industry Expectations and Curriculum Design

The previous section concluded by emphasising the importance of research informing practice and vice versa. In this section we consider relevant factors in industry that might influence curriculum design.

3.3.1 Industry Needs and Expectations

Cappel (2001) refers to the IS profession as “one of the most dynamic fields that has ever existed”. Rapid advances in information and communication technologies have caused organisations to become increasingly dependent on ICTs (Chao & Shih, 2005) within an ever-changing IS/IT environment (Banville & Landry, 1989). As an organisation or business becomes more *intertwined* with ICTs a greater need for *IS competence* is created to sustain business success and development (Peppard & Ward, 2004). This dependence generates various career opportunities (Chao & Shih, 2005) and causes employers to seek an increasing number and variety of skills from new employees (Richards et al., 2011; Gallivan et al., 2004; Smits et al., 1997). The popular media view this as reason for serious concern as there is “no end to the skills crunch” and the ICT world is rife with “a scramble for best talent ... a missing middle and a talent grab” (Harris, 2011). A further limiting consequence of these diverse organisational needs is that guidelines and requirements for hiring IT/IS professionals are often vague (Lotriet et al., 2010; Chao & Shih, 2005). Smits, et al. (1997) concur that few tasks are more challenging to the IS executive than the dilemma of recruiting, training, motivating and retaining professional staff. In addition, employee turnover usually results in a loss of productivity and can be both disruptive and expensive (Niederman & Sumner, 2001). This calls for an active mobilisation and utilisation of existing skills (Benamati & Lederer, 2001) as well as an increased focus on the transferability of skills when IT/IS professionals move between countries, jobs or different positions in the same company (Lee, 2005).

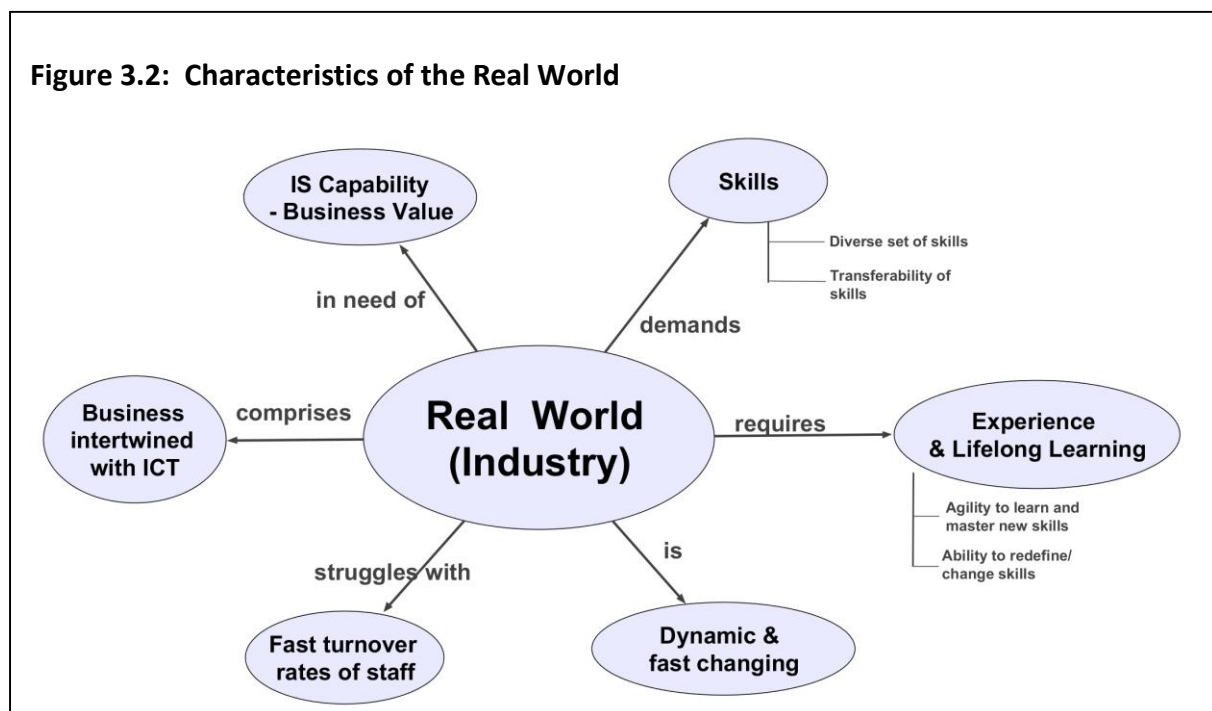
Although a large variety of job opportunities are on offer, the expectation that applicants should have at least two to five years’ experience presents a stumbling block to new graduates (Chao & Shih, 2005). An employer survey suggests that industry-based work experience and real-life projects are the best training for graduates (Hagan, 2004). The incorporation of experiential learning activities in a curriculum also helps to prepare

students by equipping them with the insight needed to face problems in the real world (Beard et al., 2007). Despite such efforts to equip students to cope in the real world, Hagen (2004) perceives a conflict between what industry requires graduates to know and the more theoretical approach universities often follow to teach students. This alludes to the fact that organisational inability to make effective use of IS/IT and its associated resources is as much a result of inadequate competencies in IS/IT (human) resources, as it is a lack of proper business leadership and organising. The complexities of an evolving discipline and changing organisations aggravate this situation.

“The importance of information technology (Aladwani, 2002) is well established in organizations today” (Gallivan et al., 2004) and there is increasing emphasis on the demanding process of achieving real alignment between business and IT (White, 2004). According to White (2004) this alignment can be established through an essential three-model role of IS/IT which focuses on maintaining business momentum (MBM), improving business results (IBR), and providing appropriate technology leadership (TL). These roles are respectively concerned with outcomes as a result of services and systems improvement (MBM); establishing new products and markets to create competitive capacity (IBR); and managing existing technologies to ensure stability, efficiency and cost effectiveness of IT outputs (TL). Talented human resources are needed not only to develop information systems, but also to leverage the communication and coordination capabilities of IT/IS in order to enhance business processes, address organisational change and provide these organisations with ongoing sustainable competitive advantage (Gallivan et al., 2004). Peppard and Ward (2004) confirm that the sustained development of IS competencies among organisational members allows organisations to better exploit the advantages of technologies and develop IS capability to manage IS/IT towards the delivery of business value. Section 2.2.3 of Chapter 2 highlighted the multi-dimensional character of the concept of competence, depending on the context in which it will be used. Although it was argued that in a complex real-world environment a holistic understanding of the concept of competence is necessary, the development of skills forms an integral part of competency development and needs careful consideration.

Which skills are most important? Several authors agree that increased diversity in the IS job market, the corresponding pressure to accommodate changing technical, managerial

and business skills, and the enhanced prominence of interpersonal skills, pose a serious challenge to both those who educate and those who recruit IT professionals (Beard et al., 2007; Braun, Tesch, & Skeldon, 2005; Chao & Shih, 2005). Despite this challenge and the dilemma of there being no *one-size-fits-all* curriculum, a survey of IS/IT alumni indicated that students are well aware that industry needs IS professionals with more than just technical skills (Chao & Shih, 2005). Communication skills, honesty and integrity, and teamwork skills were placed top of the list of characteristics in a survey conducted in 2006 (Beard et al., 2007). In their survey of job skills for IT professionals over the past 17 years, Gallivan, et al. (2004, p. 83) found that although companies claim to hire “well-rounded employees with good business knowledge and soft skills”, they continue to focus on the simpler option of evaluating mostly “hard skills”. Students should therefore be “flexible - to fit where they are needed” and be willing and able to face new and unfamiliar challenges (Beard et al., 2007, p. 180).



Source: Researcher’s own construct (Informed by, amongst others, Lotriet et al., 2010; McMurtrey et al., 2008; Beard et al., 2007; Chao & Shih, 2005; Lee, 2005; Gallivan et al., 2004; Peppard & Ward, 2004; White, 2004; Cappel, 2001)

It seems that not much consensus has yet been established regarding the core skills needed for IS/IT professionals. Lee, Yen, Havelka and Koh (2001) maintain that it is in any event

difficult to gauge skills importance, as skill requirements change during the lifetime of a professional's career. In addition, ambiguous results being achieved in current studies can possibly be attributed to the many methodologically diverse studies (Baskerville & Myers, 2002), different data collection techniques used, or the different classification schemes used by different studies (McMurtrey et al., 2008). A study done by McMurtrey et al. (2008, p. 102) not only provides a "comprehensive, updated and statistically valid set of skills", but further confirms previous investigations and supports the dualistic nature of the IS discipline (Hevner et al., 2004). Overall, soft skills, like problem-solving, critical thinking and communication skills remain the most important aspects for integrating entry-level employees into the job market and allowing them to grow in their organisations.

However, the importance of technical skills cannot be ignored. McMurtrey et al. (2008) and Wynekoop and Walz (2000) argue that top performing software developers should exhibit the ability to abstract business problems, creativity, technical and business knowledge, general team skills, analytical and logical reasoning, self-motivation and organisation. Findings of an empirical study done by the author and some postgraduate students emphasised the necessity to uncover and investigate the critical core of IS skills that will equip an "individual with the ability to continuously redefine possessed skill sets, and with the agility in learning and mastering newly required skills" (S11, Table 4.8, 2008).

In summary, the literature seems to reflect that IT/IS job requirements are not always clearly specified, as demand patterns are always changing and limited procedures are available to assess the capabilities of prospective employees. In addition to these factors there is not always consensus as to which skills are considered to be most important, other than the expectation of industry that employees should be able to cope with current situations, and have abilities that will allow them to adapt effortlessly in a dynamic environment. Ever-changing and unstable environments require transferable lifelong learning skills (Lee, 2005), and the important responsibility this places on both the IS practitioner and the academic as educator cannot be denied (Gallivan et al., 2004).

3.3.2 Curriculum Design to Meet Industry Expectations

The rapid changes in the IS/IT environment and in the job market have serious implications for educators in this field (Kumar, 2006; Brandon et al., 2002; Gupta & Wachter, 1998).

Despite the fact that some basic principles, such as object-oriented programming (OOP) principles or data normalisation remain stable, changes to technology platforms, architectures and environments are significant and influence the way educators teach and learners learn. Educators are thus constantly challenged in the effort to adhere to a model curriculum while at the same time adapting their courses and programmes to meet current employer needs (Janicki, Kline, Gowan, & Konopaske, 2004). Keeping IS curricula current is important but has proved to be very difficult, as evidenced by the fact that there have been only two major changes to the model IS curriculum over the past decade. Educators should guard against simply trying to train students and rather focus on equipping students with appropriate skills beyond the traditional (Kumar, 2006) and with the ability to learn new technologies as they evolve (Janicki et al., 2008). Comments like these in the literature may raise questions like: What is meant by skills beyond the traditional? How can we identify these skills? How can we assess their value, especially soft skills that are more difficult to define or validate in exact ways? What procedures and processes are necessary to develop required skills and how should this be done? How do we encourage students to learn new skills fast and effectively?

Problem areas and guidelines for redesign: An evolving study by Janicki et al. (2008; 2004) mentions a number of problem areas to consider when IS programmes are developed. It is necessary not only to determine the most appropriate body of knowledge to be included, but also to balance business and technology skills. The most recent advances in technology must be incorporated in order to balance training and certification desires, and employer expectations for both entry level and advanced IS/IT professionals need to be met, despite the fact that IS academics' understanding of required knowledge often does not coincide with that of practitioners (Janicki et al., 2004). A study by Turner (2004) highlights the lack of connection between technical and non-technical business subjects that are part of the IS curriculum, and proposes a model depicting the level of interaction between elements of both areas in an attempt to provide curriculum designers with insight into the importance of elements that are often difficult to quantify. This is of particular significance to the current study, as alluded to in section 3.2 which emphasised that the IS discipline is not only concerned with the study of technological and social systems, but most importantly also

with the study of the phenomena that emerge when the two systems interact (Kroeze et al., 2011; Lee, 2001).

Despite the fact that curriculum design issues should be addressed effectively, employers often feel that their requests for more emphasis on transferable skills (like communication, social, analytical and critical thinking) are not heard by academia (Gruba, Moffat, Søndergaard, & Zobel, 2004). Gruba et al. (2004) argue that conditions like mutual trust amongst stakeholders, committed leadership and purposeful incentives can encourage and sustain changes to curricula. However, over the past 30 years the IS discipline has experienced three major revisions of the IS model curriculum, with IS2002 and the recent IS2010 being revised in the last decade.

3.3.3 Model Curricula

The development of a comprehensive curriculum usually involves a combined effort of numerous individuals and reflects the interest of thousands of faculty. It is grounded in the expected requirements of industry, represents views of organizations employing graduates, and is supported by other interested organizations (Topi et al., 2010).

IS 2010 is the third major revision (and only the second in the past decade) in the series of model curricula that recommend a formal body of knowledge for undergraduate degrees in IS (Topi et al., 2010) (see Figure 3.3). These curricula have resulted from a collaborative effort between the Association for Computing Machinery (ACM) and the Association for IS (Topi et al., 2010), following the initiative of several earlier task groups to define IS-related curricula in the early 1970s (Topi et al., 2010). IS2002, which was a minor update of the more significant IS'97 curriculum, has been widely accepted as the basis for accreditation of the undergraduate IS programme over the past decade. The rationale behind IS2002 is that a balanced IS curriculum should reflect the multidisciplinary characteristics of the field of IS and should incorporate three major areas: a broad business and real-world perspective, strong analytical and critical thinking skills, and strong interpersonal communication and team skills (Gorgone et al., 2002). However, a major flaw in this curriculum is that IS2002 proposes a 'one-size-fits-all' solution, despite the fact that this is not feasible as mentioned earlier in this section. The reality is that dramatic contextual changes are continuously happening around us in technology, industry and professional practice (Topi et al., 2010). At

the same time, a more flexible curriculum is necessary to reach beyond the exclusive business domain so to incorporate other domains as well.

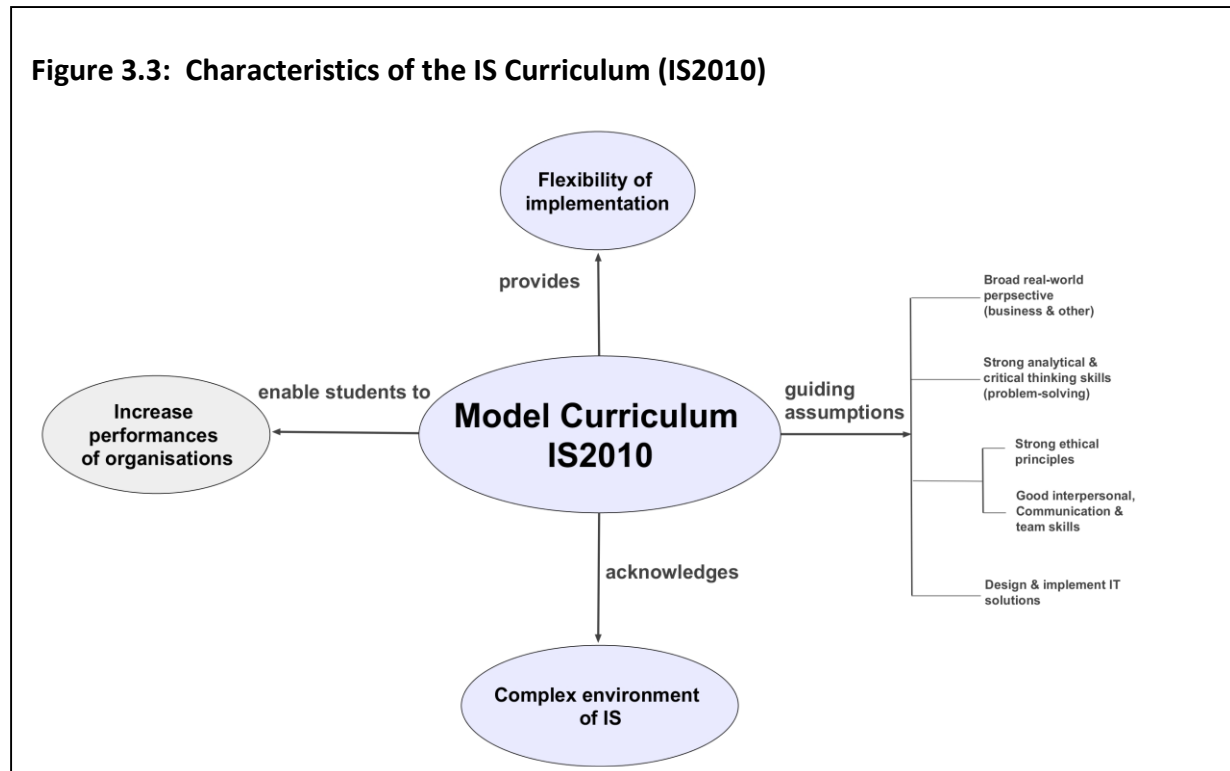
An alternative model is proposed in the Computing Curriculum (ComputingCurricula, 2005, 2004), which was built on the IS2002 effort as a cooperative project of ACM, AIS and The Computer Society (IEEE-CS). This curriculum depicts IS as an applied discipline, primarily concerned with the relationship between information systems and organisations, and places IS at the intersection of exact sciences (e.g. General Systems Theory), technology (e.g. Computer Science), and behavioural sciences (e.g. Sociology) (ComputingCurricula, 2005, 2004). This presents particular challenges for teaching and learning, as future IS professionals need to be equipped with a wide range of analytical and critical thinking skills that will enable them to solve business problems, as well as strong technical, interpersonal communication, and team skills to contribute to the successful delivery of software products.

The new revision of IS2010 acknowledges that information systems are complex systems within a rapidly changing environment, requiring a unique set of resources and expertise (Topi et al., 2010). Topi et al. (2010) argue that it is critically important to address the shortcomings of the previous versions by focusing on four major areas characteristic of the IS profession. IS professionals should go beyond the business school perception and be able to function within a broad variety of domains; they should have strong analytical and critical thinking abilities; they should not only have good interpersonal communication and team skills, but also exhibit strong ethical principles; and they should be able to design and implement IT solutions that will increase the performance of an organisation (Topi et al., 2010). The design of the IS2010 curriculum content and structure has been driven by a body of knowledge that represents a wide variety of specific skills and knowledge (IS specific, foundational and domain specific) underpinning the high-level capabilities needed by IS graduates (Topi et al., 2010).

This new format embraces the notion of a semi-flexible curriculum that has core knowledge areas and specialised knowledge areas that have seven elective courses as the building blocks of career tracks. The first of these courses is called Foundation to Information Systems and the seventh is a capstone course, referred to as IS Strategy, Management and

Acquisition. The development stream is one of the non-core knowledge areas that can form part of an undergraduate degree. Although programming (or development) is notoriously difficult to teach and many reports exist that students do not find it easy to learn programming (Rogerson & Scott, 2010), Sewchurran (in Kroeze et al., 2011, p. 382) argues that although the majority of students emerging as IS graduates are not nurtured to pursue careers as developers, development knowledge still remains “crucial for understanding and appreciating analyst, modeling, and managerial outcomes”. This viewpoint supports the argument put forward in the present thesis that development experience helps students to create a perception of the sometimes “messy ill-defined contexts in which they will be plying their IS competence” (Kroeze et al., 2011, p. 382). If development experience is lacking, it will deprive students of a deep learning experience that includes reflective practice and sense-making (Sewchurran & Scott, 2009; Scott & Sewchurran, 2008). The decision by the ACM task team to make development non-core in the latest IS2010 curriculum, may affect the quality of graduates produced by those undergraduate programmes choosing not to include it. A further concern is that although the current IS2010 release lists several of the issues mentioned above as part of their motivation for revising the curriculum, the “how” of the practical implementation is not always communicated with sufficient clarity.

It is evident that curriculum design is not an easy feat, and careful consideration is needed when making decisions about what to include when designing and implementing a curriculum. The complex and dynamic IS/IT environment poses a crucial need for specific training in flexibility, creativity and innovation, the breadth and depth of which have yet to be explored for inclusion in curriculum guidelines (Gupta & Wachter, 1998). A scholarly concern for improvement and a motivation for continued and lifelong learning have mobilised both academia and industry worldwide to recognise the capstone course as an effective way to address the skills deficiencies that potential IS/IT graduates may exhibit (Moore, 2006; Lynch, Goold, & Blain, 2004; Brandon et al., 2002; Novitzki, 2001; Tuttle, 2000; Gupta & Wachter, 1998). Moreover, this mode of teaching is not new (Lynch, et al., 2004) and dates as far back as the teachings of Confucius in 450BC: “Tell me, and I will forget. Show me, and I may remember. Involve me and I will understand”.



Source: Researcher's own construct (Topi et al., 2010)

3.4 Integrated Environment of Capstone Courses

Although the concept of a capstone course is well established, not all higher institutions implement it in the same way. In Chapter 1 we referred to Moore's (2006) overarching definition of a capstone course as a complex interactive environment, integrating learning from previous academic experience in a student-centred and student-directed way – “the curricular embodiment of convergence” (p.13). Lynch, et al. (2004) classify the different ways of implementing a capstone course into four different models: the industry sponsored model, the studio model, the traditional model, and the directed model. These models may differ in terms of the amount and type of support they provide, the way the courses are structured, and the specific deliverables required. They however all use a project based approach (Kumar, 2006) which involves student participation in a comprehensive, collaborative and usually team-based capstone project (Brandon et al., 2002).

The real-world experience that students thus gain through intensive teamwork and collaboration with other stakeholders from the inception of the capstone project to its implementation is common to all models (Lynch, et al., 2004). It undeniably provides an

experience through which skills are developed that are of immediate value to industry and where immediate contributions in industry can be recognised (Brandon et al., 2002).

Determining clear goals for a capstone course is crucial as they will have a significant impact on the design decisions of such a course (Clear et al., 2001). A capstone course can be designed to have either a product orientation or a process orientation or both in varying degrees. In a product-orientated capstone course the focus is primarily on a completed project that will be evaluated for robustness and quality. The process-oriented capstone course focuses more on the critical analysis and reflection that occur during the development of the product, than on whether it works correctly (Clear et al., 2001). A product can typically include a research-type paper, formal presentation, software artefact or a formal report. Despite these different orientations, “the ability to bring a significant project to successful completion through independent work and teamwork is the hallmark of a valued individual” (Clear et al., 2001, p. 94).

Of equal importance is the identification of a body of knowledge to specify the underlying content of an IS capstone course. To sufficiently address both the computing and business aspects of the IS discipline, the curriculum design for the course should draw on existing bodies of knowledge. Schön (1983, p. 21) argues that professional knowledge powerfully shapes “both our thinking about professions and the institutional relations of research, education, and practice”. It is however important to guard against an instrumental approach as embodied in the Model of Technical Rationality that claims “professional activity consists in instrumental problem solving made rigorous by the application of scientific theory and technique” (Schön, 1983, p. 21). It remains necessary to establish a critical awareness of the limitations of professions and bring to the fore the important role that phenomena like complexity, uncertainty, instability, uniqueness and value-conflict play in practice.

From these perspectives, the following sections embark on a discussion of the major components of capstone courses in an attempt to identify gaps and synthesise the available literature. Opportunities and benefits of a capstone course are discussed extensively in the literature, and the main aspects are highlighted in the next section. The three sections

thereafter discuss the three major components of capstone courses in general: project management, people and the development of the project.

3.4.1 Opportunities and Benefits

A capstone experience allows students to see the bigger picture. It facilitates the integration and convergence of the learning acquired from all those courses that were part of their academic experience – the culminating experience of a curriculum (Kumar, 2006; Clear et al., 2001). Moore (2006) contends that if a capstone course is designed in a student-centred and student-directed way, it demands the synthesis and analysis of knowledge and skills that will result in a positive and successful learning experience. In this way students embark on an action learning cycle, where the next step is “the process whereby knowledge is [once again] created through the transformation of experience” (Kolb, 1984, p. 41). It is reasonable to assume that the deep involvement of such a learning experience can ‘enable’ students as they gain understanding. The Oxford dictionary refers to the “act of enabling” as empowerment; and Dawson and Newman (2002, p. 126) contend that “empowering students provides a means of ‘protecting’ them against the rapid changes that take place in IT”.

The capstone experience further assists in cultivating industry alliances and cooperation (Moore, 2006). In their seminal paper on capstone courses, Gupta and Wachter (1998, p. 441) describe a well-designed capstone course as a unique opportunity to “respond to the marketplace in a timely fashion”. By “engaging students in work-like experiences through simulated and authentic learning environments” (Lynch, 2004, p. 432) capstone courses offer a degree of flexibility that can help to overcome and complement the limitations of a curriculum.

Gupta and Wachter (1998, p. 432) summarise the opportunities that a capstone course affords as follows. Firstly, a capstone course helps students to appreciate both the business-oriented and pragmatic view of the IS profession, since students are encouraged to become more familiar with professional practices and related norms of behaviour such as time management and teamwork. Secondly, a capstone course develops and reinforces technical skills when students are required to develop a particular application. Thirdly, the holistic experience of a capstone course stimulates the development of critical business

analysis skills as it provides a context for students to focus analytically on business activities from the viewpoint of the user-manager (Gupta & Wachter, 1998, p. 432). Finally, it enhances and develops written and oral communication skills, provides an outlet for creativity, and presents a serious endeavour to stay abreast of current and emerging trends (Gupta & Wachter, 1998).

Considering the opportunities that the capstone experience affords to students, it is most probable that it will deliver valuable lessons that are beneficial to student development (Brandon et al., 2002; Novitzki, 2001; Gupta & Wachter, 1998). Students may, for example, learn to value the atmosphere of trust and mutual respect between faculty and amongst students that capstone activities tend to create (Gupta & Wachter, 1998). They may start to appreciate the value of reflective observation and active experimentation as a reflection-in-action process that deepens the learning experience (Lynch, et al., 2004). Despite capstone courses being renowned as complex and resource intensive, students usually value the exposure to real-world problems. Notwithstanding the frustrations of dealing with team issues, students enjoy a sense of satisfaction in applying what they have learnt and can even come to appreciate experiences of criticism and rejection (Novitzki, 2001).

Although there are potential risks to both students and their industry clients, the intrinsic benefit arising from the commitment of a real-life client in student projects cannot be ignored (Hogan, Smith, & Thomas, 2005). Simpson, Burmeister, Boykiw and Zhu (2003) contend that the integration of real-world projects into studio-based teaching encourages students to take ownership of the project outcomes, gradually exposing students to situations and skills which increase their readiness for real-life exposure.

All in all capstone courses serve to develop student capability, confidence and maturity (Clear et al., 2001). When students engage in a capstone project they are confronted with project phenomena like theory, methods and people. They are also challenged to develop expertise and become proficient as project practitioners. This translates to practitioners who are better equipped to support a challenging, autonomous and creative work environment (Procaccino, Verner, & Lorenzet, 2006), where problems are often open-ended and ill-defined (Clear et al., 2001). Such practitioners are also more likely to recognise and

effectively manage their team's need for achievement, continuous learning, and the desire to do quality work.

3.4.2 Project Management

An important pillar of a capstone course for IS students is project management education. Historically, the Project Management Body of Knowledge (PMBOK®) or PRINCE2 is taught as a body of knowledge that students need to practise (PMI, 2004). According to the Guide of the Project Management Body of Knowledge (PMBOK®) (PMI, 2004), projects have a clear beginning, are performed by people and constrained by limited resources. In addition, careful planning is vital and projects need to be controlled during the execution phase until they are finalised. Over the past decade the Chaos Reports of the Standish Group have indicated that projects continue to fail; although the 29% success rate reflected in 2004 showed improvement between 2008 and 2010, the success rate was again very low in 2009. It is however worth noting that several authors contest the credibility of these reports (Eveleens & Verhoef, 2010). Aladwani (2002) contends that although it is not possible to attribute project success/failure to a single source, the significant impact that project planning and its interplay with project uncertainty has on the success of projects cannot be underestimated. Projects that fail either miss their targets or they do not deliver the required business functionality (Nelson, 2007, 2005).

Despite these failures, the term *project management professional* still enjoys wide prominence as a result of the popularity of the Project Management Institute's (PMI®) Project Management Professional PMP® certification programmes based on the PMBOK® (Crawford et al., 2006). Other related project management qualifications like PRINCE2 Foundation and Practitioner qualifications are promoted in the United Kingdom (Crawford et al., 2006). Tools and techniques that focus on planning, organising, coordinating and control as defined in PMBOK® underpin the project management practice (Crawford et al., 2006). However, close adherence to this approach in project management education practice underpins a positivist frame that leads to a narrow focus and has not allowed for learning and sense-making to emerge effectively (Sewchurran & Scott, 2009). As a result, slavish following of these best practices as advocated by the certification programs causes practitioners to experience considerable mismatch between these practices and their actual

experiences of project work (Sewchurran, 2009). A key issue that thus needs to be addressed is the considerable confusion that exists about the true nature of IS project management (Sewchurran, 2009).

As a result the focus of project management research in the early 21st century has shifted to obtain a deeper understanding of project management practice in an attempt to improve the unacceptably high failure rate of projects (Cicmil, 2006; Cicmil et al., 2006). In recent years project management has been criticised “for its lack of relevance to practice” (Winter, Smith, Morris, & Cicmil, 2006, p. 638). Much debate has taken place to question and critically rethink the conventional approach of project management using best practices (Cicmil, 2006; Cicmil et al., 2006; Crawford et al., 2006; Winter et al., 2006; Nelson, 2005). Cicmil (2006, p. 28) further argues that the traditional approach does not reflect “organisational reality as messy, ambiguous, fragmented and political in character” and as a result project practitioner training has been both shallow and narrow (Crawford et al., 2006). The focus for project management training should shift from the dissemination of best practice to a pedagogy that imbues learners with expert abilities where thinking and knowing become an intuitive process (Cicmil et al., 2006). Cicmil (2006, p. 28) suggests that recommendations for the traditional project management best practice approach should be augmented by “concepts of practical wisdom and context-dependent value-rationality and political virtuosity”. She further calls for a move away from the perception that a project management practitioner is a well-trained technician executing the project life cycle (PLC) as a sequential process following specific methodologies and using tools and techniques on projects with finite delimiters like time, money and fixed specifications, towards the view of a project manager as a reflective practitioner who is able to learn, evaluate complex situations by simultaneously thinking, adapting and doing, and bases understanding on prior experiences and actions (Cicmil, 2006; Crawford et al., 2006). This practice perspective does not replace the normative and process-related perspectives of projects, but extends beyond those perspectives to appreciate the importance of the actions of practitioners (Hällgren & Wilson, 2008) and “to demonstrate a deep interest in the lived-experience of project actors” (Cicmil et al., 2006, p. 2).

Historically, expertise was identified by “a higher, faster and more abstract general thinking ability” (Björklund, 2007, p. 27). More recent focus has been directed towards the

development of expertise through deliberate practice and skills acquisition in line with Dreyfus and Dreyfus's five-stage model of novice, advanced beginner, competence, proficiency, and expertise (Dreyfus & Dreyfus, 1986) as discussed in section 2.2.3. The competency framework described in Cicmil (2006) and Cicmil, et al. (2006) utilises the Dreyfus model of human learning to model the transcendence of the project practitioner from following rule-based concepts dictated by the project life cycle as a form of instrumental rationality, to the manifestation of practical wisdom where situations are perceived rapidly, intuitively and holistically. As project management forms one of the core components for this study, it is important to explore the role of the project manager and concepts relating to the development of expertise in this area.

In Cicmil's (2006) framework, a *novice* project manager has no experience, but has graduated with some form of project management certification like PMBOK®. The *advanced beginner* project manager has gained some real-life experience and is becoming aware of the importance of the context of these experiences; in addition to the context independent rules of the PMBOK® guide, advanced beginners use their experience to identify factors relevant to specific situations in a trial and error approach. "Trial and error is the hallmark of crafting; scientific theories on the other hand are the hallmark of engineering" (Buhner, 2003). The *competent performer* project manager is able to improvise, take calculated risks and make informed decisions when formulating the appropriate plans and goals for a specific project (Cicmil, 2006; Cicmil et al., 2006). In the final two stages (*proficient performer* and *expert or virtuoso*) the project practitioner evolves from a reflective practitioner who already knows, to an expert, where thinking, knowing and doing become an intuitive process (Cicmil, 2006; Cicmil et al., 2006). Björklund (2007, pp. 29-30) refers to experts as practitioners with:

- the ability to automate and perform dual tasks
- the ability to be flexible and solve problems with ease
- contextual, situated knowledge and pattern recognition
- tacit knowledge and intuition

These concepts depict an “enhanced way of perceiving the world” and are predominantly gained through learning-by-doing (Björklund, 2007, p. 31). With her proposed framework Cicmil (2006) hopes to encourage a better understanding of the complex social processes that affect the work and life of members of an organisation. At the same time she addresses the concern about the need to cope effectively with project uncertainties and complexities in an as-lived project experience (Cicmil et al., 2006), thus providing practitioners with the “courage to carry on creatively despite not knowing and not being in control and all the anxiety that this brings” (Stacey, 2003, p. 393). The seemingly dissonance or apparent contradiction can be explained by the status of being *unconsciously competent*, that is the fact that “the embodiment of our experiencing provides us with the tacit knowledge” to act as if we know “who we are, where we are, and what we are doing without a great amount of thought” (Jordi, 2010, p. 15).

3.4.3 The People as the Project Stakeholders

As mentioned in the previous section, formal practices such as those embodied in PMBOK® revolve around the project manager and best practices as prime focus, and do not reflect or capture the complexities of the political and social culture of an organisation (Sewchurran & Scott, 2009). In this realm human beings are expected to identify specific characteristics and objects and use them together with appropriate rules and best practices to interact with phenomena they encounter. This positivistic approach to project management favours the belief of an objective reality and neglects social phenomena (Cicmil, 2006); in reality the project management practice comprises many different stakeholders, not all of who receive the prominence they deserve in the best practice approach.

In the unique environment of the capstone course, project stakeholders will typically include a course coordinator or instructor(s); a sponsor, in some cases also referred to as a client, who is the designated person or group for whom a product is developed; and the student teams developing the products or projects (Clear et al., 2001).

Course coordinator/instructor: The role of the course coordinator or instructor of the capstone course is a demanding one (Gupta & Wachter, 1998) and the different roles that sometimes have to be fulfilled concurrently may lead to conflict (Clear et al., 2001). An instructor (course coordinator) can for example be a project manager, a mentor, an

evaluator, a facilitator and a confidant. Several principles of good teaching as mentioned in section 2.3.1 are prominent in this special instructor-student relationship, which needs “to be carefully balanced in the interest of acting ethically and fairly, fostering independence of students and achieving course goals” (Clear et al., 2001, p. 94).

Sponsors: Sponsor can be internal or external to the university. In the case of the present study projects are not created internally in the IS Department and any sponsor from another department in the university is seen as an external project sponsor. Students may have slightly different learning experiences depending on whether an external sponsor is a non-profit or charitable organisation or a profit-making business. Irrespective of the kind of sponsor, students and sponsors should be well informed of feasible expectations, professional conduct and the importance of appropriate actions that will promote the welfare between both sponsors and students (Clear et al., 2001). These decisions should be recorded in sponsor agreement documents that are easy accessible to both parties.

Student teams: Teamwork is used increasingly in organisations to assist them to become more pro-active and to cope more effectively in a fast-changing and competitive environment (Partington & Harris, 1999). Active, collaborative learning, which occurs when members of a student team work together to develop a large scale systems development project is therefore an effective means of instruction (Clear et al., 2001), and prepares students for professional practice. Despite the positive aspects of teamwork, some conflict inevitably results from differences in the value systems, perspectives, time schedules, goals or interests of team members. A core challenge is that often “team members are drawn from pluralistic networks – people from different countries, cultures, backgrounds, worldviews and practices” (Denning, Flores, & Luzmore, 2010, p. 30). This is particularly true in the context of a multicultural university where the student body represents many different cultures and nations.

Although conflict prevention is preferable to conflict resolution (Clear et al., 2001), it is not always possible to avoid conflict completely. Although creative ways of dealing with conflict may be useful in certain situations, De Bono (1995) argues that creativity is not a natural process for most people. The brain automatically establishes and uses routine patterns, whereas creative thinking requires one to cut across these routine patterns and think in a

provocative way. De Bono (1995, p. 14) refers to this concept as *lateral thinking*, a skill or ability, which he argues, every person should possess and practise.

Another important aspect to consider is the composition of teams. The allocation of skills, interests and abilities, as well as interpersonal and teamwork skills, often impacts the success of a team (Clear et al., 2001). However, irrespective of how teams are formed, learning and development in a team is an active process that can be described using Tuckman's (1965) conceptual model for temporal change in developing teams. Tuckman (1965) calls the first stage after a team has been formed, the *forming* stage. This is an orientation stage where team members test and establish their dependency relationships with the other members. Stage two is labelled as a *storming* stage and is depicted by conflict, polarisation and resistance to group influence and task requirements. If teams overcome the conflict and resistance of the storming phase, Tuckman argues that a sense of cohesiveness will emerge in the team. As a result the members will be more open, start to express their opinions more easily, and adopt new roles and standards - they are *norming*. The fourth stage is the *performing* stage where "interpersonal structure becomes the tool of task activities ... [and] finally the group becomes a functional instrument for dealing with the task" (Tuckman, 1965, p. 396).

3.4.4 Developing the Project

The act of programming: Initially the act of programming involves the learning of programming syntax and constructs; students are then required to progressively advance to writing complete programs and subsequently to developing larger software systems. Unfortunately students are not always sufficiently prepared for these tasks. Lister (2000) argues that the approaches followed when teaching programming often skip the first four levels of Bloom's taxonomy (knowledge, comprehension, application and analysis) and expect students to write complete programs almost immediately. Such approaches only involve the last two steps of the taxonomy (synthesis and evaluation) while ignoring the cognitive development of the student, and so lead to failure (Lister, 2000). If this is the case, students are often not sufficiently prepared to embark on the development and implementation of an extensive project. Rogerson and Scott (2010, p. 155) found that third year IS students in a capstone course may have very real fears, as can be seen from student

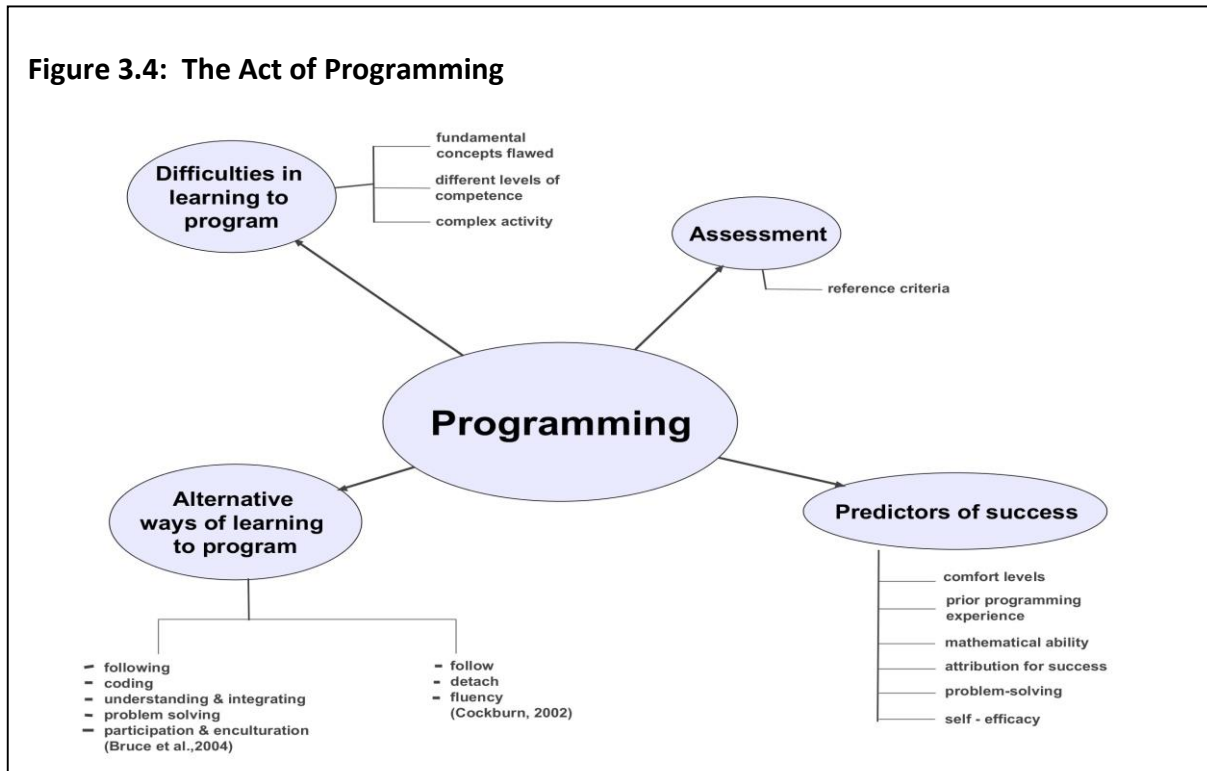
comments such as: “it’s as scary as hell ... it kind of stresses me so much” or “If I have to take programming on its own, me and him, we’ve got problems”.

The question then arises: what factors will influence students to become successful in programming?

Predictors of programming success: Learning to program is universally regarded as a complicated activity (Rogerson & Scott, 2010; Areias & Mendes, 2007; Bergin & Reilly, 2005) and students experience significant difficulties in learning to program and in mastering fundamental coding concepts (Simon et al., 2006; Bergin & Reilly, 2005). Although many possible factors have been listed as predictors of success in programming (Areias & Mendes, 2007; Bergin & Reilly, 2005), the lack of consensus as to what constitutes the essential and core programming concepts, and what the corresponding and most appropriate assessment instruments are, makes it difficult to predict programming success (Simon et al., 2006). It is also difficult to compare different studies, as the students are not always on the same level, different reference criteria are used for assessment, or the contents of the courses may differ. Despite these obstacles it seems from the literature surveyed that particular factors are critical for success in programming, including the importance of comfort levels, students’ attribution for their success, appropriate mathematical ability, prior programming experience, problem-solving skills, self-efficacy, attitude to studies and motivation (Areias & Mendes, 2007; Bergin & Reilly, 2005). In another study Kinnunen, McCartney, Murphy and Thomas (2007) examine student success in learning to program from the instructors’ perspective and found a good correlation between the beliefs of the instructors, mostly based on their own experience, and results obtained in previous quantitative studies from students’ perspectives.

The act of learning to program: If learning is about changes of experience brought about by the interaction of complementary viewpoints of learners and teachers, then it is necessary to understand the different ways in which students learn to program from the students’ perspective (Bruce et al., 2004). In their study Bruce, et al. (2004) identify and discuss five different ways of experiencing the act of learning to program, which they categorise as *following*, *coding*, *understanding and integrating*, *problem solving* and *participating and enculturation*. The first two categories depict a narrow focus where students only want to

achieve an immediate means of getting the task done and do not seek understanding. In contrast to this, if students experience learning to program as depicted by categories 3 to 5 (*understanding and integrating, problem solving and participating and enculturation*), they are driven by a deeper learning approach based on the desire to see the bigger picture (Bruce et al., 2004). Simon, et al. (2006) subsequently found that students who adopted a deep learning approach also obtained significantly higher marks.



Source: Researcher's own construct (Informed by, amongst others, Rogerson & Scott, 2010; Areias & Mendes, 2007; Simon et al., 2006; Bergin & Reilly, 2005; Bruce et al., 2004)

Bruce, et al.'s (2004) approach also aligns well with Cockburn's (2002, p. 22) theory that "people who are learning and mastering new skills pass through three quite different stages of behaviour: following, detaching, and fluent" – see section 2.2.3. The detaching phase as described by Cockburn (2002) seems to coincide with categories 3 to 5 as identified by Bruce et al. (2004) where learners experience deep learning and an enhanced understanding. In the *fluent* phase it becomes irrelevant what technique or procedure needs to be used, since the rich understanding and tacit knowledge of the doer will allow for intuitive and creative solutions.

Bruce, et al. (2004, p. 157) tend not to be prescriptive on how a particular student may transcend from one category or stage of competence to the next, but argue that such “pedagogic decision-making” should be left in the hands of the innovative and skillful teacher. A similar study by Eckerdal and Berglund (2005) uses phenomenography to analyse what students mean by *programming thinking* when they refer to the learning of programming as having to adapt a special or new way of thinking. Some students experience this way of thinking as being difficult to comprehend, whereas others experience it as a method of thinking that will enable problem solving (Eckerdal & Berglund, 2005).

The art of developing software systems: Although mentioned last, the skill of solving ill-defined problems is probably the most crucial skill to be acquired by those striving to become business or systems analysts or systems developer. It is evident from the previous sections that students find the act of programming very difficult and even more so when they are confronted with the task of composing and coordinating the components of a complete program (or system) (Areias & Mendes, 2007). The larger the software system that needs to be developed, the more difficult it becomes: “developing large software systems is notoriously difficult and unpredictable” (Buhner, 2003, p. 1), often irrespective of the role that an individual fulfils in this process.

A business or systems analyst will typically assume software systems development roles that include the gathering, defining and refining of requirements. The development of a comprehensive information system almost always involves gathering and defining the requirements of the proposed system, where a requirement can be described as a “condition or capability needed by a user to solve a problem or achieve an objective” (610.12-1990, 1990). According to Ebert and DeMan (2005), project failure can often be attributed to a changing environment and uncertain requirements during the project life cycle, and most studies on software project results conclude that effective and concise requirements play a vital role in project success. They define “requirements uncertainty” as software requirements that are either unknown or not well-defined, and argue that this can result when there is a conflict of interest amongst the stakeholders, when misunderstanding arises, when unexpected dependencies emerge between requirements, when the cost/benefit of requirements is not well defined, or when the requirements themselves are incomplete (Ebert & DeMan, 2005).

Once a sufficient set of requirements (to the satisfaction of different stakeholders) has been obtained, the design of a software system or part of the system can commence. This is a vital first step in the software development process and precedes the coding activity. However, this is easier said than done. For example, a recent study involving 314 participants from 21 institutions in the US, UK, Sweden and New Zealand concluded that the majority of graduating students are not capable of designing a software system (Eckerdal, McCartney, Moström, Ratcliffe, & Zander, 2006). The study also found that, possibly due to lack of experience, few students reach the level where they can appreciate context-dependent design principles (Eckerdal et al., 2006). These outcomes can perhaps be attributed to students not being sufficiently flexible or innovative, which may in turn be a result of insufficient prior preparation. Whatever may be the reasons, in the messy real-world problem situations where there is a neverending cycle of human needs and human wants, the human nature is constantly agitated or challenged to cope with complexities and go beyond accomplishments, while human beings take a stand on their being.

Soft Systems Methodology (SSM) emerged in the early 1970s as a methodological approach intended to help tackle these ill-defined real-world problems (Checkland, 1972). It “is a methodology that aims to bring about improvements in areas of social concern by activating in the people involved in the situation a learning cycle which is ideally never-ending” (von Bülow, 1989, p. 35).

SSM is therefore fundamentally concerned with ill-structured problems and is underpinned by the assumption that social reality is not absolute but is continuously created and recreated through different social processes in human groups (Checkland & Holwell, 1998). It further focuses on situations that persist and change within a social context and that will always include people trying to take “purposeful action”. Models comprising selected concepts of purposeful activity can then be used to coherently explore this particular type of problem situation in an attempt to find solutions. SSM thus constitutes a learning system with a learning process based on a cycle that starts by exploring the problem situation from a range of perspectives, and then continues to select the systems of purposeful activity (models) that are used to explore the problem situation. The relevant knowledge that emerges from these activities can then be actioned to improve the situation (Checkland & Holwell, 1998).

3.4.5 Learning and Teaching in this Environment

Most authors are in agreement that a capstone course constitutes a rich learning environment: “an unusual opportunity to supplement and complement ... IS Education ... and can be used to overcome limitations of a traditional IS curriculum” (Gupta & Wachter, 1998, p. 431); “multiple opportunities ... to students to demonstrate their learning” (Kumar, 2006, p. 332); and according to Moore (2006, p. 7), “a broad-mastery of learning”.

Many authors also report that they use different approaches to support the diverse learning styles of students (Kumar, 2006). Lynch (2007, p. 9) concurs by saying that “learning is a dynamic affair and situations that are difficult or impossible to quantify are still important in capstone pedagogy”.

As a project forms an integral part of most capstone courses, a project-based approach to learning (see section 2.3.2) is common and students’ feedback “overwhelmingly” indicates that a project is instrumental in achieving the “goal of providing a faithful, real-world IS experience” where the project becomes “a critical tool for incorporating” this experience (Mendoza & Ellis, 2003, p. 98).

Lynch et al. (2004, p. 433) claim that irrespective of the kind of institution or the pedagogical approach, *experiential learning* (as discussed in section 2.3.2) is “central to the development and the delivery of capstone projects”. One of the six propositions of experiential learning theory confirms this claim by stating that the “primary focus should be on engaging students in a process that best enhances their learning—a process that includes feedback on the effectiveness of their learning efforts” (Kolb & Kolb, 2005, p. 194). The 4-stage experiential learning model constitutes a balanced approach that is widely recognised in the modern context of project-driven organisations, requiring education to focus on project phenomena rather than specific roles (Sewchurran & Scott, 2009). As such it addresses the need for a “closer link between the practical knowledge and learning processes individuals go through in their development as project managers” (Cicmil, 2006, p. 36).

In summary, Moore (2006, p. 2) contends that “capstone course expectations are a display of a mastery of learning and the ability to apply it to new, unusual and integrated project requirements”. A capstone course provides an opportunity to assess students’ learning on

more than one level, not only in relation to content and skills, but also within a much broader context of universal educational expectations. It is thus incumbent on the IS instructor to ensure that the assessment of such an endeavour should receive careful consideration.

3.4.6 Assessment Approaches

The entire capstone process requires creative forms of assessment, and the method of delivery of a capstone course provides an ideal platform for a multiple assessment structure as described in section 2.3.3. This typically includes summative, formative and continuous assessment approaches (Kumar, 2006). Kumar (2006) believes that a critical part of assessment in a capstone course is ongoing feedback on student performance; this view is supported by (Biggs & Tang, 2011), who place feedback fifth on the list of characteristics of rich teaching and learning contexts. The assessment strategy used by Kumar (2006) implements a two-phased approach comprising aligned classroom discussions for students to demonstrate their understanding of concepts, and a reflective paper at the end of each course module. Clear et al. (2001) advocate that for an assessment strategy to meet expectations, it must be transparent, balanced, encompass different learning styles and encourage the critical element of ongoing feedback.

Moore (2006) contends that student competence can be assessed in three modalities: cognitive, which refers to the recall, understanding and application of knowledge; affective, which provides for expressions of feelings, values and attitudes, and professional behaviour; and finally psychomotor, which refers to the application and performance of skills and provides opportunities for an ongoing refinement process. Assessment in a capstone course is by nature summative as it evaluates “previous cognitive learning” and allows the instructor to “assess the overall collegiate learning experience of the students” (Moore, 2006, p. 1). However, it must also provide formative assessment as learning can occur in the affective and psychomotor domains (Moore, 2006).

3.5 Theory and Practice in Capstone Courses

Drawing on the literature, it seems natural that a pedagogy to nurture students for professional practice should be embedded within a science of design which, as Simon (1969,

p. 113) argues, is a “tough, analytical, partly formalizable, partly empirical and teachable doctrine”. It is thus imperative that “we need to build good and useful theory native to our discipline and to think about theorising in new ways” (Niederman et al., 2009, p. 651) and then use this theory to underpin our pedagogy and drive our research. In addition, although theories for design and action are not always recognised as theories, Gregor and Jones (2007, p. 313) argue they are “highly influential” in IS and provide crucial knowledge to IS practitioners.

Students do not always know how to apply previously learned ideas and skills to new, different, and larger problems (Polack-Wahl & Anewalt, 2006, p. 209). A humanities-enriched perspective may provide a feasible means for students to try out their conceptual knowledge during the fragile stages of competence development (Kroeze et al., 2011; Sewchurran & Scott, 2009). As mentioned before, the IS2010 curriculum (Topi et al., 2010) emphasises the importance of problem-solving and critical thinking skills; however, not much mention is made of the fact that real-world problems are often ill-defined and “do not present themselves as givens” (Schön, 1983, p. 40). It is in these environments that students need what Schön (1983) refers to as professional knowledge – that kind of knowledge professionals exhibit when they think in action (also see section 2.2.2). This knowing, he argues, is usually tacit, interwoven in “our patterns of actions and in our feel for the stuff with which we are dealing” (p. 40).

Raelin (2006) uses the term *praxis* which is derived from the Greek word “action”. Praxis not only refers to what one does, but includes an additional dimension of how one thinks about what is done by others and oneself. It thus seems logical to say that our “knowing is in our action” (Schön, 1983, p. 49). The best way of acquiring such knowledge is by means of a simulated situation under the close supervision of an expert practitioner, where the novice learner can experience the world of practice through a series of real-world problems. In this way the novice can be increasingly confronted with the complex and unanticipated problems typical of professional practice, which may be ill-defined, unstable or have value conflicts. The knowledge-in-action then takes the form of reflection-in-action where the master and the learner jointly engage in talking and working through these problems (Waks, 2001).

Table 3.1: Aligning Concepts

Characteristics inherent to the IS Discipline	Expectations and needs of Professional Practice	Guiding assumptions and some outcomes of the IS Curriculum	Resonating concepts in a Capstone Course
(Walsham, 2012; Hevner et al., 2004; Benbasat & Zmud, 2003; Baskerville & Myers, 2002; Banville & Landry, 1989, etc.)	(Chao & Shih, 2005; Peppard & Ward, 2004; White, 2004; Cappel, 2001, etc.)	(IS2010 (Topi et al., 2010))	(Rogerson & Scott, 2010; Areias & Mendes, 2007; Simon et al., 2006; Bergin & Reilly, 2005; Bruce et al., 2004)
Embrace diversity	Diversity in the job market and variety of job offers – no one-size-fits-all	Knowledge and skills of IS graduates: <ul style="list-style-type: none"> • IS specific • foundational • domain fundamentals 	Outlet for creativity; Context for developing critical thinking and analysis skills, requires synthesis and analysis of knowledge and skills
Knowledge of a broad application area; technological and social systems and phenomena emerging due to their interaction	The use of information technology is pervasive in society, organisations are increasingly dependent on ICTs. The need is for well-rounded employees with good business knowledge; soft and hard skills.	IS professionals exist in a broad variety of domains	Cultivate industry alliances and cooperation, empower to deal with rapid changes in the IT field and respond to the marketplace in a timely fashion, stay abreast with emerging trends
Intellectual discourse with other disciplines	Management and Leadership. Leveraging of communication and the coordination and sustaining of IS capabilities.	IS professionals must exhibit strong ethical principles, good interpersonal communication and team skills	Familiarise with professional practice and related norms of behaviour, written and oral communication skills, intensive teamwork and collaboration with stakeholders
A practical science - dualistic character with distinct paradigms of behavioural science and design science – concerned with the study of artefacts	Improving business results: management of existing technologies, services and systems improvement, new products and markets for competitive advantage	IS professionals must design and implement IT solutions -- enhance organisational performance.	Work-like experiences (as-lived), appreciate business oriented and pragmatic view

Raelin (2006) concurs and says that when reflection happens in the here-and-now, opportunities that can stimulate creative thinking often arise. Through these steps the novice learns how to think and talk about problems in professional practice and how to negotiate the 'ladder of reflection' about the practice (Waks, 2001). Learners thus begin to appreciate the importance of the problem setting by first identifying the things they need to attend to, while also understanding the context in which these are positioned. Secondly,

they start to appreciate reflection-in-action as a meaning-making activity which can assist the practitioner to cope with messy, complex and unanticipated situations in practice (Schön, 1983).

From the previous sections it is evident that a capstone course creates an ideal environment to link theory and practice in a classroom setting. Table 3.1 highlights how the characteristics inherent to the IS discipline align with the demands and expectations of the IS industry, and also compares how these are addressed in the latest IS curriculum guidelines. Table 3.1 further provides a conceptualisation of how the characteristics depicted by four major areas of the IS profession resonate with elements of the capstone environment.

3.6 Summary and Critique

The literature surveyed reveals an acute awareness that people are important resources in organisations, while highlighting the current shortage of employees who are resilient to change and equipped with appropriate skills, knowledge and experience to sustain IS competence (White, 2004). Organisations will be in a better position to leverage IT and benefit from profitable IT investments if they can employ graduates who are empowered to fulfil their roles in the organisation. The literature also confirms that although organisations are continuously searching for effective, efficient and innovative IT investments to gain competitive advantage, they have up to now given little attention to how enhanced business performance can contribute to sustained competitive advantage (Peppard & Ward, 2004).

A further cause for serious concern is the clear indication of an ongoing skills gap (Harris, 2011; Lotriet et al., 2010), despite many studies addressing this issue from various perspectives and several investigations of possible factors contributing to this disparity over the past two decades. Beard et al. (2007) and Hagan (2004) amongst others, hold the opinion that a solution to this problem might be to expose students to experiential learning activities like industry-listed work or real-life projects, thus better equipping them to face the problems encountered in the real world.

Several sources agree that a capstone course presents an ideal opportunity to provide students with a real-world learning experience, empowering them to cope in a fast-changing and complex environment (Lynch, 2007; Kumar, 2006; Moore, 2006; Lynch et al., 2004). Despite the wide implementation of capstone courses, there is also unanimous agreement that a capstone course provides challenges to both students and faculty (Lynch et al., 2007; Moore, 2006; Clear et al., 2001). The five reasons for concern that are discussed below indicate that the existing literature provides little guidance on how to create synergy and coherence in such a course.

The first reason for concern is the agreed importance of creating awareness amongst students about the messiness of real-world problems and the need to prepare students better to deal with these situations. As mentioned in section 3.5, Schön (1983) argues that problems are not a given. Topi et al.(2010) state in the IS2010 version of the curriculum guidelines for undergraduates in IS, that students must be problem solvers, critical thinkers and they need to *understand and frame a problem*. No mention is made of the first important steps of elucidating a potential problem and defining it (naming it) before understanding it in the context in which it appears (framing it) and then embarking on the process of solving the problem.

Secondly, it is noted that reflection is often mentioned as an important construct in the delivery of a capstone course. As argued in section 2.3.2, it seems that reflection is mostly used in the sense of its *narrow upbringing*, and is limited to a rational analytical process with the emphasis of “distilling rational knowledge from the mess of human experience” (Jordi, 2010, p. 2). For example, Dawson and Newman (2002) report that reflection is mostly done at the end of a course, or at the end of a section (Kumar, 2006). Shaun Lynch (2007) uses weekly activity reports and lessons-learnt-sessions on the last day of the course. Although Lynch et al. (2004) report that reflection-in-action forms a vital part of their experiential learning approach, no mention is made of how this is done. It seems evident that the potential of reflective practices that will facilitate integrated experiential learning is not exploited to the full.

The third reason for concern is the implicit assumption that students are adequately prepared and have sufficient prior knowledge to embark on the experience that awaits

them in a capstone course. Clear et al. (2001, p. 94) state that “the focus of the capstone course is to impart experiential knowledge while bringing a major project to successful completion. This supports the integration of and reflection on the knowledge that students have gained during previous stages of their education”. A capstone requires a two way integration. Educators are not only challenged to integrate concepts within a course, but must also work together to integrate all of the courses in the discipline to enrich the capstone experience and achieve desired learning objectives (Reinicke et al., 2012).

The fourth reason for concern refers once again to the IS2010 curriculum. IS2010 acknowledges the dynamic reality of technology and industry practices and focuses on making the curriculum “significantly more broadly applicable than the previous IS model curricula were” (Topi et al., 2010, p. vii). However, as mentioned in section 3.3.3., the exclusion of applications development from the core is reason for concern as it may deprive students of the valuable experience of what actually happens when concepts and requirements are translated into code when developing applications. Winograd and Flores (1987) posit that we often act with a certain *blindness* and it is only when breakdown occurs that new possibilities are revealed, increasing the chances of creating a *readiness-to-hand* solution – one that exhibits a kind of simplicity which makes it easy to use and easy to learn. When developing software systems it is common to experience this kind of breakdown. The omission of application development as core in the IS curriculum may deprive students of the valuable lived-experience of developing systems and the multifaceted benefit of their effectiveness in facilitating deep learning. It rather reinforces the twentieth century positivist epistemology of practice that dictated a split between research (theory) and practice, where university scholars usually create the fundamental theory for implementation by professionals and technicians (Schön, 1983).

Fifthly, a capstone course is earmarked by many as a rich learning environment (Moore, 2006) “to provide necessary integrative and emerging skills to IS students and prepare them for the challenges of their first entry level positions in industry” (Gupta & Wachter, 1998, p. 428). Very little is said about how this can be accomplished; how typical interventions can be co-ordinated and structured to bring coherence within the capstone course through an approach that will synthesise the insights derived from theory with the very act of implementing in practice. Clear et al. (2001) and Gupta and Wachter (1998) provide

extensive lists of resources and offer examples of some typical deliverables that a capstone course will comprise. However, no mention is made of any relationship between these different deliverables and the role these can play in developing required competencies. In addition, little evidence is provided of the outcomes of this rich learning experience and the transcendence and growth of the students during the delivery of a capstone course.

The next chapter provides an account of the evolution of a specific case of a capstone course at UCT. It is a structured narrative presented by the researcher and drawn from her own constant professional reflection on her experience and progressive elaboration while searching for answers to questions on transcendence and the development of competence within the environment of a capstone course.

4 Stages of Evolution: The Case of the Capstone

The whole purpose of education is to turn mirrors into windows.

(Sydney J. Harris)

Reach high, for stars lie hidden in your soul. Dream deep, for every dream precedes the goal.

(Pamela Vaull Starr)

4.1 Introduction

As illustrated in the previous chapters, the mismatch between graduate skills and industry needs in the ICT sector remains a practical reality (Seymour, Scott, Meyerowitz, Malamoglou, & Morar, 2006; Bourque, Dupuis, Abran, Moore, & Tripp, 2004), despite ongoing attempts to address this problem at a number of educational institutions. In addition “there is an increasing realisation of the difficulties professionals in innovation-related jobs face in bridging the interface of technology and business” (Thursby, Fuller, & Thursby, 2009).

The literature survey in Chapter 3 presents a strong argument for using a capstone course to effectively give students real-world experience of the diverse and complex nature of the Information Systems profession and provide them with adequate skills for the global marketplace. This is in line with this study’s main aim of striving to *empower IS majors to sustain competence across dynamic and evolving IS roles*. Most capstone courses involve an extensive team project as a main deliverable, giving students an integrated team-based experience that, according to Thursby et al. (2009), also fosters a better understanding of knowledge at the interface of different disciplines. Students agree that the project challenges them to become more creative; to cite one student, Information Systems is an “invitation to the heart of innovation”. Alumni have also indicated that “the dynamics of the university projects are exactly the same in many areas as the commercial ones they experience, right down to the interaction and attitudes of people in the team”, and that “the structure of the project that I have been working on was very similar to that of the

university projects and I felt far more confident doing this project knowing that I had already done two similar projects and encountered and overcame many of the issues associated with IT projects". This evidence supports the view that a capstone course is an ideal exit level course to nurture and prepare students to become innovative professionals, and that a systems development project as a core component gives the context for developing the necessary competences; however, there has not been extensive reflection as to how a system of interventions can be constructed within this environment so as to deliberately achieve such outcomes.

The previous chapter concluded by raising a number of concerns that need to be addressed and explored in more depth. The following cases were made:

- Students are not always sufficiently prepared for the challenges that await them in a capstone course.
- Reflective learning is regarded as "a roadmap to university success" (Biggs & Tang, 2011) and can be used as a pedagogical tool in a diverse set of learning activities and processes. Jordi (2010), however, cautions that the rich possibilities of reflection remain untapped when used from within a constructivist perspective of experiential learning. "It leaves behind the complex, rich, and subtle implicit dimensions of experiencing", and as a result students lose the opportunity "to dip into this subjective space ... to make explicit the implicit felt-sense of experience" (Jordi, 2010, p. 12).
- In contrast to the assumption of Technical Rationality that problems of choice are solved by choosing one best-suited methodology, problems in real-world practice need to be constructed from uncertain and fuzzy situations (Schön, 1983). It may also be "essential to abandon the mindset that believes that a suitable single methodology is all that is required" (Introna & Whitley, 1997, p. 42).
- If systems development is removed as a core component in the IS curriculum as IS2010 suggests, it may deprive students of a valuable as-lived experience as argued in section 3.3.3.
- A final and pressing concern is that very little attention is paid in the literature to the questions of how to attain internal coherence in a multifaceted capstone

course and how to integrate deliverables and components within such an environment in a meaningful way.

Against this setting, this chapter gives a historical account of the researcher's personal quest and *struggle* over the past ten years to develop innovative and competent IS professionals by achieving a closer fit between theory and practice within the context of a capstone course. This is not an easy feat as "integrating thought with action effectively" remains "one of the most prevalent and least understood problems of our age" and "has plagued philosophers, frustrated scientists, and eluded professional practitioners for years" (Argyris & Schön, 1974, p. 3). As such "it is an account of several iterations of reflexive learning of [both] students [and lecturer/author] learning, influenced by the education process. The account relates how ongoing transcendence occurred from being unconsciously incompetent to being consciously competent" or in some cases unconsciously competent (Scott, 2008, p. 6). Boughey (2005) asserts that such a scholarly endeavour not only involves introducing students to skills and strategies that will enable them to cope with their academic learning, it also fundamentally involves a deep engagement with the content.

This account specifically refers to the implementation of a capstone course within the Department of Information Systems at UCT. The chapter concludes with a set of questions that progressively emerged and were instrumental in conceiving and undertaking the changes that were made to the course during three distinct phases of redesign and restructuring.

4.2 A Historical Perspective

In its current form, the capstone course in the Department of Information Systems at UCT is a full-year course that not only integrates the complete body of knowledge gained in other courses of the IS major, but also adds significantly to it (see Figures 4.3, 4.4 and 4.6). Over the past ten years much thought and action have gone into the continuous development of this course. Argyris and Schön (1974, p. 3) not only believe that "integrating thought with action" is challenging, but more so that "exciting intellectual problems are related to integrating thought with action". Similarly, Raelin (2007, p. 495) holds that "ultimately, we need a synthesis of theory and practice if we are to prepare thoughtful practitioners". This

section attempts to give a historical account of the evolution of the capstone course during this time, demonstrating a convergence of focus so to merge theory and practice more effectively.

The account is constructed from the researcher's memory as an involved participant in the course, with the help of additional artefacts such as faculty handbook descriptions, course deliverables (like project documentation), course evaluations, surveys, questionnaires and student interviews, as well as some more recent contributions from those who participated in the course over the years. It also draws extensively on the researcher's own experiences in attempting to make sense of the "world" of the capstone course by referring to knowledge gained from other disciplines through the existing body of literature, and the large number of student projects (200+) that were managed over this time. Argyris and Schön (1974, p. 3) argue that "effective action requires the generation of knowledge that crosses the traditional disciplines' knowledge - with as much competence and rigour as each discipline usually demands". Although scholars may often feel challenged by the idea of working across disciplines, the nature of IS is generally regarded as interdisciplinary and diverse (see section 3.2), and IS projects typically address issues in a wide variety of domains. In addition, several empirical studies have previously been undertaken by this researcher and the resulting research papers published, with the objective of encouraging and supporting a critical reflective approach that will nurture deep approaches to learning and work towards improved solutions. The influence that this approach has had on the educational process and how it was used to aid learning and teaching in the capstone course will be highlighted.

Despite the evolving nature of the capstone course, several important elements have always been present, linked to the existence of the team project as core component. The team project has a lifespan of approximately 7 months, from mid-February to mid-September of a particular year. A real-world perspective and a broad business background have always formed a core focus of the project. Student teams of four or five members each are required to communicate with an industry sponsor who provides them with a suitable business problem. The sponsors commit to being available for a limited amount of time for meetings and to respond to queries in order to provide guidance to the teams regarding user requirements and business processes, without any monetary reward.

The course has evolved through three main phases over the past ten years. The first phase was the *baseline* phase (Figure 4.1) which signalled the offset of an evolving educational process that started in the year 2000 with the researcher in the role of project coordinator. The second phase was seen as the *grounding of skills* phase (Figure 4.2), and was initiated by the creation of a new course in 2001 with the researcher as the course coordinator and lecturer. The duration of the course was three terms (one-and-a-half semesters) and consisted mainly of the team project and related content, while excluding some theory components of the previous phase. This structure formed the foundation of the emerging capstone course at UCT and several thrusts of change were pursued during this remodelling phase, which lasted until 2004. The *emergent phase* commenced in 2005 with the capstone course changing back to a one year course, but with a structure consisting of carefully integrated theory and practice components (Figure 4.3 and Figure 4.6). It was towards the end of this phase that the notion of a coherent approach for the capstone course emerged. Although timelines for the different phases are given above, the evolution of the course has in fact been continuous and integrated. The content and procedures were interrogated on an ongoing basis and existing literature was critically evaluated to continuously assess and improve the course curriculum and course structures.

4.2.1 The Baseline Phase (2000)

The faculty handbook for 2000 described the Information Systems III course as “the final core undergraduate course in the Information Systems stream. It builds on the material covered in Information Systems II, provides a broader management view of Information Systems issues, and gives practical experience through the development of a significant information systems project” (Faculty HandBook, 2000).

The ‘first’ version of the capstone course comprised four sections. The Project Management section was closely aligned with PMBOK® principles and covered methods and techniques commonly used in information technology projects such as planning, estimating, control, measurement, reporting, user participation and team dynamics. The Corporate Computing Environments and Architectures section introduced students to concepts like local and wide area networks, client/server applications, and industry trends and developments. The Architectures and Standards section explored architecture aspects like system software,

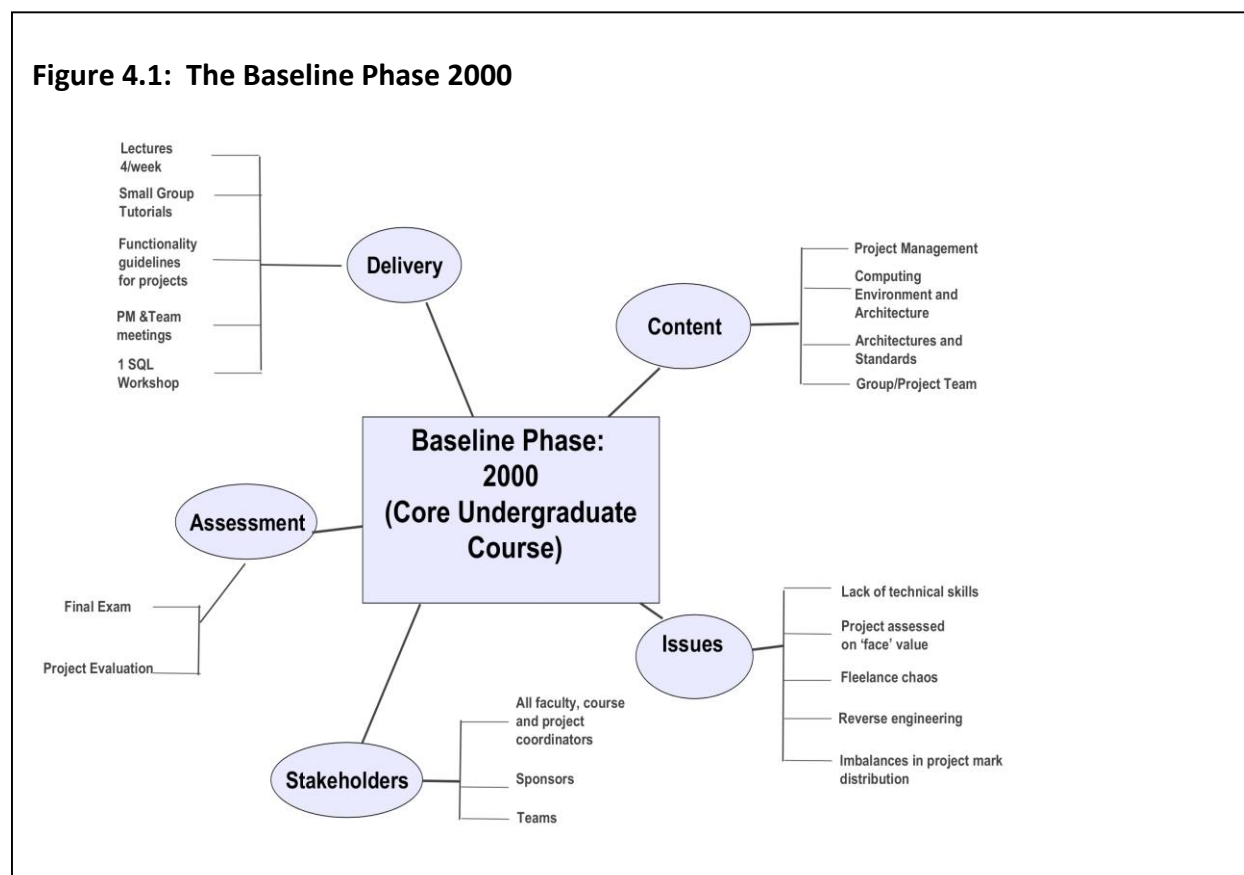
application software, data management, physical distribution, distributed object and intra/internet models and user interfaces, as well as related concepts and objectives. The Group Project, as the fourth section, contributed 30% of the overall course result and was intended to provide practical technical experience and first-hand exposure to the management and user participation issues. The fourth section also covered issues relating to the management of Information Systems in an organisation and the strategic implications of IS within the organisation. Although the researcher was introduced to this course for the first time in the role of project coordinator, and was responsible only for coordinating, supporting and managing the student projects, she elected to attend all theory lectures to better understand the link between theory and practice.

Support for the Group Project section of the course was provided to students in the form of face to face meetings, one small group tutorial per week, and project-specific functionality guidelines. The class size was relatively large, with 39 project teams comprising four or five members per team. All faculty members acted as project managers for three or more project teams to facilitate the completion of pre-defined project deliverables. These deliverables included the initial project definition, the project scope, a project plan which included some risk assessment procedures, progress reports and effort estimations, systems analysis and design documents, and the final software product. Although teams used some Unified Modelling Language (UML) artefacts during the analysis and design phases, few other structures existed to guide students in developing problem-solving abilities and testing techniques. In addition, students were only formally exposed to coding in an introductory coding course in their first year and then again when they were confronted with the task of developing a system as part of the project during their third year. This meant that the students received very little technical guidance in their programming efforts. Except for one Structured Query Language (SQL) server workshop, there were no other mechanisms to enhance skills or practise advanced technology concepts. As a result, many team members lacked technical design and coding skills.

The projects were assessed at the end of the life cycle, using standardised mark sheets for the final evaluation. Although the functionality of the systems was evaluated and tested thoroughly during this assessment, the systems were taken at “face value” and only the executable versions of the systems were examined. Since the coding was not evaluated, it

was possible that student teams could obtain good marks without adhering to good design and programming principles or consistent application of standards (Scott, 2008).

The students' inability in some cases to solve business problems effectively often meant that the design models they developed were not sufficiently rigorous to form the basis for successful coding. In these cases student teams would reverse engineer the design model from the working system to correlate with the code. A review of the projects submitted from this period showed that they did not always exhibit multi-tier architectures, and the accompanying documentation was often not in line with the actual software product. Although underlying concepts were covered and explored in tutorials and lectures, the general lack of crucial technical competencies caused significant imbalances between project teams; for example, the final project marks ranged from 35% to 99%. The student teams who obtained very low project marks did not score as poorly in their project management deliverables, which suggests that below-average project teams did not embark on a proper action learning cycle during solution development.



Source: Researcher's own construct to reflect a visual representation of the discourse

Machanick (2005) argues that students often apply possible solutions to programming and team problems in a random way, instead of reflecting on the outcomes of previous solutions before the cycle of planning, action, and reflection is repeated. For students to break away from a state of freelance chaos they should be guided to transcend via an environment of controlled quality to reach a state of crafted quality. This transcendence is most effective when students are properly guided or mentored while being exposed to real-life situations where they can experience the interplay between politics, understanding the business situation of concern and finding satisficing solutions.

During the baseline phase we sought to provide students with a solid theoretical foundation in the best practices of project management. Figure 4.1 provides a summary of the main aspects of the baseline phase. Good mentoring structures also facilitated the timely completion of project management as well as the systems analysis and design deliverables. However, it seemed apparent that students often performed activities without a clear appreciation and understanding of the processes involved, due to a lack of technical skills and perhaps also an inability to link theory and practice. Clearly, teams with the project marks below average needed more guidance to help them reach the required level of maturity in their understanding, problem-solving, and technical skills. Because of these concerns, the faculty deemed it necessary to rethink and restructure the project course and to increase the scaffolding provided within the learning environment.

4.2.2 The Grounding of Skills Phase (2001 – 2004)

In an attempt to address the limitations of the previous phase more effectively, the main focus of this new capstone course was to integrate “most of the practical elements learned in the second and third year” (Faculty Hand Book, 2001). In 2001 the Information Systems III course was thus split into 4 new courses: IT Management, IT Applications, Electronic Commerce and Group Systems Development Project course (Capstone Course) that spanned three terms from February to September.

This new version of the capstone course excluded the theoretical project management and IT management components and was predominantly a practical course focusing mainly on the team project and related content and concepts. The objectives for this course were rephrased to align the content and the curriculum. Students were to obtain and consolidate

knowledge and skills in systems development, and were to be prepared for the corporate and real-world computing environment while practicing formal project management and the concepts of systems engineering (Scott, 2006; Seymour et al., 2006). Principles of teamwork and “soft” IS issues, such as motivation and ethics, were to be extended. This course not only had to provide a solid foundation for those students continuing to postgraduate IS study, but also had to expose students to the challenges, advantages and problems of working with real-world users (Scott, Alger, Pequeno, & Sessions, 2002).

Over the next few years (2001-2004) deliberate efforts were made to improve the course holistically and encourage deep approaches to learning (see section 2.3.2). In the words of Biggs and Tang (2011, p. 255): “we want[ed] students to know what the whole project [was] about; and how each contribution [fitted] into the project as a whole and want[ed] them to explain how they [thought] they [had] achieved the intended learning outcomes through participation”. This involved aligning the capstone course with the Model Curriculum (IS’97 and later IS2002); more attention was also given to improving team dynamics and sponsor commitment (Scott & Pollock, 2006), the refining of the project processes, and in some cases also the redefining of the deliverables and the scope of the projects. Specific attention was given to creating an awareness of software testing and guiding students to test their systems more extensively throughout the life cycle of the projects (Scott, Katovsky, Burdzik, & Elley, 2004; Scott, Zadirov, Feinberg, & Jayakody, 2004). Several initiatives were pursued to enhance the technical skills of the students and encourage closer adherence to systems development standards. A multiple assessment strategy was adopted which included a range of measures and evaluations that went hand-in-hand with the changes in the course content, in an attempt to adequately address the complexities of assessing team projects (Scott, van der Merwe, & Smith, 2005; Scott & van der Merwe, 2003). This also necessitated continuous refinement of the strategy to better assess the quality of the final product, as well as to improve the understanding of the underlying business problem and principles, technical skills and soft skills, and to properly assess the individual contribution of each team member to the group project. Several research studies were undertaken throughout this time to guide these changes and to assist in raising the students’ level of maturity (see Table 4.3 and Table 4.4).

One of the main products of this phase was a comprehensive course reader comprising all the course and project hand-outs such as templates, guidelines, rules, mark-sheets and rubrics. This concise repository gave the students a comprehensive overview of the content of the course at the onset of the course. Table 4.5 provides a summary of the evolution of the capstone course over this period.

Curriculum design and course content: The development of this version of the capstone course was guided by the Model Curriculum and Guidelines for Undergraduate Degree Programs in Information Systems (initially IS'97 and then IS2002) (Gorgone et al., 2002) and the Guide to Undergraduate Degree Programmes in Computing, which extends skills from more theoretical principles to those important for application and development in a project-driven society (ComputingCurricula, 2005, 2004). Changes to the course design embraced the development of the important characteristics of an IS professional, as suggested by IS2002, including a broad business and real-world perspective, strong analytical and critical thinking skills and strong interpersonal communication and team skills (Gorgone et al., 2002).

To fully reflect these major areas, the systems development project course [capstone] was designed to give students first-hand experience of the management issues and complexities of running a real-world system development project. Students experience the subtleties and complexities of interacting with actual users in real organizations, some of whom may have had no prior exposure to computer technology and applications in business. An important added benefit was that students gain experience of working in teams and realize the challenges that this entails (Scott, 2006, p. 4).

Team selection, team dynamics and successful projects: Scott, Tichenor, Bisland and Cross (1994) state that no single team selection method is the best, and that the selection criteria should depend on the specific course, the demands placed on students and lecturers, the length of the course and the abilities of the students involved. However, since effective teams are at the core of high performance organisations and exposure to teamwork is

important in the preparation of students for the real-world environment (Katzenbach & Smith, 1993), specific practices were introduced to facilitate the team formation process.

A self-selection approach was used whereby students selected their own teams (Scott & Pollock, 2006). A survey instrument that allowed students to grade themselves according to key concepts and rank their individual abilities and skills was designed to aid this process and completed at the start of the course. It was hoped that students would use the survey results to create more balanced teams, and teams were encouraged to choose members who might bring different skill sets to a particular team. In addition, a faculty member from the Department of Organisational Psychology was contracted to facilitate the team formation process; the same surveys were used in this process to match remaining students and finalise team formation.

A further enhancement regarding team dynamics was introduced when the Centre for Conflict Resolution (CCR) at UCT was contracted to conduct four teambuilding sessions with students through its Mediation and Training Services (MTS) Project. This intervention seemed to be effective as very few complaints or issues were experienced in the teams during 2001 and 2002. In 2003 and 2004 a special consultant conducted a series of team exercises with students to cultivate an acute awareness of team skills (Scott & Pollock, 2006). As part of this intervention, students completed several team questionnaires and team exercises that were subsequently made available for further empirical research.

Project selection, industry involvement, project scope and success: A generic theme was identified for each year's project and was introduced by means of a similar real-life case study at the start of the year, which helped students to conceptualise the problem space more vividly. In 2001 a relationship was established with the Cape Information Technology Initiative (CITI) ("a non-profit organisation established in 1998 to develop and support the information and communications technology cluster in the Western Cape", <http://www.citi.org.za/>); guest lecturers of other organisations also presented their specific real-life case studies to the students. Students commented that they found this exposure to the real world stimulating.

The *project brief* of the baseline phase was further refined to provide specification and functionality guidelines related to the generic theme. Within this prescribed framework, students were expected to identify a business problem that would fit the particular theme. Projects were chosen from many different areas, including school systems, specific systems for large corporates, hospitals, the government, disadvantaged communities, non-profit organisations, and other smaller industries and companies. In 2001 students developed a web-based management system with specific focus on the scheduling of resources; for this project the office administration problem faced by CITI was used as case study. In 2002 students developed a comprehensive web-based management system to be used as a generalised administrative tool. In 2003 it was a tracking system and in 2004 the focus was on ordering systems. In addition to the real-life demonstration of a typical project in the problem space, the project brief provided examples of typical cases in this problem space and gave some functionality guidelines to assist the students in their initial thinking about the problem situation. The students were strongly advised to allow time to go back to verify the models they built. They had to arrange time to simply observe in the workplace without taking up staff time; collect and analyse as much information about the business as they could, like sample documents and reports if those were available; and respect the confidentiality of the sponsor's information at all times.

Students also had to identify a contact person at the particular organisation to act as an idea sponsor. Such a sponsor would typically commit to provide a minimum of two days' worth of time during the project to assist in drawing up requirements, prototyping user interfaces, and assessing documentation and installation procedures. Communication with sponsors was improved in 2001 and sponsors were given initial guidelines to assist them in conceptualising and understanding the project context and formulating user needs; they also contributed to the evaluation of team presentation skills and cohesiveness (Scott & van der Merwe, 2003). These guidelines further initiated the development in 2002 of two rubrics to be used by sponsors for evaluating student performance. The first rubric was completed once the user requirements document was handed in and comprised three main sections: general conduct, interview/meeting conduct, and problem definition and formulation of user requirements. The second rubric was completed at the end of the project, with the main sections being presentation skills, business solution, teamwork and

systems evaluation. Each of these sections was broken down into relevant sub-sections to assist sponsors in their evaluation and to ensure a standard approach across all teams. This process provided useful feedback on the progress of the teams and allowed the course convenor to become aware of issues with sponsors at an early stage, should there have been any.

The different roles of project manager, quality manager and tutors within the course were also documented. A hybrid of the Systems Development Life Cycle (SDLC) approach was implemented as the fundamental software methodology used. The capstone project was broken down into clear interim phases: project definition, system analysis, design, building, and testing, each of which incorporated systems development deliverables, project management deliverables, and quality control procedures. The initial suite of eight interim deliverables guided students in the application of previous knowledge (theoretical and practical) and in the acquisition of new specialised skills needed to elicit user requirements, solve their specific business problem, understand scope, and complete the analysis, design and building phases. Each of these deliverables was evaluated by the allocated project manager and discussed with the team to provide constructive feedback. This formed part of the continuous assessment used in the course and is discussed later in this section as well as in sections 2.3.3 and 3.4.6. Table 4.1 shows how the interim deliverables were aggregated into a milestone deliverable for each phase of the project, culminating in the final deliverable, which was a complete shrink-wrapped product consisting of all the documentation and the actual software system. Several templates used to guide students in the development of the deliverables were designed and enhanced during this phase. UML artefacts were extended and used more effectively during the analysis and the design phases in order to avoid the reverse engineering of models at the end of the project.

Table 4.1: Project Phases and Corresponding Milestone Deliverables
(Scott, 2006)

Phase	Milestone Deliverable
Project Definition & Planning	Business Case
Systems Analysis	User Requirement Specification
Systems Design	Systems Specification
Systems Build and Testing	Shrink-wrapped Product

Initially only the five most successful projects were presented to a selected audience, at a special awards evening. After 2001 it was decided that all the project teams should get a chance to present their systems, not only as an opportunity for demonstrating them to industry and the wider public, but also to acknowledge their efforts throughout the year and the sense of pride they had developed for their projects. An expo event that showcased all the systems development projects to industry, learners from nearby schools, and the wider public was thus initiated in 2002 and sponsored by a large company. Different keywords or slogans like “dedication, determination and discovery” were used every year to reflect the experiences of that year, advertise the event and exhibit the students’ pride and commitment. This served to encourage students to *truly engage* in their team projects during the year (Boughey, 2005) and reflected the principle of *strong trust* in the students’ work as advocated by Bain (2004).

Together these processes helped to deliver the interventions to promote critical thinking, critical being, and transformation, which according to Doyle (in Bain, 2004) underpin the discourse of higher education. The improved development environment resulted in some successes for the department and the students. For example, the successful completion of an industrial effluent sample tracking and reporting system by a third year team for the Municipality of Cape Town in 2003 initiated further collaboration with the City of Cape Town for the following two years.

In 2004 one of the third year teams won the development category prize at the second Microsoft Project Firefly competition, with their V-Track system for General Motors, South Africa. This system allowed both dealers and customers to keep tabs on all vehicles once they left the factory. Project Firefly (currently referred to as the Imagine Cup competition) was a national competition hosted by Microsoft and organised for all academic institutions in South Africa. Another project in 2004 was implemented successfully at African Cork Suppliers (Pty) Ltd., a company that supplies products for South Africa’s wine industry, including corks, bottles, chemicals and barrels. This project, called CorkIT, included an automated stock costing and tracking system, and an order tracking system which handled sales and purchase orders. After the completion of the project, two members of the team spent an additional 200 hours on the sponsor’s premises to test and implement the system.

Enhancing technical skills: In an attempt to address the deficiency in technical skills apparent in the previous phase, specific technical topics were identified to bridge the gap. Project teams were each given a topic to research, prepare, and then present to other members of the class during a seminar session. The technical concepts had to be explained and demonstrated by means of accompanying documents, artefacts and software programs. Each team consulted with the course convener prior to their presentation to ensure that the material presented was of the required standard. More than half of the comments received from the student evaluations in 2001 contained suggestions of how benefits obtained from the technical topics could be enhanced, especially by using student groups that differed from the project teams. In 2002 the technical topic groups were formed by combining members of different project teams. The intention was that the students who presented a particular technical topic would subsequently take their new skills back to their individual project teams.

Although some students enjoyed the challenge of investigating and researching technical concepts and claimed that it “inspired their thinking on solving problems” and was a “fantastic dynamic for sharing knowledge and learning”, some students still complained about the “vagueness of the technical topics”. They argued that the technical topics were “too generalised” or that the topics they were not involved in caused “restricted learning”, or just that the technical topics provided “little value”. On the other hand, students enjoyed the full-day workshops to learn SQL server concepts for database management and they expressed the wish that they could have “had some more workshops like the SQL one”. The need for “deliverables for code along with the written deliverables”, “some technical help in the beginning”, “more coding knowledge” and more “guidance on technical aspects” emerged frequently in the course evaluations.

The comment: “I think it could be much better if every student on his/her own could make a small application for each and every one of the tools available...”, further emphasised that students indeed needed more practical experience and emphasised Maturana and Varela’s (1987) maxim of “all knowing is doing and all doing is knowing”. The technical topics clearly did not address the lack of practical experience sufficiently. Not all students benefited equally from the material presented and the seminars did not produce the student commitment and deep learning that would usually be expected from a more hands-on

approach. Although the topics provided students with material and directions for tackling certain tasks when developing their software systems, they did not sufficiently address the fundamental coding issues and deficiencies in coding skills that existed and did not prepare students adequately for the complex task of translating requirements into code. Further enhancements to the capstone course were clearly needed to specifically improve the development of problem-solving skills and coding abilities.

This change was enacted by providing students with the task of developing a pilot system in the first half of the course as a way of *testing the field*. The pilot system attempted to address various issues. During the development process students were usually expected to implement object-oriented design and programming principles within an n-tier distributed environment. Unfortunately novice developers struggle with even simple 2-tier applications and are likely to be completely out of their depth in n-tier environments (Lhotka, 2006). Because of this, it was crucial to establish a well thought through generic framework and patterns that could be applied repeatedly when developing highly scalable and maintainable object-oriented business applications. This framework was implemented through a step-by-step approach and comprised seven three- to four-hour workshops that provided students not only with coding skeletons for developing integrated object-oriented n-tiered systems that they could utilise again and again for subsequent software development, but also a way of starting to think about solutions to problems. “In the software world, the easiest way to reduce overheads is to increase reuse, and the best way to get reuse out of an architecture (both design and coding) is to codify it into a framework” (Lhotka, 2006, p. 33). The existing library ordering system that was available for faculty members provided an excellent case for the pilot system due to the several limitations of that application. The Commerce Faculty librarian introduced the problem scenario to the students at a special planning workshop. The pilot system then incorporated all the concepts needed to develop a basic system within a well-designed framework and adhered to good software engineering principles. Additional and individual support was provided during these workshops by selected tutors and the course lecturer. Coding lectures were scheduled to synchronise with the respective workshops in the series to introduce new, relevant theoretical concepts. Although this was an attempt to address the deficiencies in technical skills and programming abilities, many students found the learning curve too steep. They only did a semester

programming course in their first year and did no programming in their second year, hence they complained that it was “too much work” and that the lecturers “move too fast for those who have never programmed or are not good at programming”. In addition to learning programming, the programming platform changed in 2003 to a newer version and they felt that “3rd year students have to learn .NET for the first time and use it for the project. This is really going to lower the overall performance.” The step-by-step workshops were meant to function as a series of teaching tools, but some students were too unsure of the concepts and felt that they did not “have the skills/knowledge to complete workshops/tutorials” efficiently. The fact that the workshops built on one another, made some students anxious about their ability to cope as the workshops were “too fast paced” and “very time consuming”. Despite this, other students enjoyed the workshops sessions and reported that these “workshop sessions and templates were excellent”. One student proposed that “with regards to OO-programming, do more of it in first year so that at a third year level, students are in a position to do the project without additional tuts”. The department became aware of this gap and decided to introduce additional programming sections in the second year analysis and design courses of 2003. As a result the third year students of 2004 were better equipped and did not find the learning curve that steep. The workshop series for 2004 was also revised by improving the content and removing possible ambiguities so as to enhance the student experience.

In 2003 students were further introduced to a technology platform for workgroup environments using Microsoft Project Web Access, which enabled standardised and consistent planning and reporting even though team members resided at different physical locations. Project and resource information could be stored on the server and the web access promoted collaboration amongst team members working on the same project. This also provided a secure repository for the deliverables and documents of the individual projects. Students, however, found the web access slow and the software unnecessarily complex and were reluctant to use this platform.

The comprehensive assessment strategy: In keeping with the view that assessment is necessary for teaching as it enhances and supports the learning process (Shepard, 2000), a comprehensive assessment strategy was introduced and continuously refined. The most significant changes introduced in this phase were the development of various assessment

tools used to implement different types of assessment that would optimally address all facets of the team projects (Scott & van der Merwe, 2003).

The assessment strategy was based on the assessment approaches discussed in sections 2.3.3 and 3.4.6 of the literature survey. It revolved around principles of comprehensiveness, coherence, and continuity advocated by Pellegrino et al. (2001) and included elements of dynamic assessment, assessment of prior knowledge, the use of feedback, teaching for transfer, student self-assessment, and the evaluation of teaching, as proposed by Shepard (2000). The principle of comprehensiveness was achieved by addressing the different assessment needs posed by the different facets of the team projects and by giving students various ways to demonstrate their competence. Continuous assessment occurred throughout the course and regular and multiple assessment opportunities were used to measure students' progress over time (see Table 4.8). These opportunities were carefully chosen to ensure overall coherence, meaning that the different assessments should be compatible, complement one another and should align with the body of knowledge to be assessed. Assessment practices included formal summative assessments e.g. traditional exams; informal formative assessment to assist the students and the lecturers, e.g. self-assessment, peer-evaluation and course evaluation; and formal continuous assessment which took place over the duration of the course, e.g. dynamic assessment of interim deliverables (see Table 4.2). This balanced approach kept students informed and aided in the resolution of issues surrounding the objectivity and fairness of the assessment practices used for student team projects and other interventions related to this endeavour (Scott, 2006; Scott & van der Merwe, 2003).

Table 4.2: Assessment Instruments
(Scott, 2006)

Element of Assessment	Course component	Instrument
Formal Summative Assessment	Tests, Exams, Presentations, Sponsor Evaluations	Test, Exams, Scoring Rubrics
Formal Continuous Assessment	Interim Deliverables, Workshops and Milestones	Mark and Feedback Sheets
Informal Formative Assessment	Self-assessment, Peer-evaluation, Course Evaluation	Questionnaires and Checklists

In this and subsequent versions of the capstone course, scoring rubrics formed the backbone of the assessment instruments used; these were found to be the most effective way to align all the stakeholders on the course and to stimulate conversation. The use of rubrics is in line with moving towards a qualitative standards-orientated assessment model as advocated by Biggs (1993). It is the best way to limit bias and to convey to the students the standards against which they will be measured. Both analytical and holistic rubrics are used, depending on what is being assessed. Table 4.8 illustrates how various assessment instruments like exams, checklists, questionnaires, mark sheets and scoring rubrics are currently used during the course. Most of these items were introduced during this phase, with the exception of item 2 and items 7 to 11. Clear assessment procedures with associated timelines and/or deadlines were put in place for the assessment of all course deliverables, and all templates and course documents were collated in a course reader. Cohen et al. (2002) argue that due to the nature of groups and group learning, clarity on the assessment criteria is necessary for successful administration. It also gives students direction and a structure within which they can learn and grow.

A peer-evaluation process was added as a further refinement of the assessment approach in 2003 in order to recognise the individual contributions to team performance (Scott et al., 2005). Assigning the same grade to all group members implies equal effort which is often not the case. When assessing team projects, equal contribution by all group members cannot be assumed, and as stated by Cooke et al. (1997), the focus cannot be on the product alone. The use of peer assessments became essential to allow team members to voice their perceptions of their own contributions and those of the other members in the team (Holland & Feigenbaum, 1998); this approach can also be used to discourage social loafing, a term used to identify students who under-perform in project teams (Scott et al., 2005). A mid-year exam, introduced in 2003, helped to increase the weight of their individual contribution towards the final mark of each student. This exam comprised three parts: the first section tested students' learning and insight in their individual project, while a case study was provided to test the students' coding and UML skills in the other two sections.

Management processes: Most faculty members acted as project managers (PM) and provided guidance to their allocated project team(s) from the perspective of their

experience. They ensured that teams made satisfactory progress and that the scope of the individual projects was in accordance with the project specifications. Although project teams were required to manage their own work, they could contact their PM on a regular basis as deliverable review points approached and set up regular meetings at the PM's convenience to review the particular deliverable. PMs and other faculty members also assisted in evaluating the final project presentations. Project teams completed a team role document that listed the different roles and their responsible members, while a team contract formalised the commitment of the individual team members. Fourth year students with excellent technical skills assisted as tutors in workshops, marked workshop and tutorial exercises and manned hot-seats. A junior lecturer and a Masters student acted as quality managers. Lecturers followed an "open door" policy where students were encouraged to communicate via e-mails, text messaging and regular informal face-to-face meetings. The project delivery process was supported by Microsoft Project Web-Access Environment to facilitate planning and control.

Reflection-in-action and research to inform the process: Several significant changes marked this grounding of skills phase. A more focused approach was implemented to control the scope of the projects and to encourage teams to choose projects well suited to the specific theme of the year. Communication with the sponsors was improved and they were given the opportunity to evaluate the particular student team's conceptualisation of the business problem, their understanding of the requirements and the final product.

The EXPO provided a suitable platform to showcase the projects to industry and the wider public. Intense efforts were made to enhance the technical skills of students through the implementation of a coding framework, and mechanisms to test systems more systematically were introduced. Finally the comprehensive assessment approach that was implemented reassured students that they were rewarded fairly and also challenged them to develop more creative systems.

The above changes could not have happened without the underpinning of in-depth research and a reflective approach. During this time several empirical research studies were undertaken to understand, support and enhance the relevant processes. This ongoing reflection-in-action nurtured the construction and reconstruction of knowledge which in

turn influenced the development of the course and resulted in further publications and research. Table 4.3 provides summaries of the empirical research studies (S1-S8) and the relevant publications during this time are listed in Table 4.4. Some papers were initially presented at conferences and then later published in specific journals after making changes to the title and some content.

Table 4.3: Research Studies to Underpin the Grounding of Skills Phase

Study ID	Title of empirical research study	Year
S1	An Investigation into the Skills Alignment Between the Systems Development Industry and Students at UCT.	2001
S2	An Investigation into Systems Development Skills and Education at a Tertiary Level.	2002
S3	The Understanding, Feasibility and Use of Web Services in the South African Context.	2002
S4	The Alignment of Software Testing Skills and Procedures of the Information Systems Students at UCT with that of Industry Standards in South Africa.	2002
S5	Do Existing Web Application Testing Tools Lead to an Increased Degree of Successful Web Application Development in the South African Environment?	2003
S6	The Status of Software Testing in South Africa.	2003
S7	An Investigation into the Extent to Which the Systems Development Group Projects have Contributed Towards a Skills Transfer and Process Improvement Competencies Between Industry and the Students of UCT.	2004
S8	An Investigation into a Model which will Assist in the Formation of a Group Structure in Order to Optimise the Effectiveness of the Systems Development Group Projects.	2004

Although progress was made and significant changes were implemented in the third year capstone course during this phase, the need for an integrated capstone experience, fusing practical experiences with theoretical concepts to grow competence, became more pertinent. There were numerous reasons for this, the most important being that students could not always see the relevance of the project management principles in the capstone course, as it was not always easy to align the project management course's deliverables with those in the project course.

Despite the coding framework and step-by-step workshops used to develop a systems thinking approach, the attrition rates associated with programming still remained. Students felt that the learning they had to do to develop their own system was too vast; at the end of the series of workshops they needed to revisit individual workshops to get a deeper understanding of what was done and why. The constant changing of the development

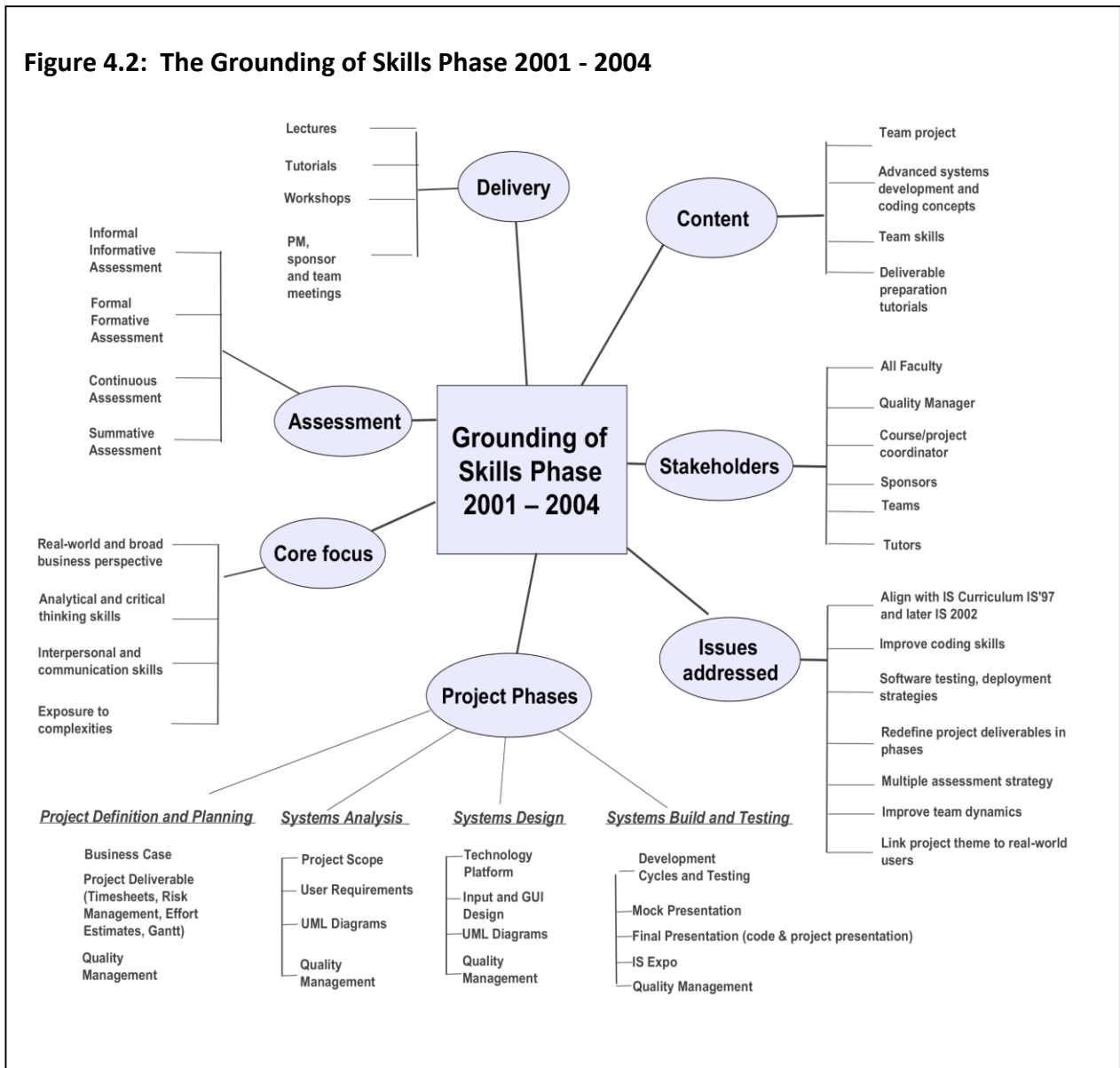
platform to stay current and keep up with the changing Microsoft environment did not simplify matters (see Table 4.5). Jenkins (2002, p. 53) argues that “if students struggle to learn something, it follows that this thing is for some reason difficult to learn.”

Table 4.4: Publications to Underpin the Grounding of Skills Phase

Study	Title of research paper	Conference	Journal
S1	The Skills Gap Observed Between IS Graduates and the Systems Development Industry (Scott et al., 2002).	C (2002)	-----
S4	The Alignment of Software Testing Skills of IS Students with Industry Practices (Scott, Zadirov, et al., 2004).	C (2003)	JITE (2004)
Reflection-in-action	Using Multiple Assessment Approaches to Enhance Objectivity and Student Learning (Scott & van der Merwe, 2003).	C (2003)	EJISE (2003)
S6	The Impact of the Adoption of Object-Oriented Testing Practices – A South African Perspective (Scott, Katovsky, et al., 2004).	C (2004)	----
Reflection-in-action	Systems Development Group Project: A Real-World Experience (Scott, 2006).	C (2004)	ISEDJ (2006)
Reflection-in-action	The Use of Peer Assessment as a Component of the Assessment Strategy used for IS Student Group Projects / Peer Assessment: A Complementary Instrument to Recognise Individual Contributions in IS Student Group Projects (Scott et al., 2005).	C (2004)	EJISE (2005)
S7	Skills Learnt During a Systems Development Course: Graduate Perceptions of Skills Transfer and Industry Alignment (Seymour et al., 2006).	C (2005)	ISEDJ (2006)
S8	Effectiveness of Self-selected Teams: A Systems Development Project Experience (Scott & Pollock, 2006).	C (2006)	IISIT (2006)

The effort required of students during the grounding of skills phase, as shown in Figure 4.2, succeeded in raising awareness of team activities, creating a solid skills base and guiding individuals to become team players. However, no in-depth enquiry into the underlying reasons for this was conducted and insufficient cognisance was taken of the students’ own perceptions. It also became evident that the lack of integration between the practice of systems development and the project management theory concepts should be addressed to give students a richer experience of how theory should inform practice. The individual components of the capstone course did not carry sufficient weight and created situations where some students could obtain marks they might not have deserved, due to social loafing in the team context.

Figure 4.2: The Grounding of Skills Phase 2001 - 2004



Source: Researcher’s own construct to reflect a visual representation of the discourse

In order to address some of the limitations experienced towards the end of the grounding of skills phase, the project course changed from a three-quarter year course to a two-semester course at the start of 2005. This newly created capstone course now included project management theory within the systems development project course.

Table 4.5: The Evolution of the Grounding of Skills Phase

	2001	2002	2003	2004
# of teams (4-5 members)	44	42	38	23
Dedicated coding lectures	☑	☑	☑	☑
Technical topics	☑	☑	---	---
Practical workshops	1 (SQL)	3 (SQL; ASP & OO)	7 workshops (Pilot system – Coding framework)	7 workshops (Pilot system of 2003 - refined)
Project presentations	☑	☑	☑	☑
Coding presentations	---	☑	☑	☑
Sponsor evaluation	Rough guidelines	Rough guidelines	☑ (rubrics)	☑ (rubrics)
Peer evaluation	---	---	☑	☑
Conflict resolution in teams	☑ (CCR)	☑ (CCR)	☑ consultant	☑ consultant
Mid-year exam/test	---	---	☑	☑
EXPO	---	☑	☑	☑
Course reader	---	---	---	☑
Software platform	VB 6 SQL 7	VB.NET SQL 2000	VB.NET SQL 2000; MSProject 2002; MSProject Web Access 2002	VB.NET 2003 SQL 2000; MSProject 2002; MSProject Web Access 2002

4.2.3 The Emergent Phase (2005 – 2009)

The initial challenge of the emergent phase was to align and integrate the concepts taught in the project management lectures more effectively with the project deliverables of the individual team projects. Although the grounding of skills phase provided a sound basis for the emergent phase, it was predominantly characterised by a constructivist approach; as such it sometimes focussed more on rigid process and control than on being “in touch with the deep internal processes of development as the driving force of meaning making and change” (Jordi, 2010, p. 14). To address this situation, the emergent phase was also characterised by an approach of progressive elaboration where continuous, step-by-step

enhancements were made to the course to take advantage of the dynamic process of learning through experience. As such, the word 'emergent' best describes this evolutionary characteristic where "problem interpretations, deliberations and actions unfold unpredictably" (Markus, Majchrzak, & Gasser, 2002, p. 182) in some cases. The following sections give an account of the main changes implemented in the capstone course over this period.

Curriculum design and course content: Although the IS2002 Model Curriculum (Gorgone et al., 2002) and The Guide to Undergraduate Degree Programmes in Computing (ComputingCurricula, 2005, 2004) still formed the core of the capstone course, several limitations that were experienced with these curricula, were addressed in the successive deliveries of the course from 2005 to 2009 (Scott, Brown, Pearce, & Weimann, 2009; Scott & van der Merwe, 2006).

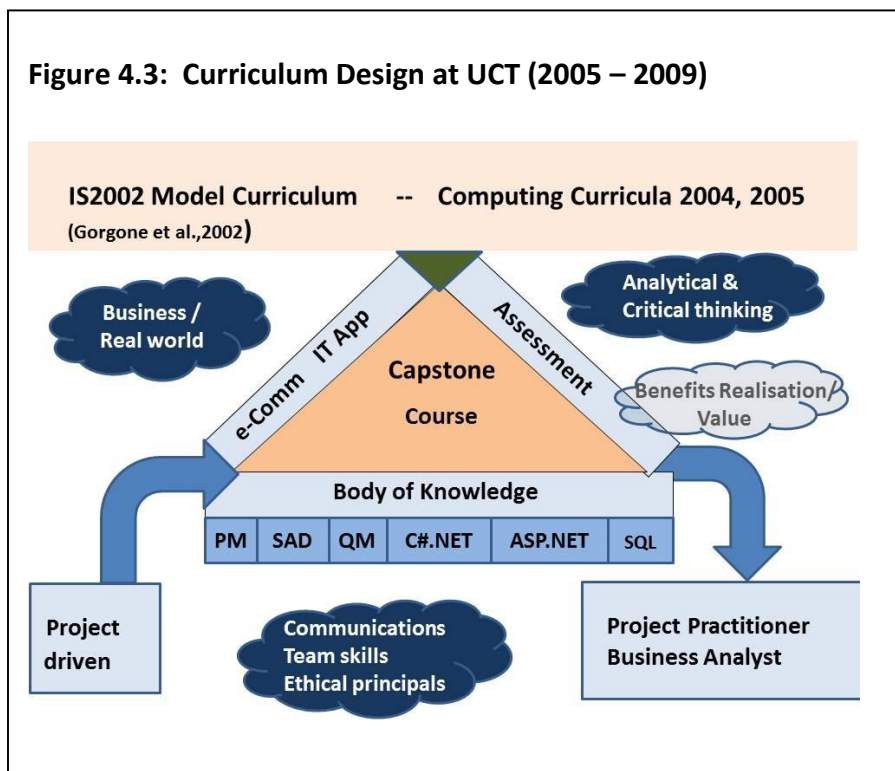
Most importantly, the design of these curricula largely ignored the complex reality of projects, the related social processes and their emotional aspects, and the value creation and reflective practices which could assist in re-evaluating the nature of projects and project management. It was crucial to develop a curriculum that would instil and stimulate a new mindset in the project practitioner (in this case the students) of being conscious of the multiple perspectives of projects and the interplay of project phenomena that would enable them to deal more effectively with the complexities involved as discussed in section 3.4.2 (Scott, Sewchurran, & van der Merwe, 2008). Winter and Szczepanek (2009, p. 1) confirm that it has become necessary to reject approaches like 'just do it', 'one best way' or 'follow the manual' and seek "instead to encourage a pragmatic and reflective approach based on consciously seeing projects from multiple perspectives". The capstone course evolved around the three main components of project management, project phenomena and project implementation to imbue IS majors with this particular mind-set. Each one of these components was revisited and refined to better contribute to an interactive and integrated environment that would foster IS competence and the development of skills to support an innovative professional career in business and ICT. The emphasis was to depict the manifestation of a real-life experience, where theory and practice are tightly coupled.

For IS practices such as project management, students first need to undergo a particular experience; and then they need to reflect upon that experience to extrapolate learning. This form of learning is important to new practitioners, for once students enter the world of practice, no matter how hard they try to apply theoretical criteria or use advanced analytic techniques, they confront technical, cultural, moral, and personal idiosyncrasies which defy categorisation. In this phase students are introduced to a form of reflection which requires them to construct meaning from their experiences and uncover and make explicit to themselves what was planned, and what has been observed or has been achieved in practice (Scott & Sewchurran, 2008). This reflective practice is instrumental to facilitate “a dialogue between bodily felt experiencing and cognitive formulation and expression of that experience” and results in a “process of mind-body integration” (Jordi, 2010, p. 13).

After 2006 the *project management* component was therefore redesigned to stimulate a lived experience on projects and create project practitioners, rather than providing students with only a theoretical body of knowledge (Scott et al., 2008). Although it still covered theoretical aspects of project management like the project life cycle, scope management, project planning, critical success factors, planning reference frameworks, project controls, estimating techniques, risks management, communication management, it also emphasised an alternative approach with a focus on mediating and understanding *project phenomena*. For example, the involvement and role of the different stakeholders in this environment were emphasised and not just that of the project manager. Students were made aware of the intricacies of interpersonal understanding, relationships and collaboration through a conceptual and critical reading exercise. Carefully selected papers (readers) introduced students to important concepts when developing projects and working in teams. The critical analysis of and reflection upon these readings in the context of project experiences promoted learning and sense making, and allowed students to appreciate that projects do not always have an existing structure and that the implementation is neither linear nor sequential (Sewchurran & Scott, 2009; Scott & Sewchurran, 2008). For example, they became acutely aware of the complex environment of teamwork and the role of effective communication in developing necessary life skills. One student summarised this aptly by stating: “... One vital learning experience I have had over the duration of the project thus far is about communication”. The dialogue thus created, reflected a conscious effort to create

an environment where students become aware of the “importance of the context of experience” (Cicmil, 2006, p. 35). The above approach provided a sound basis for *implementation* with continuous feedback into the practical component of the course.

Figure 4.3 provides a visual representation of the integrated environment of the capstone course at the Department of Information Systems at UCT towards the end of the emerging phase. It shows the underpinning body of knowledge, the external influences and the major outcomes of the course. The effective delivery of the course content in this context depended on carefully planned interventions to utilise and encourage action learning and to promote reflection.



Source: Researcher’s own construct

(Informed by Computing Curricula, 2005, 2004; Gorgone et al., 2002)

Team selection: Due to the smaller class size, students were encouraged to select teams with only 4 members. We believed that these teams could still achieve an adequate mix of skills and personalities while allowing a fair spread of the required work. It is relevant to note that the disparity between the demand and supply of IT professionals is currently a global phenomenon and is the cause of great concern. For example, during 2000 – 2005 universities in the United States experienced a 50% drop in student enrolments and despite

the current growth in IT career opportunities, student numbers have not yet increased significantly (Hunsinger, Land, & Chen, 2010; Saunders & Hunsinger, 2008).

Project selection: In addition to students being allowed to find their own project according to the specific theme, it often happened that a pool of project requests already existed at the onset of the course. These projects would typically be proposals received from the community or from industry partners suitable for the third year. Student teams were allowed to tender for those projects they found interesting; and a project could then be allocated to a specific team on merit.

Management processes: The entire process of the capstone course was increasingly managed as a coherent, deliberately chosen set of activities or interventions. All processes were still carefully monitored and adherence to deadlines was maintained. With the declining number of students, the three lecturers participating on the course acted as project managers and assisted in most of the project management tutorials and the marking of documentation.

An electronic learning management system provided an additional platform for communication through announcements, chats, and course evaluations, and also acted as a repository for all online course material and marks. In addition most project teams created their own project site as a repository for all project resources and as a collaborative environment for the team. A special electronic hand-in facility was used to ensure that all workshop deliverables and tutorials were handed in on time.

Enhancing technical skills: The coding framework of the grounding of skills phase was again implemented using the step-by-step workshops of the pilot system to guide the system development efforts (Rogerson & Scott, 2010; Scott, 2008). Although it had a positive impact on the quality of the final products and guided students through the *Novice* and probably also the *Advanced Beginner* stages of skills development by Dreyfus (2001) (as described in section 2.2.3), the *hand holding* provided by this approach seemed to stifle innovation and creativity among students and they struggled to transcend and commence with the development of their projects autonomously (Scott, 2008). In 2005 a one-week workshop was introduced at the start of the university mid-year break to help *kick-start* the

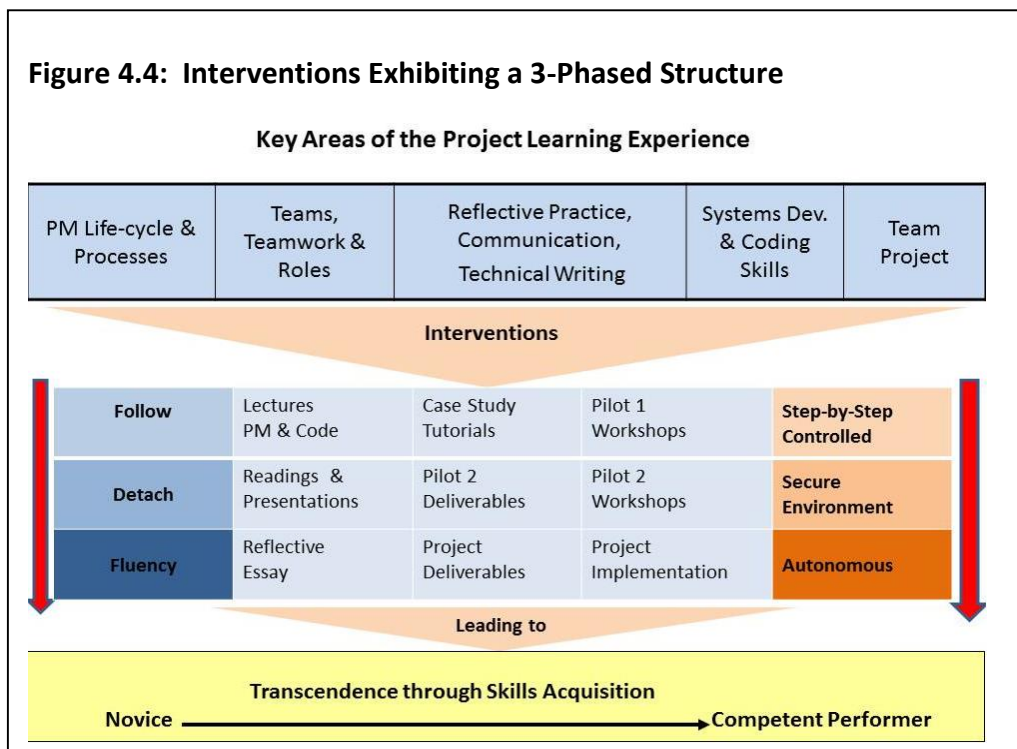
coding activities; however, this was only partially successful and led to the introduction of a second pilot system. To implement this, four workshops relating to the second case study were successively scheduled after every second workshop of the first pilot system. The primary objective was that students had to master the concepts learned in the previous two workshops of the first pilot system, before they attempted a particular workshop of the second pilot system. Almost no scaffolding and hand holding were provided during the workshops for the second case study, and students were challenged to demonstrate their own understanding and expertise. With this second pilot system in place, the students followed an approach that aligned with Cockburn's (2002) three stages of development namely, following, detaching and fluency. The step-by-step process of the first pilot system represented the following phase; the second pilot system allowed students to develop a better understanding and begin to detach, while the development phase of the team project challenged students to become fluent.

Teaching for Integration and Interaction: The teaching and learning activities still involved lectures, tutorials, workshops in computer labs, and student team presentations; one-on-one or team discussions, facilitation and mentoring, and interactions with industry and sponsors; various assessment opportunities; as well as the development and finally the delivery of a shrink-wrapped product at the end of the course. The body of knowledge of the course increased significantly with the inclusion of the project management section. Five key areas within the new body of knowledge were identified: the project management life cycle and processes; teams, teamwork and roles; communication, reflection and technical writing; software skills; and the team project. All of these areas resided under the three main components of project management, project phenomena and implementation as shown in Table 4.7.

It was critical that the integration and alignment of the different activities in this diverse and complex environment were well thought through to ensure the effective delivery of the course. As a result ongoing changes were made during this period, which happened on two dimensions. The first dimension mostly involved efforts that were intended to align and integrate elements of the three main components of the course. For example, elements of the project management component were aligned with elements of the capstone project and project deliverables. The topics for case studies and discussions were chosen

accordingly. This meant that project management lectures, discussions and tutorials that dealt with project definition and planning were synchronised with project activities like identifying and finding a project, initial sponsor liaisons, interim deliverables related to the business case and then finally the business case hand-in as a milestone deliverable. Similarly, interactions with industry (like mentoring) and concepts addressed in dedicated lectures and tutorials to enhance software skills were aligned with coding workshops.

The second dimension involved the redesign of related interventions in terms of growing task complexity and autonomy. This insight was gained with the successful restructuring of the coding workshops according to Cockburn’s (2002) three stages of development of following, detaching, and fluency. The redesign of the interventions in this way contributed to tighter integration and coherence amongst the elements of the capstone course. Figure 4.4 provides an illustration of the 3-phased structure of the interventions, whereas Table 4.6 provides the schedule as implemented in the capstone course.



Source: Researcher’s own construct

(Informed by sections 2.2.3, 3.4 & 3.5 and in particular by Cockburn, 2002; Dreyfus & Dreyfus, 1986)

Table 4.6: Schedule and Teaching Methods

(Adapted from Scott et al., 2008)

Key Areas	Component	Teaching and Learning Activities/ Contact Time
Project Management Life cycle and Processes	Project Management Theory	+/-14 x 45-minute lectures
Communication and Teamwork	<ul style="list-style-type: none"> • Conceptual Readings • Reflection and Reflexive Learning • Student Presentations 	(6-8) x 45-minute group presentations and discussions 2 x 120-minute tutorials
Project Management Practice; Systems Analysis and Design	<ul style="list-style-type: none"> • Case Study Experiences 	1 x 120-minute real-life case presentations 4 x 45-minute Pilot 2 deliverable discussions 4 x 120-minute tutorials
Software Skills	<ul style="list-style-type: none"> • Advanced Coding Concepts • 2 Pilot Projects 	+/- 10 x 45-minute lectures 11 x 4-hour coding workshops +/- 4 x 120-minute tutorials
Team Project	<ul style="list-style-type: none"> • Interaction with Industry Sponsor • Project Management Deliverables • Analysis and Design Deliverables • Formal Presentations (Code and Project) 	February – September Facilitation, meetings (weekly/bi-weekly) and evaluations 1 x 90-minute power-point and live project presentation 1 x 60-minute code presentation

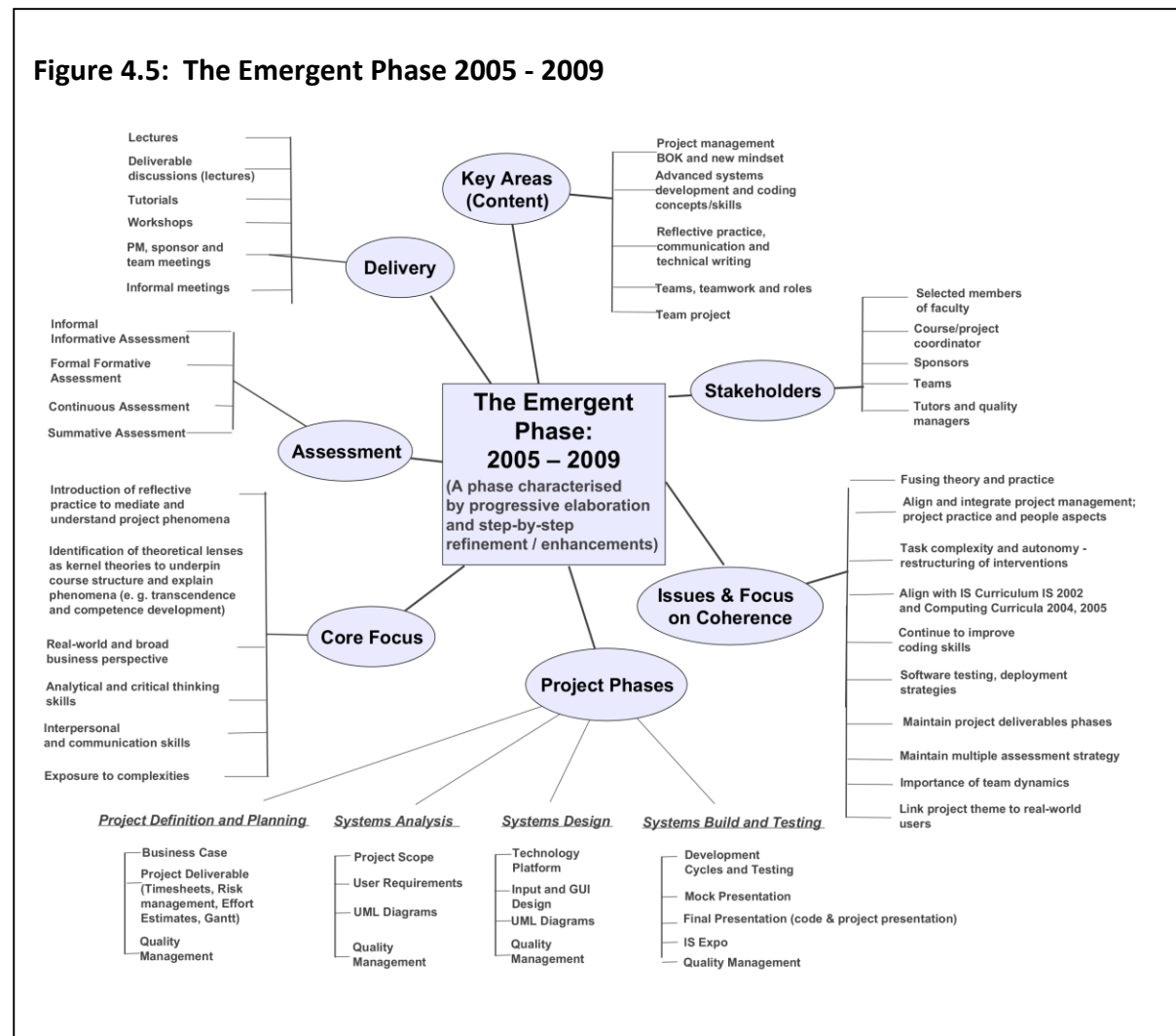
As mentioned in the previous paragraphs, the project management component of this phase was transformed to provide students with a more appropriate discourse in project practice. This approach created a dynamic and interactive environment that extended beyond the teaching of best practice and enabled students to negotiate their project experiences. Course readers provided students with a range of concepts, analogies and metaphors that not only aided their comprehension, but also gave them the vocabulary to articulate and make sense of their feelings and emotions as well as those of their team members, during project experiences and thereafter. As one student commented: “we are terribly non-compliant to team dynamics. We have come to terms with the tendencies, values of each other and accepted that there is merit, or accepted to continue working harmoniously” or “I sometimes played this role of devil’s advocate ...”. As such this discourse became a powerful tool that students readily adopted and used for reflection as well for conscious reflection-in-action (see section 2.3.2).

Table 4.7: Assessment Strategy

(Adapted from Scott & van der Merwe, 2006; Scott & van der Merwe, 2003)

	Component	Occurrence	Key assessment strategy (Shepard, 2000)	Group / Individual	Contribute to final mark
1	Mid-year exam (PM and Proj A and D)	Once - 3hr exam	Prior Knowledge	Individual	Yes (30%)
2	End of year exam (Code)	Once - 3hr exam	Prior Knowledge	Individual	Yes (10%)
3	Interim deliverables	7 - Bi-weekly (1 st semester)	Dynamic Feedback, Explicit Criteria	Team	Yes (4%)
4	PM meetings	Bi-weekly (1 st semester)	Feedback	Team	No
5	Milestone deliverables	3 - Approx every 6 weeks	Dynamic Feedback, Explicit Criteria; Rubrics	Team	Yes (10%)
6	Technical workshops and Tutorials	*Weekly (1 st semester)	Prior Knowledge, Teaching for Transcendence	Individual	Yes (4%)
7	Mentorship programme	*5 topics - 1/team (1 st semester)	Teaching for Transcendence, Evaluation of Sessions	Team	No
8	Technical topic presentations (Only done in 2001,2002 & 2010)	1 Presentation/ team	Teaching for Transcendence, Dynamic Feedback, Scoring Rubric.	Team	Yes
9	PM and Reflective Tutorials (Case Study or Readings)	*Weekly (1st semester)	Prior Knowledge, Teaching for Transcendence	Team	Yes (5%)
10	PM presentations	1 Presentation/ team	Teaching for Transcendence, Dynamic Feedback, Rubrics	Team	Yes (2%)
11	Reflexive essay	Once (1 st semester)	Student Self-assessment, Teaching for Transcendence	Individual	Yes (3%)
12	Weekly updates	Weekly (2 nd semester)	Feedback, Student Self-assessment	Team	No
13	Sponsor meetings	When required	Feedback	Team	No
14	Sponsor evaluations	Twice (1 st & 2 nd semester)	Dynamic Feedback, Rubrics	Team	Yes (2%)
15	Course evaluation	Twice (1 st & 2 nd semester)	Evaluation of Teaching	Individual	No
16	Peer reviews (Self and team assessment)	When required and part of final assess	Student Self-assessment, Rubrics	Individual	Yes (Final Assess)
17	"Mock" Presentation (part of interim deliverables)	Once (2 nd semester)	Dynamic Feedback Explicit Criteria, Rubrics	Team	Yes
18	Final project presentation	Once – 2 hour	Explicit Criteria, Rubrics	Team	Yes (20%)
19	Final code review	Once – 1 hour	Explicit Criteria, Rubrics	Team	Yes (10%)
20	IS EXPO (schools and industry)	Once (Year-end)	Dynamic Feedback	Team	No

Assessment strategy: The assessment strategy introduced in the grounding of skills phase was maintained and enhanced during this phase. The focus in this phase was to introduce a larger component of individual assessment by introducing two opportunities for summative assessment (Table 4.7; items 1 & 2). During the mid-year project management exam the students’ understanding of the project management body of knowledge and project phenomena were assessed, as well as their understanding of their specific business problem, the context and the requirements. In the coding exam the emphasis was not as much on writing exact code, as on assessing students’ comprehension of involved and complex business processes and their ability to translate these processes into logical and concise code-related algorithms.



Source: Researcher’s own construct to reflect a visual representation of the discourse

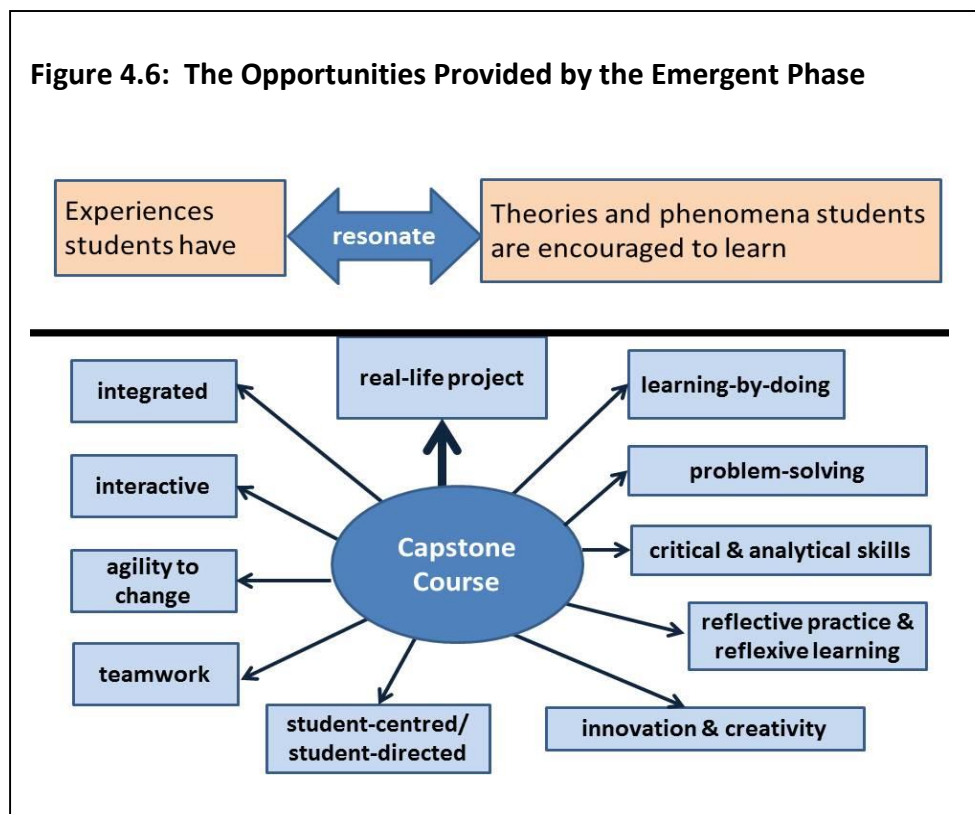
An effort was also made to align and integrate different assessment opportunities for the various components of the course. Items 7, 9, 10 and 11 (Table 4.7) specifically addressed the project management theory concepts, reflection and project phenomena that were regarded as crucial to guide the practice of the development process. Copies of the relevant assessment instruments and accompanying documentation were published on the electronic learning management system well in advance, ensuring that students were aware of the assessment criteria and associated standards. This included a marks distribution table that reflected the weighted contribution of the different components of the course to the final mark.

In summary: During the successive deliveries of the capstone course in the emergent phase, an alternative approach was constructed “to equip students with an understanding of how communication occurs, how competences are acquired, and how to understand the influences of power and agency on themselves and others in a typical information systems project context” (Sewchurran, 2008, p. 1).

This was essentially done by embedding deliberate opportunities for reflection within the set of interventions that formed part of the course. These interventions were intended to achieve three objectives: firstly, they were structured in a logical and consistent way to support Cockburn’s (2002) concepts of follow, detach and fluency; and secondly, they were intended to make the project experience more true to life and thus impart reflexive learning skills. Thirdly, the intention was that these interventions should nurture growth and transcendence following Dreyfus’ taxonomy of skills acquisition as discussed in section 2.2.3 (Dreyfus, 2004; Dreyfus & Dreyfus, 1980). The transcendence and growth that students experienced are best illustrated using the words of one of the students:

My weaknesses are complemented by others’ strengths, and through this I can discover my weaknesses, build my strengths and emotional intelligence through working in a team setting. Walking away from the project without realising and documenting the growth experience would inhibit future growth because wisdom and mistakes from past experiences haven’t been fully understood (Reflexive essay (RE01), 2008).

It was also necessary to investigate how these interventions could be organised to nurture IS competence and lifelong learning. It was only towards the end of this stage that important concepts contributing to the students' experiences emerged, as illustrated in Figure 4.6. The theoretical lens for "embodied cognition" of Maturana and Varela (1987) was also identified to make sense of the concepts of competence and lifelong learning. Figure 4.5 extends Figures 4.1 and 4.2 and provides a summary of the main elements of the emergent phase.



Source: Researcher's own construct informed by sections 3.4 and 3.5

The evolution of the emergent phase has thus been driven by an ongoing process of reflection and enquiry as is evident from the empirical research studies listed in Table 4.8 and the publications shown in

Table 4.9. The cause and effect of the contributing or foundational theories that emerged through this process are shown in Table 4.10. These theories are also referred to as kernel theories by authors like Walls, Widmeyer and El Sawy (2004) and Kuechler and Vaishnavi (2008) and will be discussed in more depth in Chapter 5.

Table 4.8: Research Studies to Underpin the Emergent Phase

Study ID	Title of empirical research study	Year
S9	An Assessment of the Implications of Teaching Software Development without Adhering to Formal Industry Standards.	2006
S10	Ready to Build? A Longitudinal Study to Monitor the Progress of Systems Development Project Teams and Gauging their Readiness to Begin the Building Phase.	2007
S11	An Investigation into Uncovering the Critical Core of Information Systems Skills	2008
S12	The Fear Factor: A Phenomenological Investigation into IS Students' Experiences when Learning Programming in a Tertiary Institution.	2009

Table 4.9: Publications to Underpin the Emergent Phase

Study	Title of research paper	Conference	Journal
Reflection-in-action	Reflecting the Body of Knowledge in Both Curriculum and Assessment: A Case of IS Student Group Projects (Scott & van der Merwe, 2006).	C (2006)	----
Collaborative	Information technology team projects in higher education: An international viewpoint (Lynch et al., 2007).	C (2007)	JITE (2007)
Reflection-in-action	From Requirements to Code: Issues and Learning in IS Students' Systems Development Projects (Scott, 2008).	C (2007)	JITE-IIP (2008)
Reflection-in-action	Windows to the Real World – A Comparison of IS Project Management Student Learning (Scott et al., 2008).	C (2008)	----
Reflection-in-action	Reflection-in-action: Using Experience to Reconstruct Meaning in a Learning Environment (Scott & Sewchurran, 2008).	C (2008)	----
S9	Ensuring Success and Quality Through the Use of Standards in Team Projects: Students' Perceptions (Scott et al., 2009).	C (2009)	Chapter (2009)
Reflection-in-action	Learning and Making Sense of Project Phenomena in Information Systems Projects (Sewchurran & Scott, 2009).	C (2009)	
S12	The Fear Factor: How it Affects Students Learning to Program in a Tertiary Environment (Rogerson & Scott, 2010).	C(2010)	JITE (2010)

Table 4.10: Kernel Theories Identified During the Emergent Phase (see section 2.2.3)

Kernel Theory	Cause	Effect
Stages of Behaviour: follow, detach and fluency (Cockburn, 2002)	This theory can be used to gauge the level of complexity of a task.	The structure of each intervention determines its desired effect for a specific level of competency.
	This theory can be used as a theoretical lens to understand an individual's behaviour when performing a task.	A sense-making tool to direct and explain the choice of an intervention at the correct level of complexity for a particular stage of behaviour.
Stages of Skills Acquisition (McPherson, 2005; Dreyfus, 2004; Dreyfus & Dreyfus, 1980)	This theory can serve as a lens to illuminate how learning and teaching can facilitate skilful coping to nurture a student's transcendence through different stages of skills acquisition.	Aids the appropriate explanation and the identification of the level of skills for a particular individual.
The Theory of Embodied Cognition. (Maturana & Varela, 1987)	A theory of knowledge can be used as a theoretical lens to "show how knowing generates the explanation of knowing", a learning-by-doing paradigm.	A tool to gauge competence: to explain the construction and internalising of knowledge; the ability to use the correct knowledge and act accordingly in a specific situation; the ability of students to engage in their own learning; embodied vocabulary.

4.3 Summary and Anticipating the Next Phase

This chapter provided a broad historic overview of the different implementations of the capstone course over the past decade, with the most significant changes happening during the emergent phase. The main concern has been to understand and find ways of empowering IS majors to become competent lifelong learners who will fulfil their role in industry as innovative professionals. "All human beings - not only professional practitioners - need to become competent in taking action and simultaneously reflecting on this action to learn from it" (Argyris & Schön, 1974, p. 4). In the emergent phase it became apparent that specific theories can be used very effectively to guide reflection and to structure interventions with the potential of building a pedagogy that will aid the development of reflexive learners who will attain a higher level of competency at a faster rate.

In the special case of the capstone course we are thus looking towards developing a theory that will prescribe how graduate students can be educated to cope with and understand the complex world of lived experience from the perspective of those who live in it. As mentioned in Chapter 3 (section 3.4), it seems natural that a pedagogy to nurture students for professional practice should emerge from a theory that is embedded within a science of design.

The next chapter will discuss the design science research methodology and will illustrate how it suffices to provide a very appropriate research framework for the development of a capstone course and the accompanying theory.

5 The Science of Design

Everyone designs who devises courses of action aimed at changing existing situations into preferred ones.
(Simon, 1969, p. 55)

5.1 Introduction

There is general consensus that the concept of design science originated from a chapter in Herbert Simon's (1969, p. 55) book, *The Sciences of the Artificial*. In this chapter he argues that design, as the "intellectual activity that produces material artefacts", is at the core of all professional practice, and is of no less significance than study areas in the natural or behavioural sciences. Venable (2006, p. 184) concurs that "the conduct of Design Research provides an excellent opportunity for the IS field to increase its relevance to practice in industry".

This chapter describes the methodology to be followed in this research study. In the first section the chosen research paradigm is described both in terms of the design research methods in education and those in the humanities enriched design research paradigm. This is followed by an explanation of the two-step process used to express design knowledge as theory. These discussions provide an important platform and a context within which to explain the research methodology for a capstone course that is presented in the subsequent sections. It includes framing the research, outlining the steps in the research process and giving an account of the two-step theory building process. The design evaluation methods, the section that describes the 'making of data' and the data analysis section follow after this. The chapter concludes with a brief summary of the research methodology.

5.2 Building Theory in the Sciences of the Artificial

When faced with complex problems, we often have to settle for a satisficing solution: a solution that will be the best alternative amongst those currently available. In cases where no obvious alternatives exist, we may need to question our reasoning and look towards new

ways of synthesising and constructing solutions (Simon, 1969). Using Simon's terminology, we realise that "no one in his right mind ... no one, will settle for good or better if he can have the best"; nevertheless "in the real world we usually do not have a choice between satisfactory and optimal solutions, for we only rarely have a method of finding the optimum" (Simon, 1969, p. 64).

Gregor and Jones (2007) concur that although theories for design and action in IS are often not recognised as theories, they remain highly influential. For this reason Gregor (2009, p. 1) extends Simon's (1969) quest for a science of design to "a critical investigation of how theorising in Information Technology disciplines should occur". The profound significance that design work and design knowledge have for both research and practice in IS cannot be ignored. For example, taking a perspective relevant to this study, these theories can be used to prescribe the architecture of various applications in an IS curriculum that can be very useful to practitioners working in the field (Gregor & Jones, 2007).

In the real world,

Information systems and the organisations they support are complex, artificial, and purposefully designed. They are composed of people, structures, technologies and work systems. Much of the work performed ... deals with design – the purposeful organisation of resources to accomplish a goal (Hevner et al., 2004, p. 78).

Section 3.1 of this study refers to Roode's (1993) claim that the IS discipline involves the study of information and information systems in a social setting, as well as the effects that this interaction has on the total system comprising people, technology, organisations and society. The rich phenomena that emerge as a result of this interaction have great significance for IS research (Cole, Purao, Rossi, & Sein, 2005). I have also previously alluded to the dualistic approach where the focus is on both people and technology. According to Hevner et al. (2004, p. 75) this approach requires knowledge from the two complementary but distinct paradigms of behavioural science and design science. "The behavioural science paradigm seeks to develop and verify theories that explain or predict human or organisational behaviour", whereas "the design science paradigm seeks to extend the

boundaries of human capabilities by creating new and innovative artefacts” that will address important and relevant problems not previously amenable to computational approaches. In environments that must take into account both actions and senses, it is not always possible to simply assemble problem solutions from components; in most cases it is necessary to search for an effective solution by evaluating and comparing alternatives, or by searching for new alternatives where none exist.

One such persistent problem is that of preparing students for professional practice. Despite many attempts over the past decades, the arguments presented in section 3.3 show that this challenge still remains. This research is therefore about the quest to design, develop and implement a capstone course as a coherent practice (both flexible and efficient), underpinned by a design science theory about this practice, in order to extend the capabilities of IS majors to such an extent that they become empowered. In the humanities-enriched environment of information systems (Kroeze et al., 2011), it is apparent that a research approach for such a study will have to combine both the behavioural science and design science paradigms. The world we live in, in this case the IS environment, comprises man-made artefacts.

The activity of building theory in such a world is thus a research endeavour and deeply embedded in the sciences of the artificial. In the next sections I first provide motivation from the literature for design science as a research paradigm. This is followed by a discussion on how research can be conducted within this paradigm.

5.2.1 Design Science as Research Paradigm

Guba and Lincoln (1994, p. 107) refer to a paradigm as a “basic belief system”, which has to be accepted on faith as no real proof exists for the “ultimate truthfulness” of a specific paradigm. It provides a framework for conducting research as it deals with first principles and represents a perspective that is firmly rooted in a particular scientific discipline (Burrell & Morgan, 1979). In Kuhn’s theory a paradigm can be described as “a package of ideas and methods, which, when combined make up both a view of the world and a way of doing science” (as cited in Godfrey-Smith, 2003, p. 77). This definition has given rise to design science being seen as a research paradigm that involves its own particular elements of the philosophy of science (Baskerville, 2008), since the underlying world view revolves around

ideas about the creation of innovative artefacts as well as applicable methods for developing and using these artefacts. Similarly, Vaishnavi and Kuechler (2004, p. 1) describe design science research (DSR) as “yet another lens or set of analytical techniques and perspectives (complementing the Positivist and Interpretive perspectives) for performing research in IS”. Fischer (2011) on the other hand, contends that due to the immaturity of IS design science research (ISDSR) there may not yet be consensus amongst researchers on the fundamental concepts of the field and hence design science may still be in a pre-paradigmatic phase.

It is agreed that design science comprises more than artefacts, although the artefact is perceived as the central element in design science. What exactly the artefact comprises, is still highly contested. For example, Orlikowski and Iacono (2001) call the IT artefact the “core subject matter” of the IS field. Hevner et al. (2004) and March and Smith (1995) on the other hand, assert that an IT artefact is not simply the instantiation of some hardware or software entity (implemented and prototype systems), but also encompasses related constructs (vocabulary and symbols), models (abstractions and representations) and/or methods (algorithms and practices) that are instrumental in the development and use of information systems. A more holistic definition by Gregor (2009) states that artefacts are complex systems that involve both technical and social components, which can be physical or abstract.

Nevertheless, there is consensus that “design science has to do with the systematic creation of knowledge about, and with design” (Baskerville, 2008, p. 441). Hevner et al. (2004) call it an important dichotomy of both a process and a set of activities, the world as being acted upon (processes) and sensed (artefacts). In the field of design science, first principles therefore involve the purposeful “creation of artefacts and the introduction of those artefacts into otherwise natural settings”, and as such, design science is firmly rooted in the Sciences of the Artificial (Baskerville, 2008, p. 442; Hevner et al., 2004). For this reason, and because it also allows for theory development (Gregor & Jones, 2007), DSR is seen as the most appropriate vehicle for this research, despite the tension that exists amongst researchers about what exactly is meant by an artefact.

In this study the capstone course, as an artefact, will be perceived as a particular instantiation of a theory to be developed for a coherent practice. This aligns with Gregor and Jones' (2007, p. 320) argument that "a design theory is something in the abstract world of man-made things ... a theory instantiated would have a physical existence in the real world" that would not exist "without human intervention" (Gregor, 2006, p. 619). The implications that these statements have for the instantiation of a capstone course and the development of the accompanied theory will be discussed in greater detail in section 5.3.

5.2.2 Design Research in Education

In education, design science research often designated as just 'design research', has been associated with the development of curricular products, interventions strategies or software tools (Middleton et al., 2008). In many cases the theory of design from the engineering sciences is employed as a useful analogy for this kind of research in education. In these cases the focus is often on conducting design experiments that would typical include three phases namely, preparing an experiment, experimenting to support learning and then finally conducting a retrospective analysis on the data generated during the experiment (Cobb & Gravemeijer, 2008). Design-based research, in addition to design research emphasises the "long term projects in single settings and compelling comparisons of innovations and collaborations between researchers and teachers" (Juuti & Lavonen, 2006, p. 54). Juuti and Lavonen (2006) further argue that these research projects would typically produce artefacts using an iterative process while at the same time offering new educational knowledge to teach, learn and design innovations. In their 'compleat' design experiment Middleton et al. (2008) propose a six phase cycle for their research process. These phases are congruent with the steps in the research cycle used by Hevner et al. (2004) and Kuechler and Vaishnavi (2008) that was adapted for this research study (see Figure 5.1).

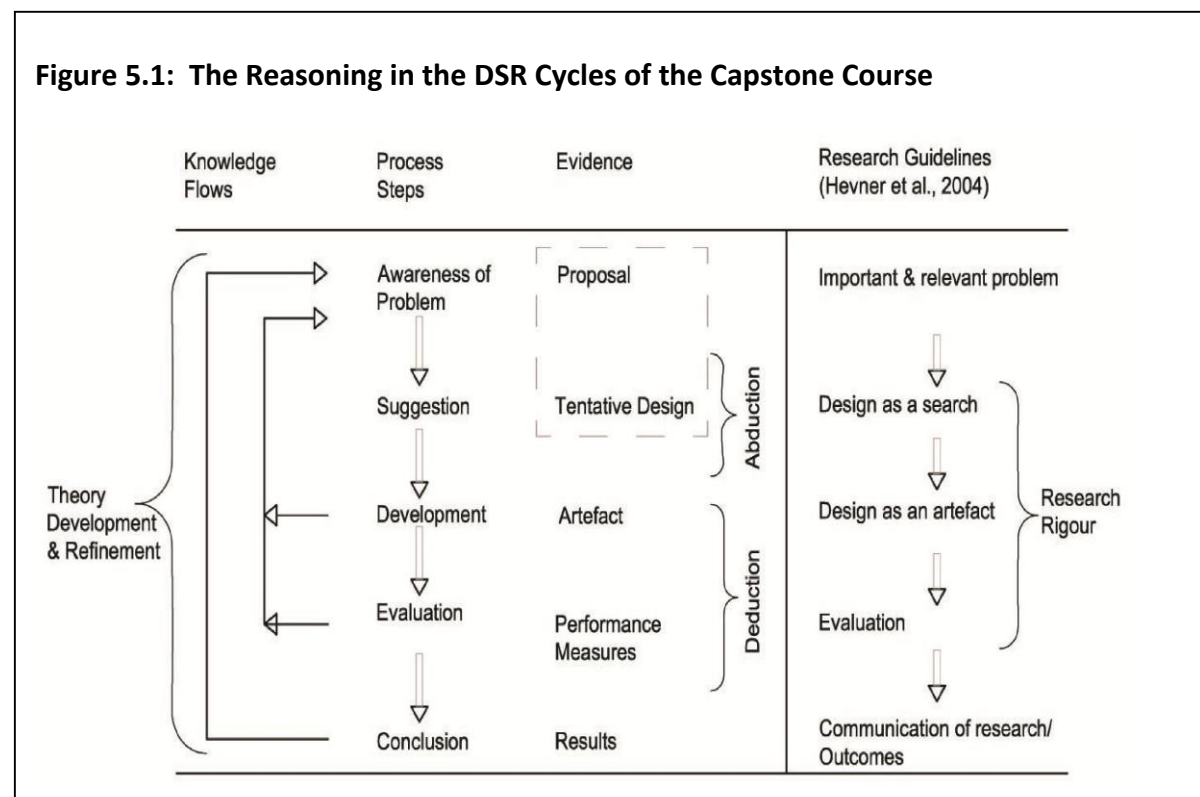
5.2.3 Humanities Enriched Design Science Research

Fischer (2011) identifies three key criteria that uniquely exhibit the fundamental aspects of ISDSR and thus delineate ISDSR from other types of IS research. These are utility and problem, normative theory, and the artefact and its theory components. The first criterion concerning *utility and problem* indicates that design science is fundamentally a solution-oriented or problem-solving paradigm (Fischer, 2011). The problems addressed must be

relevant and seek to create artefacts as innovations that encompass “ideas, practices, technical capabilities, and products through which analysis, implementation, management and use of information systems can be effectively and efficiently accomplished” (Hevner et al., 2004, p. 83). Secondly, ISDSR develops *normative theories*: theories for design and action (Gregor, 2009, 2006; Markus et al., 2002). These theories are mainly prescriptive (how-to) theories rather than descriptive, explanatory and predictive (Gregor, 2006; Hevner et al., 2004). Baskerville (2008) as well Gregor and Jones (2007) are in agreement that these normative theories should include explanatory components. This is especially true with regard to the multi-paradigmatic nature of the IS community (Vaishnavi & Kuechler, 2004) and the kernel theories that form part of the ISDSR theory, although they are obtained from other paradigms; the term ‘kernel theory’ is often applied to specific theories used to aid the development of an artefact or to build a design theory itself. The third criterion relates to *the development of artefact types or theory components*. The artefact topology proposed by March and Smith (1995) that differentiates between constructs, models, methods and instantiations seems to be widely accepted (Chatterjee, Rothenberger, Tuunanen, & Peffers, 2007; Hevner et al., 2004). In addition, since ISDSR must pass the tests of both science and practice (Markus et al., 2002) it should include theory in the development of the artefact and make a theory contribution (Cole et al., 2005). These theories will advise design solutions, govern design requirements (Kuechler & Vaishnavi, 2008; Walls, Widmeyer, & El Sawy, 2004, 1992), enable refinement or further development (Simon, 1969) and provide theoretical grounding for the artefact (GoldKuhl, 2004). They are often taken from reference disciplines and act as foundational theory (Hevner et al., 2004) or kernel theories (Kuechler & Vaishnavi, 2008) in the ISDSR.

To ensure the credibility of a research endeavour and to conduct, evaluate and present the research effectively, it is incumbent on IS researchers and for that matter IS researchers in education, to formulate clear boundaries of DSR within the IS discipline and to develop a comprehensive set of guidelines to understand, execute and evaluate good DSR (Hevner et al., 2004). To this end Hevner et al. (2004, p. 79) suggest a conceptual framework with three components which was adapted for the purpose of this research (illustrated in Figure 5.3) and will be referred to as a three-tier framework. The first or *environment tier* frames the research activities by defining the problem space, identifying the phenomena of interest

and assessing the needs. This problem setting phase as Schön (1983) calls it, is important to establish the *relevance* of the research. The second or *IS research and education* tier exhibits the interplay between behavioural science and design science. The behavioural science research component has to do with the development and justification of theories to explain or predict phenomena related to the identified need. The DSR component has to do with the building and evaluating of artefacts designed to meet that need. DSR is thus of a pragmatic nature (Hevner, 2007; Van Aken, 2005) and according to Cole et al. (2005) truth and utility for a pragmatist are seen as indistinguishable. The goal of behavioural science research is truth, whereas that of DSR is utility – “truth informs design and utility informs theory” (Hevner et al., 2004, p. 80). This constitutes an iterative process that will refine the theory and re-assess the artefact. The third or *knowledge base* tier provides the raw materials in terms of foundational knowledge from prior research or reference disciplines (Hevner et al., 2004). This can include, for example, foundational or kernel theories, constructs, models and methods that can be used in the development/build phase; it can also offer methodologies that can be used to justify and evaluate the research endeavour.



(Adapted from Kuechler & Vaishnavi, 2008; Vaishnavi & Kuechler, 2004)

Rigour is achieved in the extent to which the foundational material and the methodologies provide justification and validation. Hevner (2007, p. 91) notes that “it is the synergy between relevance and rigour and the contribution along both the relevance and the rigour cycle that define good design science research”. This three-tier framework serves to define the boundaries of this research in terms of the phenomena of interests, and activities around these phenomena; the building and evaluating of the artefacts (both theory and capstone course); and the foundational knowledge such as the kernel theories that contribute to the rigour of the research process (see Figure 5.3).

Hevner et al. (2004) identify seven guidelines for conducting research within the boundaries of this framework. In response to an important and relevant problem (guideline 2), DSR must produce a viable artefact (guideline 1). Extensive and rigorous evaluation of this artefact is necessary (guideline 3) and the resultant contributions (theoretical and practical) must be properly verified (guideline 4). In this respect the application of rigorous methods in the construction and evaluation of the artefact and the verification of the research contributions are vital (guideline 5). Simon (1969, p. 69) argues that solutions to design problems “are sequences of actions that lead to possible worlds satisfying specific constraints”. In a world that includes both actions and senses, as noted in the beginning of this chapter, problem solutions cannot simply be assembled from components, and an intensive search process may be needed to find effective alternative solutions to a problem. Different kinds of strategies are thus necessary in finding satisfying if not optimal solutions (guideline 6). Guideline 7 refers to the effective communication of the research results to those parties who may want to implement or further study or extend the content.

Figure 5.1 shows a mapping of Hevner’s (2004) guidelines to the research guidelines for theory development proposed by Kuechler and Vaishnavi (Kuechler & Vaishnavi, 2008; Vaishnavi & Kuechler, 2004). They argue that this methodology provides effective guidelines as it “emphasises the knowledge generation inherent in the method and because it originated in an analysis of the processes inherent in any design effort” (Vaishnavi & Kuechler, 2004). Figure 5.1 also effectively illustrates the reasoning used during the iterative process of developing the capstone course as a DSR project, where refinement and development of the theory can happen within the individual iterations of the cycle as shown.

The phenomena of interest for DSR in Gregor and Jones' (2007) terminology correlate with the criteria described by Fischer (2011) and reflect the understanding of the concept of an artefact as used in this study. They refer to an artefact that physically exists as an instantiation or a material artefact. In the case of this study, the *material artefact* pertains to a particular implementation of the capstone course. Since this refers to an actual instance rather than an abstraction, the word 'concrete', also used by livari (2007), seems a better fit than 'material' as used by Gregor and Jones (2007). Artefacts that do not physically exist, like theory (including constructs, methods and models), are called abstract artefacts. Human beings conceptualise and describe these abstract artefacts and use them to create instantiations or concrete artefacts that can in turn be utilised and understood.

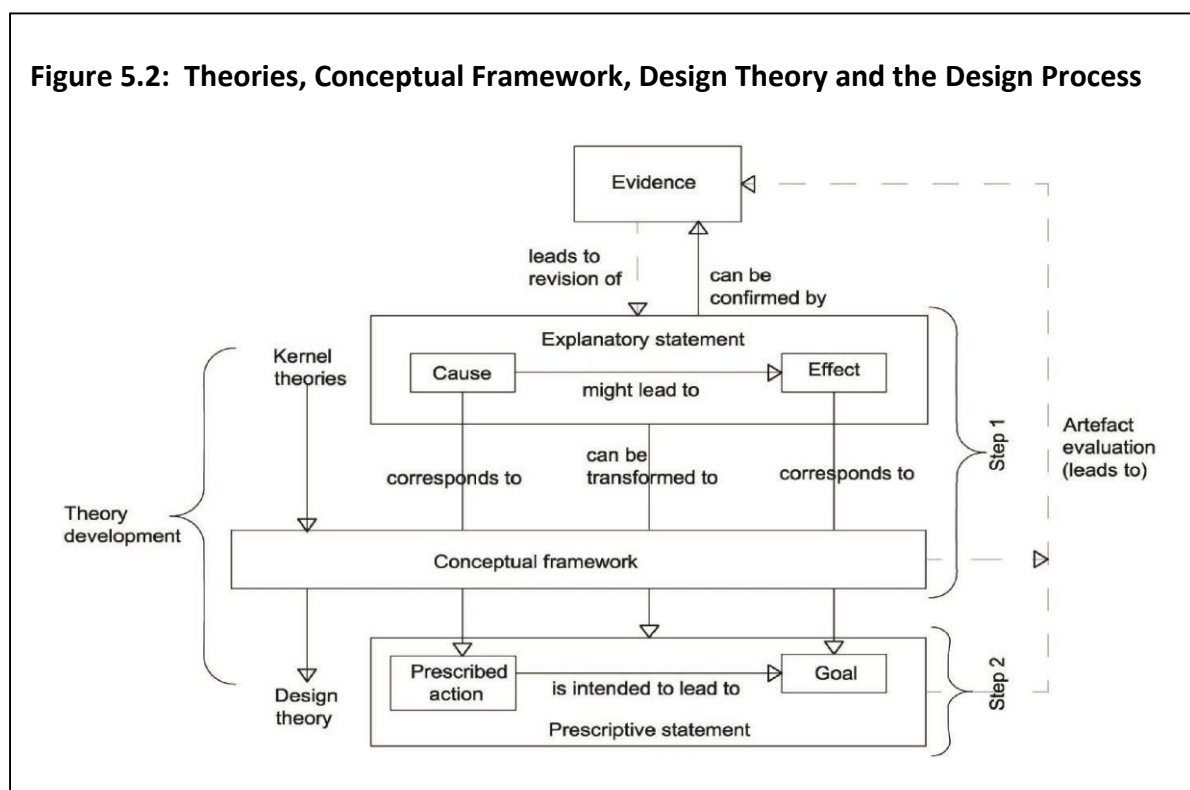
The *instantiation* of the capstone course as a sequence of actions (processes and sets of interventions) used to develop, implement, extend or collate core IS subject matter (Orlikowski & Iacono, 2001) can be perceived as a composite *concrete artefact* that has undergone continuous refinement over the past decade. The intention for this particular artefact is to become an implementation of a practice towards empowering IS majors. The development of a *design theory* (as the *abstract artefact*) that will provide prescriptive statements for this practice, will depend on the use of several kernel or foundational theories as highlighted in the conceptual framework for a coherent practice (see Figure 5.5 and Figure 5.6). These kernel theories can aid to structure the different components more effectively, and to better guide change, transcendence and adaptability. In addition these theories can be used to explain or predict the effects or outcomes envisioned.

5.2.4 Design Science Theory

This section highlights the importance of expressing design knowledge as theory and suggests a two-step process. The first step comprises an inductive process to generate explanatory hypotheses, while the second step focuses on the formulation of the theory by using Gregor and Jones' (2007) anatomy for a design theory.

The design process is not the mere implementation of practical knowledge, but a process carefully governed by practical design theories and as such "design theory will make a difference for design" as "theorised practical knowledge" (GoldKuhl, 2004, p. 61). "Theorising at heart relies upon the methods judged suitable for knowledge development"

(Gregor, 2009, p. 5). For these reasons Gregor and Jones (2007) deem it vital to explore how design knowledge is effectively expressed as theory (Kuechler & Vaishnavi, 2008; Vaishnavi & Kuechler, 2004) as it supports the argumentation for rigour and it influences the way in which design science is formalised (Simon, 1969). Many different conceptions exist with respect to the use and development of theory in DSR (Kuechler & Vaishnavi, 2008), most of them originating from Simon's (1969) view that a theory of design comprises a number of components and a substantial body of knowledge. The scope of such a theory will therefore incorporate both the design product and the design process with theory elements in both product and process.



(Adapted from Kuechler & Vaishnavi, 2008)

Theory building in the sciences of the artificial occurs through artefact construction, where the researcher or others actually construct the objects of study in what is called design science (Gregor, 2009). Although this presents unique challenges because of the difference from other branches of science, it also brings to the fore a rich variety of special features. As said in section 5.2.3, design theories are normative – both prescriptive and evaluative (Fischer, 2011; Baskerville, 2008). When building theory in the sciences of the artificial, one should be mindful of the central role that the artefact plays in theorising; the goal and

purpose of the artefact should be clear and its efficacy evaluated; and the importance of abduction, induction, creativity and imagination in addition to deduction, cannot be overlooked (Gregor, 2009).

According to Gregor (2009), a first step towards a theory building phase is where explanatory hypotheses or conjectures are generated as a result of earlier inductions, guesses or creative imagination. This step is illustrated in Figure 5.2 as step 1. She however adds that this step is often interpreted differently by various authors, since there are different views of what means are required to arrive at the conjectures, and different degrees of emphasis may be placed on the importance of induction from evidence as opposed to guesses and creative imagination. For example, Hevner et al. (2004) use the notion of a means-end analysis of the design activities, while Kuechler and Vaishnavi (2008) describe their theory building activities in terms of design-build-evaluate cycles. Kuechler and Vaishnavi (2008) started out using 'thought experiments' to explore the feasibility of a particular approach; this led to an approach using and refining kernel theories, which they mostly borrowed from other disciplines in order to introduce novel and creative ideas and techniques to be used in IS design problems. These kernel theories can also be seen as theories in the natural or behavioural sciences of the kind that Gregor (2006, p. 630) refers to as "explain" and "predict". The approach developed by Kuechler and Vaishnavi (2008) was predominantly used in the emergent phase of the capstone course (Chapter 4), where the use of kernel theories played a significant role in understanding concepts and defining the conceptual framework (see Figure 5.5 and Figure 5.6) that emerged from this phase. The relationships between the kernel theory, conceptual framework, design theories and the design process is shown in Figure 5.2 (adapted from Kuechler & Vaishnavi, 2008).

The constant search for more effective solutions to problems and for ways of explaining and understanding causes and effects in developing the capstone course as a practice, led to the identification and use of kernel theories. The implementation of these theories on different levels for both design and process contributed to a coherent approach. This search process is typical of DSR, since designers are not faced only by optimisation problems, but also by problems where solutions are not yet available or 'discovered' at the design point (Gregor, 2009; Simon, 1969). In situations like these, reasoning using deductive logic will not provide clear guidelines of how to proceed, and the researcher will have to resort to inductive logic

to theorise about artefacts. “The reasoning that produces design theory from the process of artefact construction can be called theory building using induction – reasoning from the particular to the general” (Gregor, 2009, p. 7). This kind of reasoning is relevant in the case of the capstone course where the solutions were not immediately evident. Abduction, as inference leading to a better explanation, can aid the understanding of what scientists do when building theory. Although Gregor (2009) argues that deductive logic remains important in theory testing, experimentation in DSR forms part of the design process, which is in contrast to the usual scientific process where the experimental method is used to test cause-effect relationships.

A second step towards theory building is when a more formal representation is developed comprising eight components used to express the design theory (Gregor & Jones, 2007). This design theory anatomy was inspired by Codd’s (1970) articles introducing relational databases; it builds upon and extends the work of Walls et al.(1992), who in turn drew upon primary sources like Dubin (1969) and Simon (1969). The eight components include: (1) The *purpose and scope* component which is necessary to specify the type of concrete artefact this theory applies to and to provide the boundaries of the theory; (2) *Constructs* as entities of interest; (3) *Principles of form and function* as a blueprint for the design of the artefact; (4) *Artefact mutability* as an indication of the flexibility incorporated in the artefact design; (5) *Testable propositions* as truth statements of the design theory; (6) *Justification knowledge* provided in the form of underlying kernel theories as a basis for and to provide explanations for the design; (7) *Principles for implementation* of the theory in a specific context, and (8) *Expository instantiation* as a physical artefact either for representing the theory or for testing (Gregor & Jones, 2007).

The expression of the design science theory in this way allows guidelines to be prescribed for the further development of artefacts of this type (Gregor & Jones, 2007) as is indicated by step 2 in Figure 5.2 (adapted from Kuechler & Vaishnavi, 2008). The building of theory in the capstone environment replicates the processes described above. The next section will thus describe the research and theory-building processes for the capstone course in more detail.

5.3 Building Theory for a Capstone Course

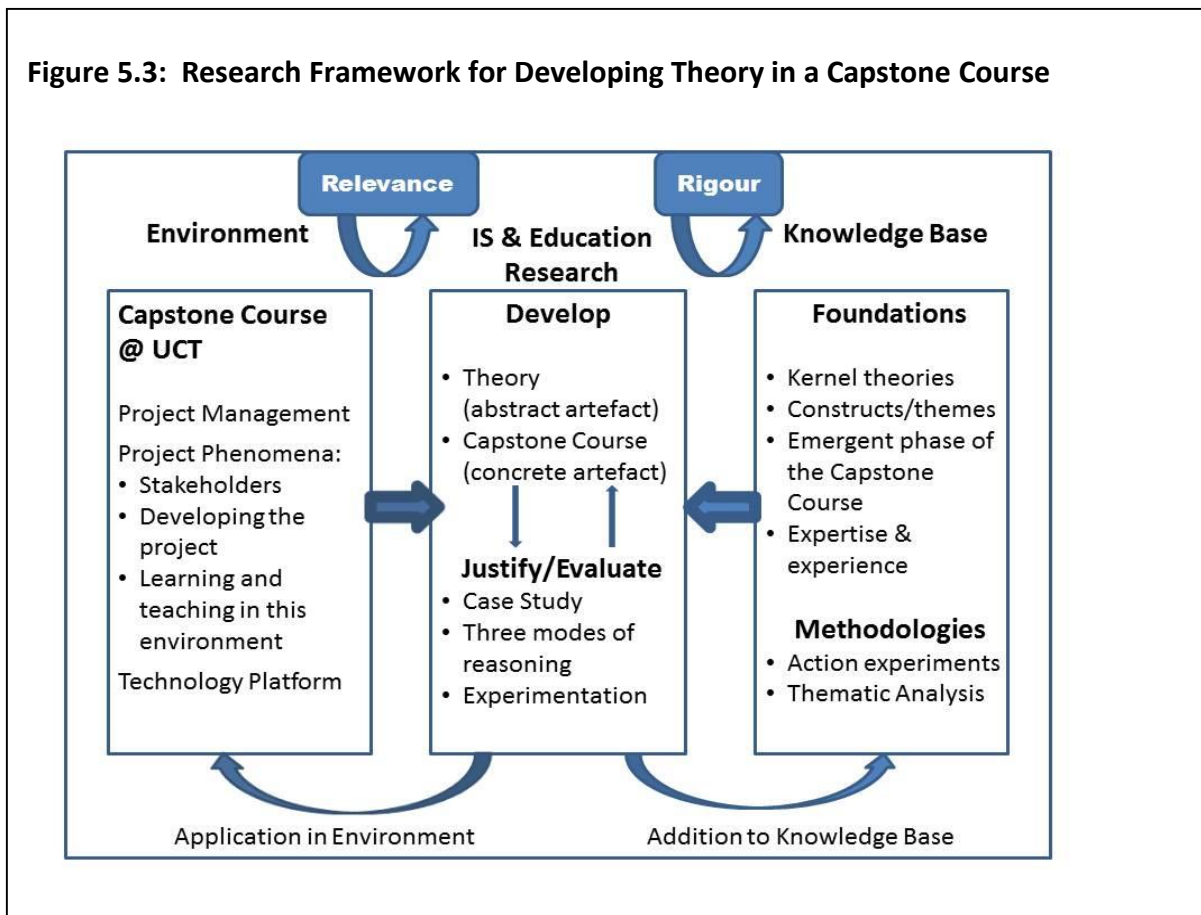
Theory helps to understand the complex world of lived experience from the perspective of those who live in it (Gregor, 2006) and fosters the development of knowledge that guides the construction of artefacts and interventions in this world (Gregor, 2009). Walsham (2006) suggests that a theory can provide structure to a research process by giving guidance to the design and data collection activities during the different stages of the research process, whereas Llewelyn (2003) highlights working, doing and reflection as three core attributes of theory.

This section will first frame this research using the three-tier Information Systems Research Framework as given by Hevner et al. (2004). The research process will then be described with reference to Figure 5.1. Finally, theory building towards a coherent practice will be given as a two-step process (see Figure 5.2). The first step, the conceptual framework as it emerged “from the researcher’s ... personal experience[s] and reflection upon theoretical positions towards phenomena to be investigated” (Leshem & Trafford, 2007, p. 99) will be explained and illustrated in Figure 5.5 and Figure 5.6. Next, Gregor and Jones’ (2007) anatomy of a design science theory will be used as step 2 of the development of the theory for a coherent practice, using the conceptual framework as “a bridge between paradigms which explains the research issue and the practice of investigating that issue” (Leshem & Trafford, 2007, p. 99).

5.3.1 Framing the Research

Figure 5.3 provides the context for this research in terms of the three-tier IS Research Framework given in Hevner et al. (2004), and discussed in section 5.2.3. It describes the environment (problem space) in which the research will take place. It also shows the complementary phases of behavioural science and design science of the second tier, where the development and justification of the theory evolve alongside the development and evaluation of the capstone course, the one influencing the other.

Figure 5.3: Research Framework for Developing Theory in a Capstone Course



(Adapted from Hevner, 2007; Hevner et al., 2004)

5.3.2 The Research Process for Developing Theory in the Capstone Course

The research activities depicted by the second tier of Figure 5.3 can be organised as a research cycle of five steps (also called phases) identified by Kuechler and Vaishnavi (2008). The iterative execution of these five steps is depicted in Figure 5.1, which also illustrates how the steps align with the seven guidelines for research suggested by Hevner et al. (2004).

The first step in the research cycle is the *awareness of the problem* (Kuechler & Vaishnavi, 2008). For the particular instance of the capstone course this was defined in Chapter 1 as how best to empower IS students to perform their roles with competence on an ongoing basis. The literature not only provides evidence that skills shortages in ICT are still critical, specifically for roles like network engineers, project managers, business analysts and developers (Richards et al., 2011), but that the “disparity between the demand and supply

of IT professionals creates a timely, interesting and relevant topic for research” (Hunsinger et al., 2010).

The second step of the process is the *suggestion* step (Kuechler & Vaishnavi, 2008) or the search step of design (Hevner et al., 2004). For Kuechler and Vaishnavi (2008) this means the implementation of *thought* experiments by working through prior research to investigate the feasibility of alternate approaches and the identification of kernel theories. Gregor and Jones (2007, p. 321) argue that theory can “be extracted from observation and inference from already instantiated artefacts”. In this study the different phases of the evolution of the capstone course during the previous decade as described in Chapter 4 provided rich information for thought experiments and reflection. Continuous search and meaning-making activities were used to extract theory and other information that contributed towards the development of the conceptual framework. Mezirow (1990) argues that when we *make meaning* of an experience, we create an interpretation of that experience. When we use this interpretation to guide our decision-making and our actions, meaning turns into learning. Learning is thus “the process of making new or revised interpretation of the meaning of an experience, which guides subsequent understanding, appreciation and action” (Mezirow, 1990, p. 1). As such, this step constituted an abductive reasoning phase in search of a better explanation that allowed theoretical relationships to enter the design effort, further promoting the aspect of coherence.

The *development* step is where all “the tentative directions for artefact generation explored in the suggestion phase are made concrete through construction and iterative refinement” (Kuechler & Vaishnavi, 2008, p. 495). In the capstone course the development phase spanned the delivery of the capstone course in 2010 and 2011 and the refining of both the theory (abstract artefact) and the delivery of specific instances of the capstone course (concrete artefact) during this time.

Kuechler and Vaishnavi (2008) argue that it is typical of DSR that the research process iterates between the *evaluation* and *development* steps, as was the case in the implementation cycles of the capstone course. A designed (concrete) artefact serves to extend and refine the theory during the iterative process rather than confirming or disconfirming the theory as is the case in natural science research, again emphasising the

inseparability of truth and utility (Cole et al., 2005; Hevner et al., 2004). Raelin (2007, p. 495) cautions that we need to be mindful that one of theory's main purposes is to inform practice; in addition "theory loses much of its vitality if uninformed by reflection on practice". This may lead to the discovery of further applications of a particular artefact, with corresponding truth statements to be incorporated into the theory. The neverending search for ways of improving learning and teaching in the capstone course environment creates opportunities for refining theory and extending the utility of the course. A more rigorous description of the interventions that were conducted as action experiments as part of the evaluation process during the two delivery cycles of the course will be given in Chapter 6.

The *conclusion* signals the end of the design project. True to the proactive nature of DSR, the instantiation (the capstone course in this particular context) preceded "a complete articulation of the conceptual vocabulary and the models (or theories) it embodies" (March & Storey, 2008; Vaishnavi & Kuechler, 2004).

5.3.3 Theory Development for a Capstone Course

The theory development in this study comprises two main phases. The first phase, the inductive phase, constructs and utilises a *conceptual framework* to formulate understanding in terms of kernel theories (as depicted in Figure 5.2) that will assist the researcher to make sense of and improve competence development during the capstone process. This phase did not involve the application of rigorous and formal procedures, but was rather "the introspective explication of the results of a cognitive process" (Kuechler & Vaishnavi, 2008, p. 497) from kernel theories to conceptual framework. The conceptual framework as depicted in Figure 5.5 and Figure 5.6 was derived through an inductive process using the kernel theories to aid the reconstruction of meaning from, reflection on and the sense making of the historical data and the researcher memory and experiences through a number of iterations. The formulation of the *theory for coherent practice* subsequently evolved and was refined from this conceptual framework and the initial set of theory propositions, during the two subsequent implementations of the capstone course in 2010 and 2011, which represents the second and deductive phase of the theory development. The intention is that the theory for coherent practice should finally include prescriptive statements of actions leading to specific outcomes. It should demonstrate how the

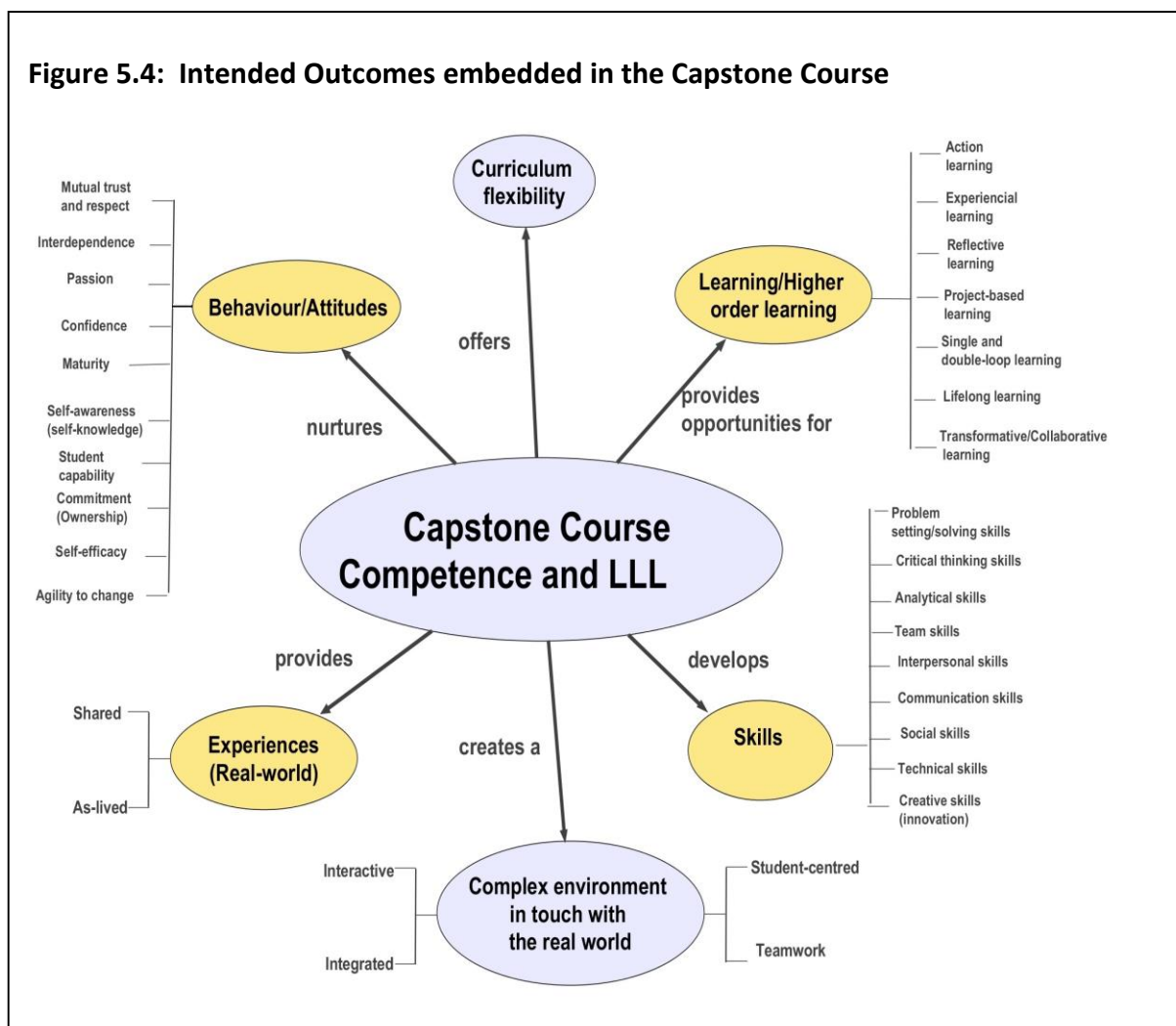
accompanying theories (kernel theories) within this framework can either be utilised to underpin or to make sense of the different activities within this coherent practice (see Figure 5.2). It will also assist to make sense of activities that might lead to the reconstruction of interventions and actions to promote transcendence and embodied cognition, nurturing competence and lifelong learning.

A conceptual framework for a coherent practice: The conceptual representation of the coherent practice of the capstone course, illustrated in Figure 5.5 and Figure 5.6, is the culmination of different theories, constructs, perspectives and reflections. Miles and Huberman (1994, p. 33) refer to a conceptual framework as a “current version of the researcher’s map of the territory being investigated”. It is “how the world is seen through our perceptions, understanding and interpretations” (Leshem & Trafford, 2007, p. 96). Persistent issues, concerns and gaps, guidelines and inspirations, as they emerged from numerous sources in the literature and the IS curriculum, guided development and assisted to articulate the expected outcomes (see Chapter 2). The experience of the researcher over the past decade in a capstone environment as well as the influences of and interactions with students and other stakeholders, like sponsors and colleagues, further helped to give structure and coherence to the framework. It contributed to the refining of the separate elements in the framework and assisted in identifying interdependencies between these elements. Although a conceptual framework evolves as the research evolves, it accommodates purpose with flexibility and coherence (Miles & Huberman, 1994). Robson (1993, p. 150) holds that

developing a conceptual framework forces you to be explicit about what you think you are doing. It also helps you to be selective; to decide which are the important features; which relationships are likely to be of importance or meaning; and hence, what data you are going to collect and analyse.

This means that a conceptual framework provides “a theoretical overview” (Leshem & Trafford, 2007, p. 96) and as such represents a holistic approach as an initial attempt to define a coherent practice. It provides guidelines for the interventions necessary to deliver the intended outcomes and facilitate transcendence, and prescribes how these

interventions should be structured (Cockburn, 2002). In addition it facilitates an in-depth understanding of how students transcend through different stages of competency (Dreyfus & Dreyfus, 1986). As such the conceptual framework forms an intermediate and very important step in the theory building process of this study. March and Smith (1995, p. 256) concur that “conceptualisations are extremely important in both natural and design science [as] they define the terms used when describing and thinking about tasks”.



Source: Researcher’s own construct informed by sections 2.2.3, 2.3.2, 3.4, 3.5 and 4.2.3.

A natural entry point for the conceptual framework shown in Figure 5.5 and Figure 5.6 is the determination of the intended outcomes. The intended outcomes of the selected or constructed interventions should be: to nurture learning and higher order learning; to develop a diverse set of skills; to provide students with rich real-life experience, and to encourage changes in student attributes and behaviour. Figure 5.4 depicts the

organisational structure of the environment of the capstone course. This structure emerged from an in-depth analysis of the literature that was subsequently enriched through a continuous process of critical reflection – “thoughtful action with reflection” (Mezirow, 1990, p. 2) during the evolution of the capstone course. It also illustrates the prominence of the intended outcomes and how the various concepts that emerged through the different deliveries over the past decade can be associated with the intended outcomes.

The significance of the four kernel theories in the conceptual framework and the role they play in it will be illuminated in the next passage. Three of the theories are described in detail as part of the section on competence development in Chapter 2 and are listed in Table 4.10. The fourth theory was added during the 2010 cycle as a further refinement of the theory.

Cockburn’s (2002) theory of three stages of behaviour guided the structuring of all the project management and project-based interventions. This theory is also used as a theoretical lens to explain the level of transcendence of the students. As part of the action learning approach (see section 2.3.2) the interventions are carefully linked and aligned. Figure 4.4 in Chapter 4 provides an illustration of how the interventions were structured to exhibit Cockburn’s stages of human behaviour. In the capstone course, students first encounter Phase 1 (P1) interventions that are controlled and provide step-by-step guidance. Phase 2 (P2) interventions are conducted in a secure environment, but provide students with less assistance to encourage detaching. Phase 3 (P3) interventions require students to become fluent and act autonomously.

The second kernel theory refers to the five stages of skills acquisition (Dreyfus & Dreyfus, 1986) and assists in a sense-making process to determine what level of competency students have reached and what is needed to allow them to transcend to the next level through enhanced skills, experience, deep approaches to learning and changes in attitude. It is a dynamic and ongoing process of en-action, fusing practical experience of projects with theoretical concepts and phenomena– in simple terms, learning by doing– to achieve embodied cognition (Maturana & Varela, 1987).

Figure 5.5: Kernel theories of the Conceptual Framework for a Coherent Practice

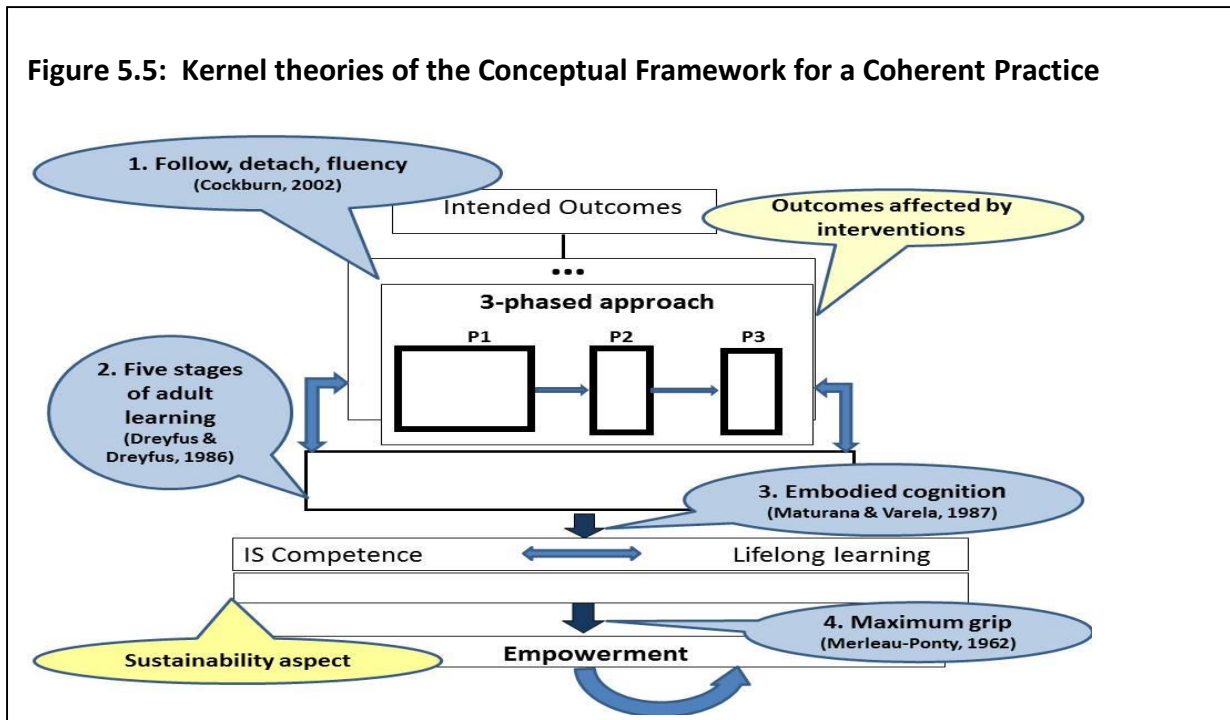
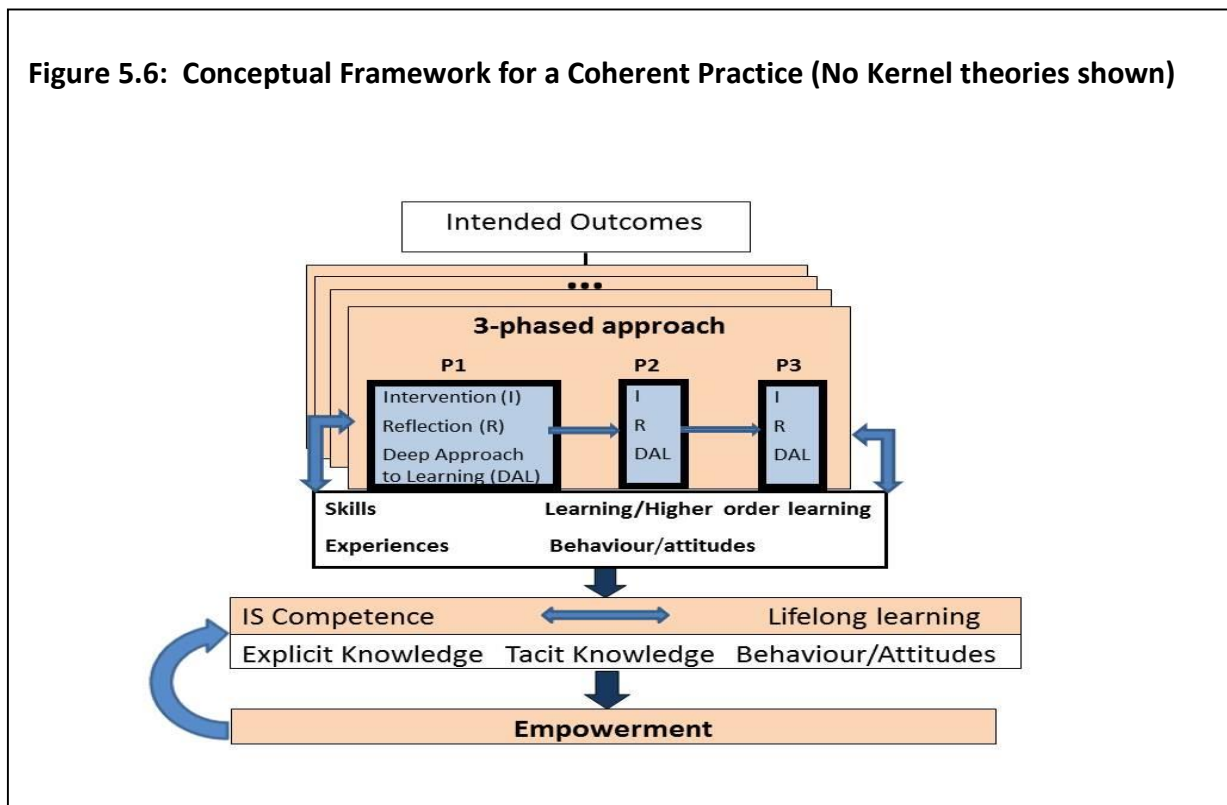


Figure 5.6: Conceptual Framework for a Coherent Practice (No Kernel theories shown)



Source: Researcher's own constructs informed by section 4.3

This continuous process of skilful activity bringing a person closer to an optimum level can also be defined by the concept of *maximal grip* in Merleau-Ponty's Phenomenology of

Perception (Merleau-Ponty, 1962). He argues that human beings always tend to improve their current situation to achieve maximum grip. It is however only because the *intentional arc* is steadily improved, refined and enriched that the body moves into a state of unconscious competency towards *maximum grip*.

Evidence exist that these internalised competencies enhanced by elements of lifelong learning comprising explicit and tacit knowledge, as well as attitudes like motivation and ownership, will finally lead to passionate and committed IS graduates empowered to cope with the real-life issues they will have to face. Empowerment evolves as “perception is built up with states of consciousness as a house is built up by bricks and mental chemistry is invoked which fuses these materials into a compact whole” (Merleau-Ponty, 1962, p. 25). The theories of embodied cognition (Maturana & Varela, 1987) and the concept of maximal grip (Merleau-Ponty, 1962) constitute the third and fourth kernel theories and provide powerful mechanisms to explain the concepts of conscious and unconscious competency. The concept of maximum grip was only added to the set of kernel theories as means of better explanation during the 2011 cycle.

The theory of coherent practice: The second phase of the theory building process took place during the delivery of the capstone course at UCT in 2010 and 2011. In March and Smith’s (1995, p. 262) view, “theorising about instantiations may be viewed as a first step toward developing more general theories”. During this phase the researcher actively sought justification for the theory for coherent practice, refining and enhancing this theory to strengthen it (Gregor, 2006). Raelin (2007, p. 500) argues that the construction of theory in this kind of practical setting “might be more apt” than before the experience, since the theory in this case is “not pre-ordained, but constituted as a living construction to capture the useful ingredients of the performance”. The resulting conceptual framework is expected to provide a foundation that will assist to develop a deep understanding of the phenomena that influence the process of transcendence of IS graduates through an as-lived project experience.

Table 5.1 expresses the initial theory of coherent practice in terms of the eight components of Gregor and Jones (2007) as discussed in section 5.2.4. This theory is refined and

expressed in more detail after discussion and evaluation of the action experiments, in Chapter 7

Table 5.1: Components of an Initial Design Theory for a Capstone Course

	Component	Component description
1.	Purpose and scope	The Theory of Coherent Practice is a framework that prescribes how a set of carefully designed interventions can be constructed and implemented to empower IS majors. In this case it is used to create a capstone course (concrete artefact) as prescribed by the theory (abstract artefact), where theory guides practice and practice informs theory in a never-ending cycle.
2.	Constructs	Skills, experience, behaviour, deep approaches to learning, transcendence, embodied cognition, maximum grip, lifelong learning; competence (also see Figure 5.4).
3.	Principles of form and function	The conceptual framework for a coherent practice (Figure 5.5 & Figure 5.6).
4.	Artefact mutability	The approach can be used to underpin and develop other exit level courses (an example is the instantiation of a postgraduate diploma course).
5.	Testable propositions (initial propositions as derived from the conceptual framework)	<ol style="list-style-type: none"> 1. Structured interventions are necessary to create a student-centred interactive and integrated environment. 2. Structured interventions are necessary to guide repetition and practice and enable transcendence. 3. Theoretical lenses can help students to make sense of their experiences, getting in touch with dissonances and guide conscious reflection while executing the interventions. 4. Guided reflective practices in a capstone course facilitate integrated experiential learning and constitute essential triggers for transcendence. 5. The ongoing guided reflective practices in a course that facilitate integrated experiential learning will develop reflexive learners. 6. Embodied cognition is a result of guided reflection and transcendence. 7. A learner experiences a state of being unconsciously competent when embodied cognition has taken place. 8. Reflexive learners are both consciously and unconsciously competent. 9. All reflexive learners are lifelong learners. 10. Lifelong learning sustains IS competence. 11. Unconscious competence builds confidence, commitment and passion and nurtures innovation, all of which are necessary to empower IS professionals.
6.	Justificatory knowledge	To be expanded upon in Chapter 7
7.	Principles of implementation	To be expanded upon in Chapter 7
8.	Expository instantiation	Capstone courses or similar exit level courses

5.4 Design Evaluation Methods

The research methods for this case study are linked to the two phases of theory development during the research process. These phases span the entire research process, from the construction of the conceptual framework to the development and refinement of the theory, including the changes and enhancement to the capstone experience during 2010 and 2011. In cases like these Mingers (2001) argues in favour of a multi-method approach, since each phase poses its own unique tasks and problems. When a research process consists of more than one phase, diversity of research evaluation methods can be a positive source of strength; different methods can focus on different aspects of reality and can thus contribute to richer insights and a deeper understanding of a research topic.

As mentioned in section 5.3.3, the first phase of theory development implemented an abductive reasoning approach to choose the better solution amongst several alternatives, for example, kernel theories and/or methods or structures for various interventions. This process was further augmented by applying an inductive approach to construct the conceptual framework from a large set of data and the experience of the researcher that systematically evolved over the past decade.

During the second phase of 2010 and 2011, the delivery of the course was orchestrated in terms of themed action experiments. Although the pool of interventions and the fields of influences (section 6.2) did not change significantly over this period of time, the themed action experiments were only formalised towards the end of 2010. The themes were however inherently present and could be properly named as a result of the constant reflection-in-action and a focus on nurturing an interactive and integrated environment that would also produce data conducive to the evaluation process. Hevner et al. (2004) note that evaluation is a crucial part of the research process in design science, it is therefore important to apply *rigorous* methods that are *well executed* to demonstrate the effectiveness and use of the design artefact. For well-structured and effective execution, each intervention in the respective action experiments was structured and executed in the same way as for a typical cycle in action research (AR). Although AR and DSR are “seemingly similar, but decisively dissimilar” (Iivari & Venable, 2009), it can be shown that they share important assumptions. For example, both AR and DSR are grounded in practical action

while also informing theory; for both the phenomena of interest do not always remain static during the research process; and they both implement specific interventions to effect change (Cole et al., 2005). In every delivery cycle of the capstone course most of the stakeholders differ and the environment created by these different stakeholders and the different projects they embark on can be decisively dissimilar. Despite these differences, Iivari and Venable (2009) agree that there could still be significant overlap when solving a socio-technical problem that involves a new solution technology and the evaluation thereof in a specific context.

In addition “AR is a research method while DSR is more of a research orientation within which one can use different research methods (including AR)”, and it thus becomes viable to use the cyclic process model of AR as a method to guide “innovative solutions” (Iivari & Venable, 2009, p. 4) such as the execution of the action experiments for the Capstone Course. This method opens up an opportunity for this study to borrow from the more mature body of evaluation that exists when performing AR (Cole et al., 2005) to construct action experiments that can be applied as a method to evaluate the respective interventions and themes of the coherent practice of a capstone course.

A cycle in AR typically includes six elements: the research theme (T); the research framework (F), or diagnosing; the research methodology (M) or action planning; the real-world problem situation constituting the application area (A) and action in the situation, or action taking; the reflection process based on F and M, or evaluating; and finally the findings as a combination of theory and practice, or the learning that emerges (Baskerville, 1999; Checkland & Scholes, 1999; Checkland & Holwell, 1998). The combination of theory and practice in a cyclical process provides participants in the experiment with the ability both to act and to apply the knowledge obtained to similar situations (Iversen, Mathiassen, & Nielsen, 2004). This study has taken its inspiration from a summary made by Iversen et al. (2004) of different ways to organise the steps and iterations in AR that combine the steps from the classic process of Susman and Evered (1978) and that of Checkland (1991) as listed above. Based on the AR approach, and to accommodate the unique characteristics of the different delivery cycles of a capstone course, each action experiment comprises six steps as illustrated in Table 6.1. These steps include an introduction to the situation of concern, an

ideas framework, planning and methodologies for the activities, the execution of the activities, evaluating the experiences, and reflection and learning.

The analysis of the *data made* during the cycles of 2010, 2011 and throughout the past decade provides important means to evaluate the experiences during the respective interventions of the action experiments. Morse and Richards (2002) argue that it is preferable to think of data as being made rather than being collected, since it did not exist before an activity or intervention. It must be “a collaborative, ongoing process” (p.87) and involves interactive negotiations between the researcher and the participants. “The data is rarely fixed and unchanging; never exactly replicating what is being studied” (Morse & Richards, 2002, p. 87).

5.5 The Making of Data

One of the primary reasons for making data in the different cycles of a capstone course was to assess student performances. Once analysed, this data however, can also be used very effectively to evaluate the experiences of these students and aid the development of both theory and practice. Not all data can be used equally effectively and the “researcher will focus on some things and pay less attention to others” (Morse & Richards, 2002, p. 88). Van Maanen, Sørensen, & Mitchell (2007) caution that it is difficult to produce good theory and that it often calls for a deep engagement in the problem domain and therefore also the data obtained, always working through inference towards the best explanation. This poses three major implications for the method used: data should be detailed, rich and complex to sufficiently explain processes and assumptions; the researcher must conceptualise the results to be able to interpret and provide in-depth explanations of the research findings; extreme cases should be considered and no data should be overlooked, enabling the researcher to adhere to the principle of opposites (Van Maanen et al., 2007).

Morse and Richards (2002, p. 89) caution the researcher that “making data is a cognitive process requiring immense investment from the researcher”; it is a vital part of any research endeavour and is not to be taken lightly or passively. Paré (2004) contends that if different types of data are collected from different sources using different methods, it will not only result in a wider coverage, but it may also provide a better understanding of the phenomena under study. Table 5.2 adapted from Yin (2003) depicts five of the six types of

qualitative evidence together with their strengths and weaknesses as given in Paré (2004). The historical or archival data type includes the previous instantiations of the capstone course as physical artefacts (the sixth type referred to in Paré (2004)).

Table 5.2: Data Making Method

(Adapted from Yin, 2003)

Sources of Evidence	Strengths	Weaknesses
Documentation	<p>Stable – can be reviewed repeatedly. Easily accessible</p> <p>Unobtrusive – not created as a result of the case study</p> <p>Exact – contains exact names, references, and details of an event</p> <p>Broad coverage – long span of time, many events and many settings</p>	<p>Retrievability – can be low</p> <p>Biased selectivity – if collection is incomplete.</p> <p>Reporting bias – reflects (unknown) bias of author</p>
Historical (Archival)	(supports to current processes)	
Interviews	<p>Targeted – Focuses directly on case study topic</p> <p>Insightful – provides perceived causal inferences</p>	<p>Bias – due to poorly constructed questions</p> <p>Response bias</p> <p>Inaccuracies – due to poor recall</p> <p>Reflexivity – interviewee gives what interviewer wants to hear</p>
Direct Observation	<p>Reality – covers events in real time</p> <p>Contextual – covers context of event</p>	<p>Time consuming</p> <p>Selectivity – unless broad coverage</p> <p>Reflexivity – event may proceed differently because it is being observed</p>
Participant Observation	<p>(same as for direct observation)</p> <p>Insightful – interpersonal behaviour and motives</p>	<p>(same as for direct observation)</p> <p>Bias – investigator’s manipulation of events</p>

A rich and diverse set of data elements, both qualitative and quantitative, has been accumulated during the past decade. Due to the dynamic nature of the course in its early stages and the structural changes that occurred, only course data since 2005 has contributed directly towards this research project. The entries in Table 5.3 reflect the set of data items in the capstone course from 2005 until 2011 with a relevant code to more easily identify each item. A separate column was added to distinguish between historical data and the data items for the evaluation cycles of 2010 and 2011. In those cases where data elements/items are omitted, it means that the interventions were only implemented in later years. For example, a set of additional interviews (IIP01) was conducted with 16 of the 22

students of 2011 at the beginning of 2012. Another set of 45 interviews was also conducted with alumni students (AI01) graduating between 2006 and 2010 in their workplace at the beginning of 2012.

Table 5.3: Historical Data Items and Data Items of the Cycles of 2010 and 2011

Data item	Code	Years accumulated	Cycles for 2010 & 2011
Course documents -Course outline	CD.	2002 - 2009	2010 & 2011
Project documents -Project brief -Project deliverables - Sponsor guidelines -Sponsor letter	PD.	2002 - 2009	2010 & 2011
Suite of assessment rubrics -Interim deliverables (8) -Milestones (3) -Sponsor evaluations (2) -Project presentation -Code presentation	AR. ID01-8 M01-4 SE01-2 PP CP	2002 – 2009 (continuous improvement and redevelopment)	2010 & 2011 Interim deliverables(7)
Summary of all marks	AM01	2005- 2009	2010 & 2011
Course survey primer	CS01	2005; 2006; 2008; 2009	2010 & 2011
Team roles template	TRT01	2006 - 2009	2010 & 2011
Lessons learnt	LL01	2006 - 2009	2010 & 2011
Course evaluations (2)	CE01; CE02	2005 - 2009	2010 & 2011
Peer evaluation	PE01	2005 - 2009	2010 & 2011
Sponsor evaluation	SE01; SE02	2005 - 2009	2010 & 2011
Reflective essays (theoretical lenses)	RE01	2008	2010 & 2011
Class presentations (PM)	CPPM01	2007, 2008	2010 & 2011
Team interviews	TI01	2008; 2009	--
Informal alumni email questionnaire	AQ01	2005; 2006	--
Personal interviews (during course)	PI01; PI02	--	2010 & 2011
Life skills tutorial	LS01		2010 & 2011
Personal interviews (2011-post course)	PIP01	--	2012
Alumni interviews	AI01	--	2012

The historical data (2005-2009) and the data generated during the action experiments of 2010 and 2011 comprised a variety of text documents including dedicated course and project documentation with accompanying assessment rubrics and a collection of marks obtained for major deliverables over the years. As illustrated in various tables in Chapter 4, the historical data has been augmented by a number of papers dedicated specifically to this study and which were published in international conference proceedings and journals, as well as a set of relevant empirical research studies conducted in-house by postgraduate students where the researcher acted as mentor. These empirical studies were aimed at informing, improving and reconstructing previously held constructions in the case of the capstone course at UCT. Several course evaluations and surveys were completed, interviews were conducted, and e-mail communications also occurred over the decade to inform the research.

The capstone course provided a unique and favourable environment to the researcher as active participant (participant-observer, facilitator and teacher-coach) with ample opportunities for face-to-face encounters, observations, interviews and collaboration. Interviews were unstructured as the researcher primarily sought to learn from the individual students what mattered and how they understood procedures. The 45 alumni interviews at the beginning of 2012 were conducted by a research assistant, to be used for his postgraduate research and in this study. Although the transcripts made from the interviews were mainly used for the evaluation of experiences, they also provided insightful information about the performances of students. Interviews were conducted according to the guidelines provided by Myers and Newman (2007) to assist and sensitise the interviewer to the complexity of the process and thus allowed the researcher to see the interview as an unfolding drama with the interviewee and the interviewer both presenting themselves as actors and audience.

5.6 Data Analysis

“Preparing data for analysis is a process of transformation”, and ideally the data should be kept as close as possible to the actual events (Morse & Richards, 2002, p. 99). In addition, “if qualitative research is to yield meaningful and useful results, it is imperative that the material under scrutiny is analysed in a methodical manner” (Attride-Stirling, 2001, p. 386).

In order to keep the data as close as possible to the actual events, the researcher was deeply involved in all the data-making efforts; and where data had to be captured electronically, most of the original hard copies were filed and retained as illustrated in Table 5.3. This allowed the researcher to frequently revert back to the original copies where necessary during the analysis. In some cases, like course evaluations or peer evaluations, the text components of the captured data were less dense and Microsoft Excel was considered an appropriate tool for data analysis. Interviews and essays on the other hand were considered dense text files and these files were coded and captured in ATLAS.ti. Attride-Stirling (2001) prompts researchers to not only implement more systematic ways of recording data, but also to disclose their methods of analysis. Effective reporting techniques can lead to enhanced interpretations that can also aid other researchers when doing similar projects; Table 5.4 therefore provides an overview of recording techniques and tools used for analysis in this study.

In this study it was important that data was analysed in such a way that it could be used to justify the theory and evaluate the respective action experiments of the capstone course. All interpretation and analysis during this research process were grounded in the underlying principles of hermeneutics. All processes used the fundamental principle of the hermeneutic cycle that suggests that human understanding is created by a constant movement back and forth from the interdependent parts to the whole that they form (Klein & Myers, 1999). Through such an iterative process the researcher becomes more grounded in the data and develops a deeper understanding of the phenomenon under study as increasingly richer concepts emerge (Ryan & Bernard, 2000).

The intended outcomes and the theoretical lenses of the conceptual framework guided the analysis of the data. The intended outcomes provided *organising themes* and lists of associated concepts or *basic themes* that characterise a particular organising theme as shown in Figure 5.4 (Attride-Stirling, 2001). According to Attride-Stirling (2001, p. 387) “thematic networks aim to explore the understanding of an issue or the significance of an idea.” While “thematic analyses seek to unearth the themes salient in a text at different levels ... thematic networks aim to facilitate the structuring and depiction of these themes”.

Table 5.4: Data Recoding Techniques and Tools for Analysis

Data Element	Code	Recoding Method	Analysis Tool
Project and code presentations	PP ; CP	Original documents	Report summary per team (electronically)
Summary of all marks	AM01	Electronic document	Excel Graphs
Course survey	CS01	Electronic documents Numeric analysis	Excel Text; graphs and thematic network
Team roles template	TRT01	Original documents	-
Lessons learnt	LL01	Electronic documents	Excel Text and graphs
Course evaluations (2)	CE01; CE02	Electronic documents Numeric analysis	Excel Text and graphs
Peer evaluation	PE01	Electronic documents Numeric analysis	Excel Text and graphs
Sponsor evaluation	SE01; SE02	Original documents Marks captured	--
Reflective essays (theoretical lenses)	RE01	Electronic documents Marks captured	ATLAS.ti 6 Profile (summary and thematic networks)
Class presentations (PM)	CPPM0 1	Original documents Marks captured	Report summary per team (electronically)
Team Interviews	TI01	Sound: transcribed	--
Informal alumni email questionnaire	AQ01	Electronic documents	--
Personal Interviews (during course)	PI01; PI02	Sound: transcribed	ATLAS.ti 6 Profile (summary and thematic networks)
Life skills tutorial	LS01	Captured electronically	Excel Text; Significance figure
Personal interviews (2011-post course)	PIP01	Sound: transcribed	ATLAS.ti 6 Profile (summary and thematic networks)
Alumni interviews	AI01	Sound: transcribed	Excel Text and Graphs

It was thus necessary to scrutinise the data for those basic themes or concepts that would match or augment these characteristics to serve as justification of the theory and as an indication of the degree of transcendence that occurred for a particular student. Morse and Richards (2002) caution that coding is a theorising activity and should always be seen as reflection, to be reviewed and revisited. The scrutiny techniques were thus further augmented by manipulative techniques. Some of these were applied using Excel, while in the more text-dense cases special software (ATLAS.ti in this case) was used to perform the

laborious techniques more effectively. Ryan and Bernard (2003) refer to four possible options, these being: cutting and sorting, word lists and key words in context, word co-occurrence and meta-coding. Triangulation was further used to investigate data from the different sources “to build coherent justification for the themes” (Creswell, 2009, p. 191).

One of the pressing issues of this research was to answer the question of how a set of carefully structured interventions can be used to grow competence through an as-lived project experience in such a way that it will encourage deep approaches to learning. Most importantly, it should nurture transcendence and foster lifelong learning. In order to gauge the transcendence of a particular student, the codes and quotes of all the interviews and the essay for that student through the course of a year were grouped together in ATLAS.ti to provide a profile for the student. This profile was then summarised again in a table and the main concepts highlighted. In addition, a thematic network was created for every student using the organising themes and the basic themes to provide an indication of competence development for a particular student.

5.7 Summary of the Research Methodology

This chapter commenced by identifying and motivating the research paradigm for this study. It then framed the research by defining the problem space and knowledge base for the research endeavour. It further explained the main steps in the research process to develop and justify the theory as abstract artefact, while simultaneously developing and evaluating the capstone course as a concrete artefact. The theory building process for this study comprised a two-step process of developing a conceptual framework to illuminate and make explicit what one thinks one is doing, as an intermediate step towards theory building. The data analysis phase subsequently plays an important role in transforming the data to facilitate the effective evaluation of the themed action experiments; this is discussed in Chapter 6.

Table 5.5 provides a summary of the proposed research design for this study.

Table 5.5: Summary of Research Methodology

Research context	The capstone course of the IS major at the University of Cape Town (UCT) implementing an approach to nurture lifelong learning and to create a critical awareness of the IS roles through an as-lived project experience with the intention to empower IS graduates to cope in the real world.
Research paradigm	Design Science
Research method	Two-step theory development process in design science research. This process includes the evaluation of themed action experiments to validate and refine the theory of coherent practice.
Data-making methods	<p>Consisted of qualitative and quantitative archival and future data, gathered using different methods from a single capstone course in one university.</p> <ul style="list-style-type: none"> • Historical data (see Table 5.3) • Relevant published papers • Relevant postgraduate empirical research reports mentored by researcher. • 2010 and 2011 third year classes: observations/course documentation/reflective essays/interviews/surveys/rubrics/course and peer evaluations/course marks (Table 5.3) • 2012 interviews with returning 2011 students • 2012 interviews with alumni from 2006 to 2010 in the workplace
Data analysis (analytic strategy)	<p>Theoretical lenses will be used to develop research outcomes. All analyses and interpretations will be subjected to the principles of hermeneutics. Thematic analysis techniques will be applied to illustrate the themes and create a deeper understanding.</p> <p>Additional tools like Microsoft Excel and ATLAS ti version 6 were used to aid the analysis process.</p>

6 Themed Action Experiments

There is no burden of proof.

There is only the world to experience and understand.

Shed the burden of proof to lighten the load for the journey of experience...when in doubt, observe and answer questions. When certain, observe and ask many more questions.

(Patton, 1990, p. 143)

6.1 Introduction

Chapter 1 of this study highlighted the importance of the need to find an alternate and possibly better approach to structure and *evaluate* capstone courses. Chapter 2 made the case in more detail and investigated the relevant broader theoretical foundations. The aim was to provide a good understanding of the nature of theory, and then to use this understanding to explore relevant theories that could support an alternative approach and provide mechanisms for understanding, explaining and prescribing relevant actions in a capstone course. A number of teaching and learning approaches were then explored, including theories around deep approaches to learning. This is in line with Raelin's (2007) assertion that we need to examine our own teaching practices and create "a scholarship of practice" (Braxton, 2005, p. 288) that will refine and develop different kinds of knowledge if we want to discover means of how to encourage learning that nurtures competence development and addresses the need for resilient lifelong learners.

In Chapter 3 the focus was on merging theory and practice. Raelin (2007, p. 495) argues that when "merging theory and practice we will end up with better theory, better practice, and better learning that will prepare us for both" ... "ultimately, we need a synthesis of theory and practice if we are to prepare thoughtful practitioners". An in-depth analysis of the literature was conducted to get a better understanding of the IS practice, which resulted in identifying and aligning the key characteristics of the IS discipline, the expectations and needs of industry, and guiding assumptions of the latest IS curriculum. These characteristics

and assumptions were then matched with concepts usually ascribed to capstone courses (Table 3.1 provides a succinct summary of this analysis). The intention of this analysis was to identify gaps or reveal possibilities for alternative approaches.

Simon (1969) argues that in worlds that include both actions and senses, an optimum solution rarely exists and finding an effective solution often involves an extensive search, comparing and evaluating alternative solutions if they exist. This has indeed been the case for the particular instance of the capstone course, and Chapter 4 presented a historical account of how we grappled with this idea for almost a decade. Chapter 4 also discussed how, through the years, three distinct stages were experienced in the evolution of the capstone course, which underpin this study's search for a better explanation. This search led us to the point where we could undertake the construction of a theoretical explanation which could be proposed as pedagogy of coherent practice.

Chapter 5 discussed the research methodology, the philosophy and the underlying principles of design science research to motivate why it is well-suited to underpin the construction and evaluation of the capstone course and to develop and justify the associated theory of coherent practice. The objective is not only to arrive at a design theory, but also to simultaneously design such a theory; which in turn indicated that the first step in the research process for theory building requires an abductive approach. The searching for and suggestion of the best-suited kernel theories to explain and make sense of the different aspects of the conceptual framework and provide the foundation of the core theory, do not happen in a linear fashion, but require a continuous process of interpretation and learning (see Figure 5.1). In section 5.3 of Chapter 5 the philosophy and principles of design science research were applied to enable the theory building process for a capstone course. The theory development process for the capstone course, as is typically the case for a design science research project, comprised two steps. The first step was an inductive process to construct a conceptual framework, the topology of which was described in great detail in section 5.3.3. In the second step, the components of the initial theory of coherent practice were expressed in Table 5.1. The next step involved refining and evaluating the theory of coherent practice, which was done by means of a series of action experiments undertaken during the delivery cycles of the capstone course in 2010 and 2011. How these experiments were conceived and constructed is discussed in detail in the following sections.

In summary then, the purpose of this introduction was to remind the reader of what has been done to arrive at this point in the study, and to bear in mind that the state we are now at is to *evaluate* the delivery of the capstone course by verifying the theory which was used to design it, through a series of action experiments. Given that “the utility, quality and efficacy of a design artefact must be rigorously demonstrated via well-executed evaluation methods” (Hevner et al., 2004, p. 83), each action experiment comprises a carefully structured set of interventions or activities related to a particular theme. The application of these methods themselves must be rigorous to ensure research rigour (Hevner et al., 2004). Cole et al. (2005) refer to these methods as the *forming of a plan*. The next section describes such a proposed plan, followed by the staging of the action experiments with the interventions that formed part of each experiment according to specific themes as proposed by the plan (see Figure 6.5).

6.2 The Plan

This section provides an overview of how the action experiments and the particular themes associated with these experiments were conceived. Seven themes were used to categorise the interventions; a brief motivation for this organisation is given below, to be followed in section 6.3 by a description of each individual experiment. Although the interventions for the capstone course have been revisited and refined on an ongoing basis during the evolution phases of the capstone course, the maturity of the conceptual framework (Figure 5.5 & Figure 5.6) at the start of the evaluation cycles of 2010 and 2011 enabled us to re-evaluate the suite of interventions in terms of the criteria embedded in the framework. Winter and Szczepanek (2009, p. 2) argue that all “practical action is based on some knowledge or theory” and the “important point is whether or not practitioners are aware of the theory guiding their action”. The knowledge-experience or theory-practice cycle that demonstrates the interplay between theory and practice, where the “practitioners’ knowledge is rooted in their experience of the world, and their experience in the world is guided by their personal knowledge” (Winter & Szczepanek, 2009, p. 2), reflects how the perceptions and beliefs of the researcher as course coordinator and of the teams participating in the delivery of the capstone course were engrained in the design of the theory. It also influenced the process of constructing and categorising the interventions.

The overall plan and the fields of influence that played a role in the construction of the action experiments will be described in the following paragraphs.

Firstly, it was important to revisit and determine *what interventions* were necessary to fully encompass the five key areas of the body of knowledge for a capstone course as listed in Figure 4.4 of Chapter 4. This required the construction of additional interventions where deficiencies were detected.

Secondly, it was important to ensure that the *interventions were structured* to:

- realise the intended outcomes for the capstone course as depicted by the conceptual framework, so as to develop a wide variety of applicable skills; encourage higher order learning; gain experience, and enable specific changes in student attitudes and behaviour.
- guide repetition and practice so as to nurture transcendence (Dreyfus & Dreyfus, 1986) (using Cockburn's (2002) 3-phased approach as described in sections 2.2.3 and 5.2.4).
- effectively merge relevant theory and practice.

Thirdly, in constructing the action experiments for evaluating the theory, it was necessary to *categorise the interventions* into themes (Figure 6.1) in such a way that they would foster integration and coherence, although the physical naming of the themes only happened towards the end of 2010. In this hierarchy of themes and interventions the necessary progression through follow, detach and fluency was considered for each intervention (Figure 4.4 & Figure 5.6). All the interventions, their relevant themes and the times when they took place in the course are illustrated in Figure 6.5.

Chapters 2 and 3 identified and discussed several fields of influence that have played a significant role in categorising the interventions; grounding them in the literature and verifying that the necessary interventions were properly structured and that the themes were comprehensive. These fields of influence include:

- the curriculum guidelines as found in the Computing Curricula (ComputingCurricula, 2005, 2004), IS2002: Model Curriculum (Gorgone et al.,

2002); IS2010 (Topi et al., 2010) and MSIS 2006 (Gorgone, Gray, Stohr, Valacich, & Wigand, 2006) that were revisited to re-align the interventions;

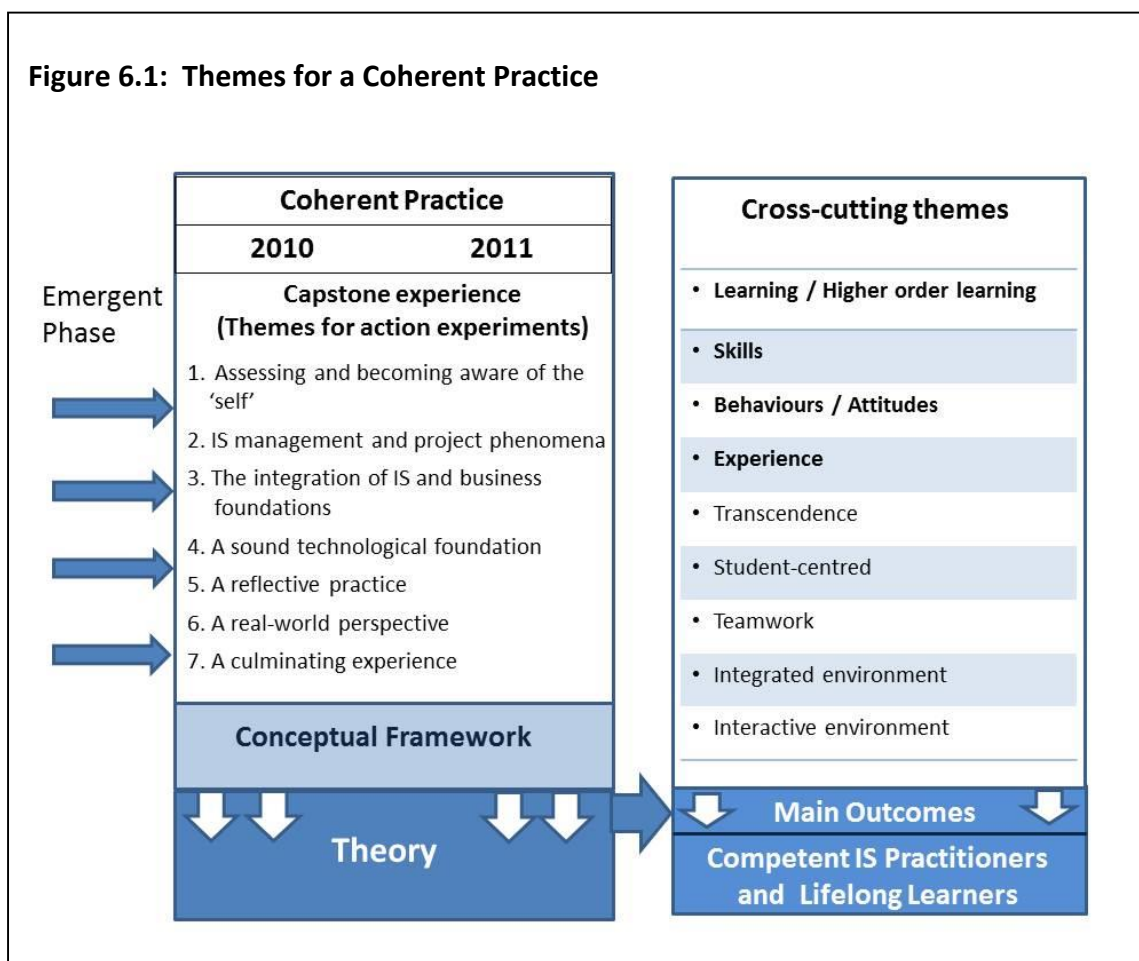
- the main areas of the Software Engineering Body of Knowledge (SWEBOK) (Bourque et al., 2004; SE2004, 2004; 610.12-1990, 1990) as well as the PMBOK® (PMI, 2004) that were reconsidered and incorporated to provide systems development knowledge and a foundation of the theory of project management;
- a new mindset of rethinking the practice of project management and emphasising a focus on project phenomena as endorsed by Cicmil et al. (2006), Winter and Szczepanek (2009) and others like Sewchurran (2008);
- the essential outcomes/objectives of capstone courses as suggested by several authors (Lynch et al., 2007; Lynch, 2007; Kumar, 2006; Lynch et al., 2004; Clear et al., 2001);
- reflections on previous delivery cycles as well as the analysis and synthesis of historical data, including research studies done and papers published during this time (see chapter 4), together with feedback from students and alumni assisted to identify issues and initialise subsequent changes to enhance individual interventions and relationships between interventions for the cycles of 2010 and 2011;
- the different theoretical lenses “for working, doing and reflection” (Llewelyn, 2003, p. 667) that were applied to the incremental steps of interventions of previous cycles to evaluate practices and those chosen to make sense of project phenomena.

The seven themes that were identified to constitute the action experiments for the theory, and which are listed in Figure 6.1, are:

- assessing and becoming aware of the ‘self’
- IS management and project phenomena
- the integration of IS and business foundations
- a sound technological foundation

- encouraging a reflective practice
- a real-world perspective and
- a culminating experience.

Figure 6.1 illustrates how these themes are situated within the theory of coherent practice (see Figure 5.6) and assist in directing the major outcomes. The cross-cutting themes shown in Figure 6.1 link to Figure 5.4 which in turn illustrates how these constructs are embedded in the environment of the capstone course and the conceptual framework (Figure 5.6).



Source: Researcher's own construct (informed by Figures 5.4, 5.5 & 5.6)

In designing the theory and constructing the experiments it became apparent that the focus of the first intervention theme had to be *assessing and becoming aware of the self*. Self-awareness creates a natural starting point of a skills development programme as all the learning we encourage students to engage in, requires that the students become aware of

themselves in the doing with others in various spaces. For example, the interventions for *a sound technological foundation* would first present students with coding workshops where they are required to follow carefully designed steps. These are then followed up with interventions that prepare them to detach, increasingly giving them more control over their actions and decision making until they reach a point where they are ready to detach and subsequently transcend as contextual experience is gained through their own systems development project, working towards fluency. This means that when students arrive at their places of work or start their postgraduate year, they are already in various stages of detaching and are ready for transcendence. A similar three-stage process is utilised in most of the interventions of the other themes, taking students through three levels of skills development (Figure 5.6). Figure 4.4 in Chapter 4 also depicts this hierarchy within some of the core interventions in the course, which are all structured to reflect the three stages of behaviour through which people usually transcend when learning and mastering new skills (Cockburn, 2002). At each moment in time a particular student will therefore be at a specific level of competence for a particular skill being acquired. Various assessment opportunities in the comprehensive assessment strategy can at given points in time help us to gauge the level a particular student has reached. For example, the comments in the individual reflexive essays, discussed in more detail in theme 5, are important indicators of a student's level of maturity with regard to team skills and team interdependence. These comments can provide evidence that students have moved beyond the novice level and beyond just knowing the concepts; they are able to identify with these concepts and use them to make changes to their own behaviour, indicating that the concepts are embodied. In the same way that we reasoned about the importance of interventions associated with creating self-awareness as a first theme, we can argue about the importance of a concluding step. The last intervention theme is thus a culminating experience providing students with a sense of pride and ownership when showcasing their projects to industry. It also includes another opportunity for reflection to make sense of a unit of experience.

In the next section the evaluation process of the seven action experiments that were conducted during the 2010 and 2011 cycles is documented and reflected upon. Raelin (2007, p. 507) argues that interventions in the practice world (the capstone course in the case of this study) should "be documented so as to know not only what is being learned, but

also how, how much, and why it is being learned”. Although very few physical changes were made to the interventions during these two cycles, any differences and changes are highlighted, with further suggestions being made where necessary in the subsequent sections. The cycles contributed holistically to the justification of the theory, however, they each also brought their own distinct learning experiences to the fore.

6.3 Intervention Themes Executed as Action Experiments

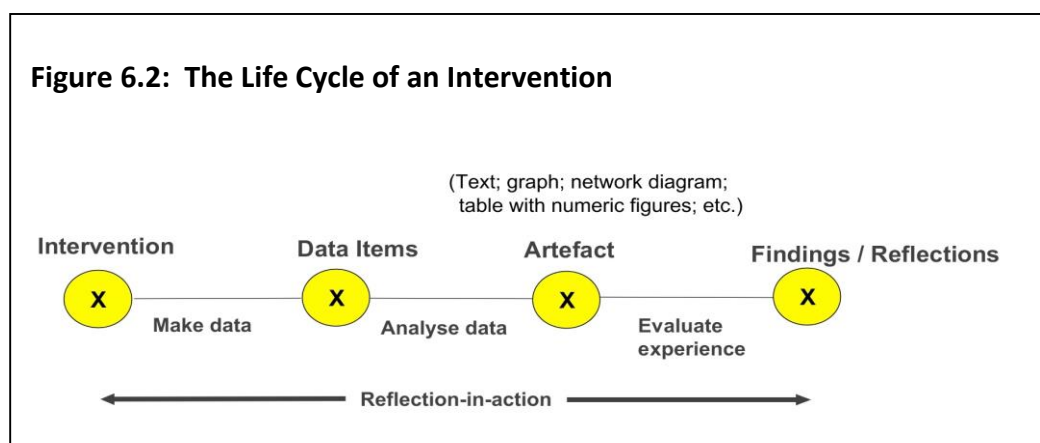
The seven intervention themes identified in the previous section and listed in Figure 6.1, are described in more detail in this section. Each theme or action experiment comprises six different steps, referred to in Table 6.1 as action elements. The different interventions in each action experiment represent the different activities undertaken in that particular experiment. The action elements are derived from exemplars of action research cycles as summarised by Iversen et al. (2004, p. 406), although unlike the AR cycles, the steps in an action experiment are executed only once during the delivery cycle of a particular instance of a capstone course. However, the general process of a next delivery of a capstone course is subject to change depending on the outcomes of steps 5 and 6 of the action experiment.

Table 6.1: Action Elements of the Action Experiments

Focus	Action elements	Description of the action element
General Process	1. Introduce the situation of concern	1. Definition and focus of the theme
	2. Define a framework of ideas	2. Providing context for the interventions and concepts to aid the evaluation of the experiment. Ideas to ground the interventions in theory and obtain support from the literature
	3. Identify and plan the activities –methodologies (what step)	3. Identify and plan the different interventions in the theme – identify their different types as well as the relevant design or methodology per type
	4. Execution of the activities (how step)	4. Execute each intervention according to a relevant method
Capstone Course Cycle	5. Evaluate the experiences	5. Using student deliverables and feedback to evaluate the experiences
	6. Reflection and learning	6. Reflect on outcomes of step 5

Although the action experiments will be discussed sequentially, the interventions of different themes often happen in parallel, or may overlap. Thus because of the way the course is structured, interventions of more than one theme may happen during the same

week. However, where a set of interventions exhibits a 3-phased structure they will naturally happen in a sequential fashion. Interventions of another set may be at a different stage of their 3-phase process, although they occur in parallel with the interventions of the other set. The specific times at which respective activities (interventions) are performed, are carefully scheduled to reinforce the interconnected and integrated nature of the different interventions. Figure 6.2 illustrates the life cycle when a particular intervention is executed, and the relevant data is collected, analysed, and presented in some or other form as an artefact (which could be any object like a graph, a text document, table or diagram). Once the experience has been evaluated, findings are obtained and further reflection can occur.



Source: Researcher's own construct informed by section 5.6

6.3.1 Interventions for Assessing and Becoming Aware of the Self

Introduction: As mentioned in section 2.2.2, Schön (1983) refers to the concept of *knowing-in-action* as a kind of self-awareness. When students become *aware of the self*, it encourages them to engage with knowledge based on experience which in turn serves as an indication that competence development is taking place. Raelin (2007, p. 509) concurs that this engagement precedes understanding and allows practitioners to “become more critically aware of their own assumptions and defences and inconsistencies between espoused beliefs and their actions”. This can provide a foundation for double-loop learning, enabling practitioners to reason and think more effectively and maximise the value obtained from actions (Argyris, 1991).

During the first two weeks of a capstone course students usually participate in a suite of four interventions: a survey (CS01), a personal interview (PI01), a life-skills tutorial (LS01) which uses introspection to assess personal values, and a mini-project as a technical exercise to assess current programming abilities. This suite of interventions constitutes the first action experiment that is documented, evaluated and reflected upon in this section.

Ideas framework: The experience of the *self* arises in the identification and sense-making of project phenomena. The ideas framework will help to direct students' attention through as-lived experiences, resulting in the following outcomes:

- an awareness and knowledge of one's own cognition styles (self-knowledge: limitations, concerns, capabilities and skills);
- an introduction to the maturation process and highlighting the need for progressing from dependence to interdependence;
- an awareness of the concept of creativity;
- an articulation of personal expectations regarding the course;
- an expression of each individual's expectations and confidence to succeed;
- an external assessment of technical skills.

Planning and methodologies: In planning the activities for this theme, the focus was on choosing interventions that would aid the building of self-awareness in an attempt to make the as-lived experience more intense and real. The objectives for these interventions are for students to assess themselves on different levels, to be assessed by others, and to introduce themselves to the other participants on the course while becoming acutely aware of their own values, intelligence psychographs, strengths, weaknesses and thinking patterns.

A survey is chosen as the first intervention to act as a self-reflective exercise and an opportunity for students to provide individual summaries of their own profiles. The interview serves as a personalised introduction and gives the course coordinator and researcher a better perspective of the student's fears for and expectations of the course.

The tutorial is designed to encourage students to start understanding themselves and to become aware of the practical implications of self-knowledge. Krathwohl (2002) in revising

Bloom's taxonomy, includes self-knowledge as a vital element in the new meta-cognitive knowledge category and refers to it as an "awareness and knowledge of one's own cognition". Self-knowledge is also termed emotional intelligence (EI) (Mayer, Roberts, & Barsade, 2008). Almost all educational, leadership and management literature states that EI is fundamental to engaging in lifelong learning and being able to work effectively with others. Self-knowledge is fundamental in the journey to move from dependence, to independence and finally to interdependence (Covey, 2004). Interdependence is the phase a person needs to be at if he/she wants to work well with others in teams and enjoy experiences in teams. Stacey (2007) thus calls for a focus that takes very seriously the everyday, ordinary experiences of our interactions with others in organisations. "Taking seriously our interdependence", instead of only advocating best practice that depends on practical tools and techniques, "leads to very different views of what is practical" (Stacey, 2007, p. 298). Raelin is most direct in implicating awareness in the learning process when he states that we should care about encouraging more knowing-in-action – "we need to pause to identify the rules and norms governing our collective understanding in the moment" (Raelin, 2007, p. 497). These viewpoints emphasise the value of practical knowledge that is not only context-dependent, but also applies to the subjective experience of the practitioner. The project practitioner thus requires self-knowledge to maximise interactions in project environments and to cope with and learn from the interpersonal relationships.

The main objective of the technical exercise is to help student gauge their current programming skills, while at the same time also providing the lecturer with an overview of the current skills level of the class. For this reason the rubric designed to evaluate the exercise is only disclosed to students once the exercise is completed in an attempt to illuminate embodied skills.

Executing activities: As the first intervention in this suite of interventions the *questionnaire (survey)* is completed on the first day of the course. It includes questions that relate to the individual's confidence in terms of strengths, concerns about weaknesses, and perceptions of the course. The survey provides an opportunity for individuals to rank themselves on a scale from one to ten on required skills listed for the capstone course. It also serves as an introduction to peers and the course coordinator as students have to list one unique

characteristic that others might find interesting. These profiles contribute towards shared understanding within the course and assist to balance skills in teams and provide useful information to those teams still looking for members.

The second intervention comprises a brief two-minute semi-structured interview with the coordinator of the course. The purpose of this informal interview is to give the course coordinator as participant in the course, a better understanding of the individual students' expectations of the course, their level of self-confidence and to stimulate ideas about creativity. According to De Bono (1995) creativity is not a natural process, but an ongoing process of expectation and demand that requires constant effort to arrive at valuable, creative ideas that will seem logical in hindsight. It is reasonable to assume that the practice of creative thinking will stimulate a willingness to accept provocation, to look for alternatives and try complete new approaches (De Bono, 1995). These aspects can play an important role in thinking about problems and finding effective solutions in the systems development environment.

The third intervention, a life-skills tutorial, is conducted in a dedicated space at a fixed time and with a maximum duration of one-and-a-half hours. It commences with a brief summary of the required pre-readings for this tutorial. Students are given a handout requiring them to complete particular tasks: identifying personal values, articulating a mission statement that relates to the fulfilment of core values, and completing a psychograph to describe their own intelligence profile.

The life-skills tutorial is specifically constructed as an exercise to enquire about the self. It is an attempt to narrow the focus on the ever-present self, thus enabling students to:

- realise that values are at the core of their attitudes, beliefs and most of their behaviour. These however, change over time and can be changed consciously once there is awareness of their influence;
- follow a structured process to estimate their values;
- articulate a mission statement that is connected to their core values;
- realise that they have multiple intelligences and they should value and focus on developing them all;

- engage with emotional intelligence in a practical manner;
- chart their psychograph using a structured process to estimate the profile of their intelligence.

The focus in this tutorial is on fostering awareness in students of the different intelligence dimensions and developing an honest assessment of their values rather than an approximate estimation.

The fourth and final element in the suite of four preliminary interventions is a mini-project. This exercise involves the development of a small programming application, given a brief description of the objectives and the requirements for the application. Students receive this exercise on the first day of term and need to complete it within 2 weeks. No restrictions are placed on what tools students can use or on the programming practices they are allowed to follow. They may, however, draw on previous experiences of what good programming principles entail. A hot seat session is arranged for those students who might need assistance.

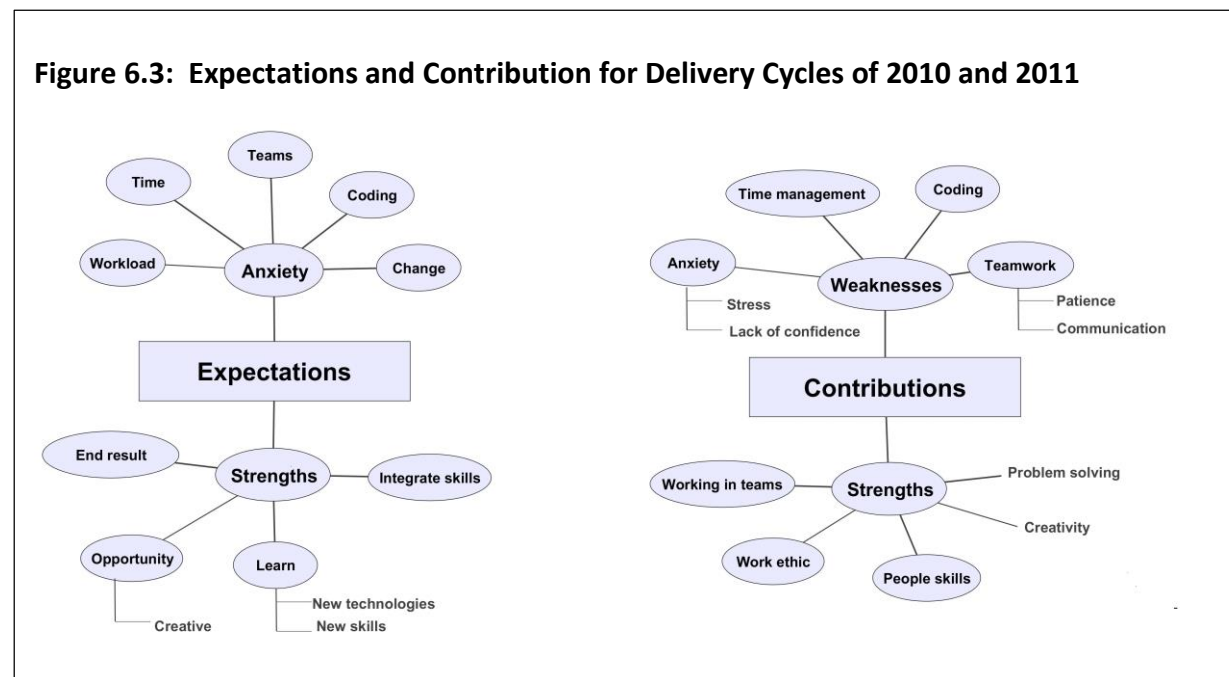
In constructing a solution for the mini-project, each individual will be able test his/her ability to:

- solve a problem and articulate the solution in programming language code;
- write code that is easy to maintain, is re-usable and involves little repetition;
- implement advanced OOP principles;
- implement the ActiveX Data Objects effectively in a .NET (ADO.NET) environment;
- utilise a three-tier architecture in the solution.

Evaluating experiences: The feedback from the surveys and the interviews for 2010 and 2011, showed similar trends. In the surveys students were required to reflect on their specific contributions, in terms of their weaknesses and their strengths, whereas the interviews focused on students' expectations, whether they were anxious or excited. Figure 6.3 summarises the main themes of these two interventions and clearly shows, as expected,

that where there were weaknesses, anxiety existed and that what students were excited about, resonated well with their strengths.

At the start of the year most students were enthusiastic about the prospective real-life learning experience and many claimed that they were hard-working with a good work ethic, had good interpersonal skills, were eager to learn and had good team skills. In most cases therefore the abilities and strengths they felt they could contribute to the course and to a team pertained to soft-skills (73% of the students claimed this for 2010, and 83% for 2011). Possible issues that might arise during teamwork were raised by a few students who were specifically concerned about dealing with team members who they thought might be lazy or incompetent.



Source: Researcher's own construct – analysis done in ATLAS ti

The greatest cause for fear and anxiety amongst students in both the surveys and the interviews, however, was their level of programming and coding skills. In the surveys of both 2010 and 2011 most students (>70%) commented that their greatest weakness lay in coding and programming skills. Except for 2006, this percentage was much higher than for previous years. It is also concerning that the average mark for the mini-project (intervention 4) for 2011 was 37%, the lowest since 2005. Despite this 'all time low' the average mark for

their coding workshops increased 30% over the first half of the course, which brought them on par with the 2010 group by the end of the year.

Comments like “... bit scared about all the work ... all the programming” (PI01, 2011); “I am fearing the coding section mostly” (PI01, 2011); “I have always been very worried about coding” (PI01, 2010); “generally just nervous about the coding levels” (PI01, 2011) showed that the anxiety referred to by Rogerson and Scott (2010) in their paper on ‘The Fear Factor: How it affects Students Learning to Program in a Tertiary Environment’ was ever-present and needed to be confronted. However, comments like “difficult, daunting and extremely difficult, but also challenging in a good way” (PI01, 2010) and “I guess I am just ready to push myself and learn in a different way ... ”(PI01, 2011) illustrated an openness to accept the challenges that lay ahead of them. Raelin (2007, p. 502) argues that the secret of learning from practice is to learn from experts who are able to revise their “cognitive patterns or frames quite flexibly in response to changes in environmental cues” (Dreyfus & Dreyfus, 1986; Schön, 1983). It was also significant that a large proportion of those students who claimed to be afraid of programming, expressed the intention or commitment to improve their programming skills (63% for 2010 and 44% for 2011 out of the total number of students).

Table 6.2: Top 8 Core Values

2010 - Top 8 Core Values	#	2011 - Top 8 Core Values	#
Integrity	6	Integrity	6
Honesty	5	Honesty	4
Open-mindedness	7	Open-mindedness	4
Learning	4	Learning	4
Compassionate	4	Love	8
Excellence	4	Dedication	4
Passion	4	Having Fun	4
Gratitude	5	Family	10

Table 6.2 lists the top 8 core values chosen by 4 or more students out of 92 possible values that could be selected for the life-skills tutorial. In 2011 four students also chose respect and religion. The occurrences of all other values were less than three for that specific year. It was interesting to note that the top core values students chose, were similar for 2010 and

2011. Four of these values (integrity, honesty, open-minded and learning) coincided for 2010 and 2011, while compassion can be associated with love, and similarly excellence and dedication can be associated because a high degree of dedication is required in striving for excellence. In this tutorial, students were also asked to articulate their mission statements in a way that was closely related to their core values and provided insight into what they would like to be remembered for and who they would like to be remembered as. Students treated this task with seriousness and sincerity, and their statements reflected an acute self-awareness and maturity, exhibiting characteristics that could be associated with the individual students throughout the year.

In summary it was evident from the interventions of this theme that at the start of 2010 and 2011 students mostly felt confident about their soft skills and believed that they could contribute positively to a team environment, although they were not always as confident that everyone else in the team shared these sentiments. Despite the fact that both the surveys and the interviews clearly indicated that students were not at all confident about their coding skills, they showed a keen interest in developing these skills. Students generally had high expectations of the real-life project experience and looked forward to delivering a complete solution while getting valuable project management experience and learning to interact effectively with all stakeholders, including their team members.

One can thus argue that at the start of a year students are generally unsure of themselves, although they are starting to become more conscious of their incompetence. In terms of Dreyfus' (Dreyfus & Dreyfus, 1986) 5-stage model they are at the novice stage. The interventions in this theme thus serve to help students acknowledge that although they lack confidence and do not yet have the necessary skills to act independently, they can be guided through different stages of development (Cockburn, 2002).

Reflections and learning: Although the four interventions were designed individually, it became apparent when reflecting and completing the table of Bloom's revised taxonomy (Krathwohl, 2002), that there are several corresponding objectives addressing the same elements of the cognitive process from different knowledge dimensions, which suggests that the individual interventions in fact tested similar concepts (Figure 6.3). The relationships that emerged between those interventions that specifically focused on

building the students' meta-cognitive knowledge (self-knowledge, contextual and strategic knowledge) emphasised *the value of nurturing different perspectives, commitment and expectations*. Quotes like "... but it is kind of do-or-die and I would rather be creative and not die ..." (PI01, 2011) and despite being scared about "the long hours ... I am excited to see the end-result" (PI01, 2011), further demonstrated the increasing importance of students' awareness "of their meta-cognitive activity, and then using this knowledge to adapt the ways in which they think and operate" (Krathwohl, 2002, p. 214).

The honesty of the students when doing the life skills tutorial was never more apparent than when we presented the mission statement and core values of one of the students at his memorial service, after his tragic death in an accident a few days after this intervention in 2011. What he wrote about himself reflected exactly what everyone else said about him at the service.

6.3.2 Interventions to Address the IS Management and Project Phenomena

Introduction: Within this theme the focus is on the different stakeholders of the team projects, the activities they are involved in, and the phenomena that emerge when they interact. Interventions under this theme therefore include:

- lectures with a project management focus;
- the selection of project teams;
- project team activities related to finding a project sponsor and getting engaged to resolve a particular situation of concern;
- regular team meetings with this sponsor;
- regular meetings with the project manager (usually a faculty member acting in this role) or team meetings;
- a mid-year exam with project management as core focus;
- weekly team-update reports in the second half of the year, and a peer evaluation process at the end of the course.

Ideas framework: Interventions in this theme are structured to *highlight and address the complexities inherent in human interaction in the organisational process*. The idea is to bring about a shift to focus on project phenomena instead of following a best practice approach that prescribes the rigid implementation of specific practices. Winter and Szczepanek (2009) argue that managers and practitioners who are involved in projects face many difficult challenges, as projects are many things at once; projects are complex, multifaceted and can include paradoxical concepts and elements. They encourage a change from an instrumental approach, where rigid adherence to a process is expected to automatically yield a successful outcome, to an alternative approach supporting the broader vision that learning creates a deeper understanding of the project life cycle. In line with the arguments provided in Chapter 3, the focus extends beyond delivering a project within budget, to specification, and on time, by emphasising the importance of fostering a willingness to be challenged and an openness to new ideas that can lead to value creation.

The field of IS is heavily reliant on teamwork to improve the quality of information systems (Meyer, 2009; Jones & Harrison, 1996). Teams in the workplace not only have a profound effect on productivity, but also make organisations more responsive and have several intrinsic benefits for both employees and customers (Beard et al., 2007; Katzenbach & Smith, 1993). It is thus evident that *teamwork is important in industry* and that universities should better prepare students for real-life projects. One of the main benefits of team projects in tertiary education is to provide students with real experience of the multiple and diverse roles that are characteristic of the daily life of an Information Technology / Information Systems (IT/IS) specialist in industry (Scott & Pollock, 2006).

Students are typically encouraged either to find their own project sponsor with a business problem that is a good fit to the project theme chosen for the particular cycle, or to tender for an existing project proposal. This approach is used to encourage buy-in early on in the project. *The challenge of finding and/or choosing a sponsor equips students with a sense of responsibility and commitment*, more so than would be the case if they were just assigned a specific sponsor. Special attention is also given to assist students in managing their project teams by providing them with theoretical lenses as coping mechanisms to effectively execute various team roles and resolve related team conflict.

Planning and methodologies: Lectures are seen as phase 1 interventions reflecting the *following* stage of Cockburn's (2002) theory (Figure 4.4 and Figure 5.6). These lectures not only provide students with core concepts of project management, but also lay the foundation for developing a changed mindset. This includes a focus on ultimate value that encourages a deep personal identification with project goals, a collective responsibility, a willingness to continually adapt, and a learning orientation, amongst others. The guided reflection exercises in the reflective practice theme, where students are required to reflect on their experience and extrapolate learning from it, are closely linked to this theme and assist to further emphasise and draw attention to the phenomena associated with the project. The real-life project management experiences in teams and meetings with project managers or sponsors can be regarded as phase 2 or even phase 3 interventions, depending on how much guidance the team receives or how innovative the team becomes when conducting these meetings. This will be dependent on their situated knowledge when applied in a specific context of a particular project. A facilitated self-selection approach is used whereby teams select their own members and peer-evaluations are included in the summative assessment at the end of the course to be able "to recognise individual contributions to group performance" more effectively (Scott et al., 2005, p. 61). While peer-evaluations are used to gauge team contributions, a mid-year project management exam is conducted to gauge individual performances and also contributes to the summative assessment at the end of the first half of the course.

Execution of activities: As said above, the *project management lectures* are regarded as phase 1 interventions and are structured to ground students in the principles of project management; while at the same time emphasising and fostering an acute awareness that key assumptions made by approaches such as PMBOK® do not necessarily hold for IS projects. As mentioned in Chapter 3, approaches like PMBOK® tend to focus on control through the measuring and monitoring of predefined processes in a linear and sequential manner, based on the rigid implementation of templates and concepts, rather than encouraging a flexible approach that is more than often required in IS projects.

The *facilitated self-selection team process* does not compromise too much on team diversity as diverse groups are often formed naturally once students are made aware of the benefits of a diverse team. As discussed in section 3.4.3, Partington and Harris (1999) found that

highly diverse teams did not necessarily perform better, and Winter (2004) found little correlation between role-diversity and performance in his study on team role-diversity among computer science student teams; although at least one strong member can influence the performance of a team (Pollock, 2009). The profile surveys of theme 1 also aid teams looking for members to find those most suitable. Project teams are furthermore encouraged to be self-managed to a large degree. Du Brin (2002) explains that self-managed teams tend to be far more productive with a higher level of overall performance due to the feeling of ownership instilled in each team member. Each team prepares a team contract to motivate and confirm the selection of roles for each of its members, including a project leader, head programmer, head documenter, communications officer and quality controller. The specific roles do not however exclude team members from other project activities, in fact it is expected that they will participate in all activities, specifically in the project build phase and coding activities. A faculty member acts as a project manager for each team; where possible these project managers are also course lecturers, although this will depend on the number of teams in a particular year.

As soon as teams are formed, they need to *find a sponsor with a business problem that is a best fit to the project theme* chosen for the current cycle. In recent years we have also had a pool of project requests from industry or the wider community and some teams will tender for these existing projects, which are then allocated on merit. Each team receives a *sponsor pack* containing relevant documentation addressed to the proposed sponsor. This includes a project brief and a letter of introduction; a sponsor contract to define the terms of the systems development project agreement between the sponsor, the team and UCT; and two sponsor evaluations to be completed at pre-determined dates halfway through the course and also after the final project hand-in. Sponsors complete these evaluations using scoring rubrics that guide them to prepare consistent feedback to the teams. *Meetings with project sponsors* commence with a kick-off meeting for each team. Since it is the first time most of the students have formal interaction with sponsors in industry, they are briefed in advance and are given a template to assist them to coordinate the kick-off meeting. All subsequent sponsor meetings and interactions with the respective sponsors become the responsibility of the individual teams.

Regular project manager meetings are scheduled for quality assurance purposes and to provide feedback to the teams on the interim project deliverables. Teams then have the opportunity to improve the quality of these deliverables by incorporating the feedback they receive.

As teams are mainly self-managed, they are accountable for their own team meetings in preparation for a deliverable or to address issues of concern. *Peer assessment practices* are applied to final grades to eliminate discrepancies between the contributions of different team members.

Evaluating experiences: Interventions in this theme played an important role in the life cycle of the capstone course as they introduced students to project phenomena, set them up for the *game*, as Cockburn (2002) calls it, and became part of their as-lived experiences. *Finding a team* and *finding a project and project sponsor* are vital and stressful activities at the beginning of a year and can influence the students' lives significantly for the rest of the year: "WORKING WITH THE SPONSOR OF YOUR CHOICE, all I can say is the course is real" (CE01, 2010). In addition, students value the "knowledge gained in building a real-life information system and working with people (group, sponsor, PM, etc) ... to create a good finished product" (CE02, 2011).

The facilitated team selection process is not an activity taken lightly, as it impacts students' lives as well as their grades. Although it was not always possible to satisfy all criteria, an honest effort was made at all times to do the best under the current circumstances. In this respect the survey and interviews of theme 1 helped to balance the team-forming process. Where teams suggested their own sponsor and project, careful consideration had to be given to the specific situation of concern, critical assumptions about the proposed project, prerequisites, requirements and the possible risks, before it was accepted. Students could tender for projects that formed part of the pool of already evaluated project proposals received from external sources.

The regular meetings and interactions with the sponsor and with lecturers in the role of project managers helped to elicit the project requirements and simulated a real-world scenario. Many of the students commented in the course evaluations at the end of the first

semester (CE01) and the second semester (CE02) that they enjoyed this real-life experience, as the comments in Table 6.3 illustrate. Comments were mostly positive, except for one comment of a student in 2010 who complained about “uncooperative sponsors not being available for meetings, etc.” when they needed them (CE02, 2010). In another incident, a student reflecting back on 2011, commented that “in hindsight ... our requirements gathering was too pathetic and non-existent” (PIP01, 2012) and felt that the lesson learnt through this experience would help them to address this issue more effectively by meeting the key stakeholders at the beginning of their honours project of 2012.

Table 6.3: Positive Aspects of the Course: Communication and Real-world Experience

Interactions and Communications (course evaluations 1 & 2 (CE01 & CE02))	Real-world Experience (course evaluations 1 & 2 (CE01 & CE02))
... energy and ‘approachfulness’ were awesome (CE01, 2010).	Real-life scenario, dealing with real people, problem, situation. Gaining valuable experience (CE01, 2010)!
The resources and extra support that are given to help us with completing the project (CE02, 2010).	The project allows for guided freedom, I really enjoy this aspect of the course (CE01, 2010).
Interaction and free communication with lecturers (CE02, 2010).	The fact that we were able to develop a real-life project with the support and mentorship of our lecturers (CE02, 2010)
...and meeting with the PM is one of the best parts because they guide your thinking and give constructive criticism, in a very relaxed environment where everyone can participate in the discussion effectively (CE01, 2010).	Getting hands on experience. Communication with our sponsor and actually filtering out their user-requirements (CE02, 2010).
Thanks ... for pushing us during the initiation and planning phases (CE01, 2011).	Teaches about the real working world (CE01, 2011).
I can easy interact with lecturers, ask questions and [accept] help (CE01, 2011).	Provides good project experience - Working on a large project helps with real-world cases (CE01, 2011).
Great communication between lecturers and students helps to make material easier to understand (CE02, 2011).	Practical experience of building a system; Project was very helpful as a guide to an IS profession (CE02, 2011).
Communication was great. PM was very supportive (CE02, 2011).	The experience and pressure of trying to solve a real-world problem (CE02, 2011).

Peer evaluations at the end of the project provided deep insight into the difficulties of teamwork. The most pressing issues in 2011 were a lack of communication, the loss of team members, and team member isolation due to the fact that some members did not always pull their weight. In 2011 four of the six teams mentioned that communication was a serious issue at certain stages during the project. It was particularly difficult because three

teams each lost a member who deregistered from the course, with one of those teams actually losing two members due to the death of a student in an accident at the beginning of the year. These personal issues left some teams feeling more desolate than others, and one team member commented that “the way teams are chosen is messed up”; although a member of another team, who was initially also very negative about losing a team member, later responded with “I am so glad that I have had this experience!” (PE01, 2011). The first team however was in dire straits with their coding as the member they lost had better coding skills, and it was necessary to provide them and the other team who lost two members with a dedicated tutor from June until the hand-in date in September. In another team, one student never felt part of his team and one of his fellow team members reported that

I don't know the actual reason for that, but from my take; he didn't accept himself as the member of the team. All these were proved by poor meeting attendance, not respecting our team deadlines. However on the side he had valuable skills, very much but all those skills and his knowledge were of no use because he could not work with his team (PE01, 2011).

In another team one of the members admitted that “I would feel wrong if I was the reason my team members do not receive the mark they rightly deserve. Therefore I hope that the mark weighting is reflective of my weighting above” (PE01, 2011). Although the team struggled with their communication with this member and his mark was affected negatively by the peer-review process, members of the examination panel for this team’s project, concluded that the particular section this student contributed was of a high standard, and enhanced the value of the project significantly.

Although there were also communication issues in 2010, including an apparent lack of commitment and one team losing a member, fewer critical issues were experienced with the teams during 2010 than during 2011. Some members of one of the 2010 teams commented that “we [they] did not take the project seriously in the beginning stages. In the end we managed to pull ourselves together and get the work done” and “at times there was conflict amongst team members that just lead to team members not participating at

times” (PE01, 2010). A member of another team commented that their “team was composed of members with different working ethics, our working systems did not complement each other as we worked differently” and another team member added that “this has been the most complex team I have worked in. We lost a team member halfway through the projects and we could not seem to agree on most things in the system” (PE01, 2010). On the other hand however, team members also reported that it was “great working with my team-mates, can’t imagine myself being in another team. We had our ups and downs, but we managed to resolve our issues” or “we managed to play off on each other’s strengths and weaknesses ... just got to chill! Team conflict will most likely occur at some stage. Just put your head down and do your part, contribute and be understanding and friendly!” (PE01, 2010).

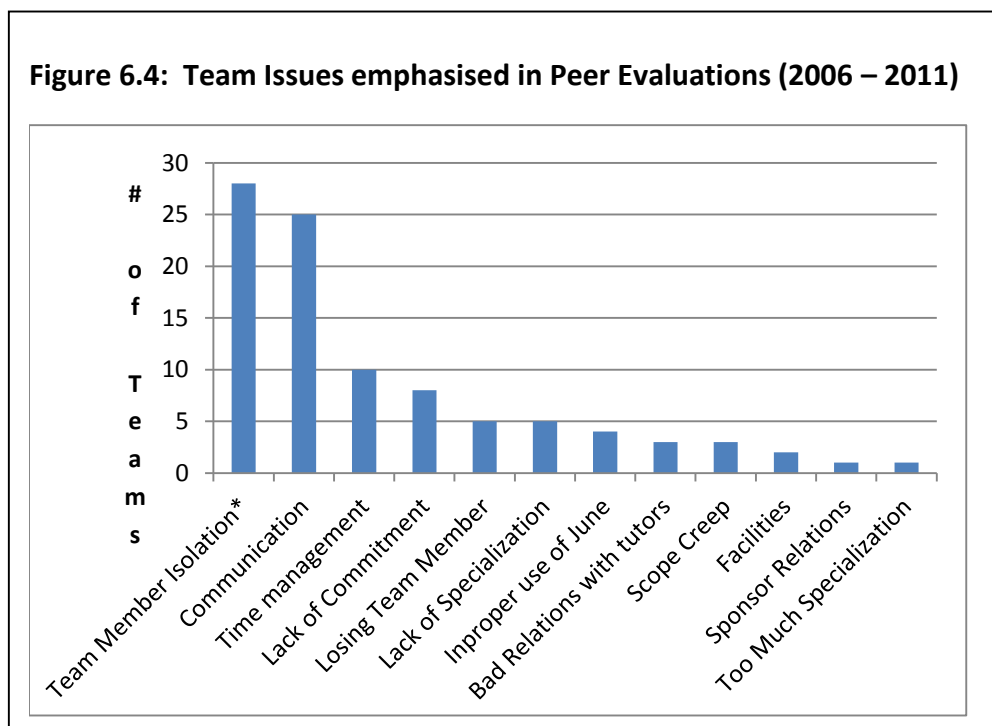
Many of the above comments confirmed that teamwork is complex, often unpredictable and some team members could be traumatised by the experience; nevertheless the comments also confirmed that the as-lived experience of the project “was a good challenge, and I learnt a lot!” (PE01, 2011).

Reflections and learning: *Changing the configuration* from 5-member teams to 4-member teams in 2010 caused some disruption in the team selection process and demotivated some team members – “I don’t want to be in a group with people like me because I won’t learn much” (PI01, 2010). Furthermore, the loss of 4 team members across three of the six teams at crucial stages of the capstone project in 2011 created the need for serious facilitation and support for the affected teams – “We came out strong but I’ll still question the way in which, you know there’s several ways of getting up Mnt Kilimanjaro. We don’t always have to take the hardest route, but that was our fate” (PIP01, 2012). Resolving the issues effectively was not always possible.

The realisation of the benefits of the team process became evident as teams not only recognised the challenges resulting from working in teams, but also came to appreciate the important benefits of this experience. The preselected readings on team dynamics, communication and shared understanding greatly enhanced the students’ understanding of team concepts, as shown in theme 5. The implementation of these concepts made the lived experience of the team process more intense and enjoyable, despite the issues that were

experienced, especially in 2011. The graph in Figure 6.4 depicts the typical team issues experienced from 2006 – 2011 for a total of 56 teams over this period, and clearly shows that member isolation and problems with communication were the most common issues. During this period only 5 teams lost a team member and of these teams 3 were from 2011 (with one team losing 2 members) and 1 from 2010. Top performing teams did not always experience fewer issues; in 2010 the 2 least harmonious teams were placed in the top three, and this was also the case in 2011 where 2 of the top 3 teams experienced some issues.

When challenged and entrusted with responsibility to find best-suited sponsors, teams responded well and lived up to expectations – *responsibility encourages commitment*. The environmental and community focus of the project theme seemed to provide additional motivation and student teams managed the process of matching the criteria of the project theme to that of a specific business problem very effectively. The teams further seemed to appreciate the experience they gained in the subtleties and complexities of the *interaction with users in real organisations*, as most of the team members had no prior exposure to computer technology and applications in business.



Source: Excel spreadsheet, Peer-evaluations (PE01)

Answers to questions in the 2010 mid-year project management exam highlighted that students still struggled with concepts relating to the new mindset of the project manager and the limitations of *Methodism* (Introna & Whitley, 1997). A few of the students however, seemed to have gained the necessary insight and answered these questions exceptionally well. In 2011 these concepts were tested again, albeit a bit differently, by requiring students to submit a second reflexive essay as part of the exam. The students in 2011 seemed to perform better using this approach, as shown by the average marks for the project management exams of 2010 and 2011 which were 57% and 65% respectively.

6.3.3 Interventions and the Integration of IS and Business Foundations

Introduction: Interventions in this theme are closely linked to the interventions in the previous theme and are crafted to link concepts of systems development, project management and quality management when designing and producing artefacts during the systems development life cycle of the student team project. These artefacts typically include a business case, a user requirement document and a systems design specification and are therefore classified into three streams related to each of these milestone documents (Table 6.4). The aim of the interventions in each of these streams is to guide students into mastering new skills while passing through Cockburn's (2002) three stages (phases) of following, detaching and fluency when producing core artefacts for their systems development projects (Table 6.4). The structure of each intervention exhibits characteristics of one of the three phases of follow, detach and fluency and as before, complexity and responsibilities steadily increase, guiding students to act and become more autonomous when doing interventions where a degree of fluency is expected from them. This again confirms the rationale that knowledge necessary to perform useful work cannot be, and is not a body of information to be learned, and learned once only.

Ideas framework: As students transcend through the different levels of skills acquisition, it is paramount to acknowledge that they *live* through several cycles of the knowledge-experience cycle where "prior knowledge assessment is essential to establish levels of competency before advancing to the next level of instruction. Transfer means that new concepts and information are not only understood, but that they can be applied and used in new situations" (Scott & van der Merwe, 2003, p. 179) and different contexts. The

comments in Table 6.3 indicate that valuable inputs from regular sponsor meetings and the faculty member acting as project manager are essential to guide teams during the deliverables to work more efficiently as individuals within a team. The objectives of this facilitation process are to assist teams to:

- identify the business problem and be able to define it succinctly;
- cope with the difficulties of obtaining user requirements and the changing nature of these requirements;
- evaluate alternative solutions and come up with a recommended solution;
- apply their prior knowledge (theoretical, as well as practical);
- acquire new specialised skills to solve their specific business problem;
- deal with and manage customer expectations and scope creep;
- analyse and design the proposed system.

Planning and methodologies: The intervention streams shown in Table 6.4 comprise sequential, well-defined interventions where each intervention was designed at a specific level of behaviour (following, detaching or fluency) (Cockburn, 2002). This process forms part of a deliberate effort to prepare and guide students to transcend through the first three stages of skills acquisition as advocated by Dreyfus and Dreyfus (Dreyfus, 2004; Dreyfus & Dreyfus, 1986). A formal continuous assessment approach constitutes a key strategy in the assessment of the interim deliverables to provide dynamic and ongoing feedback on the explicit criteria of the deliverables.

Executing activities: Three main artefacts or milestone deliverables are produced as a result of the three different consecutive streams of interventions under this theme, and are depicted by Stream 1: Project Definition; Stream 2: Systems Analysis and Stream 3: Systems Design, in Table 6.4. Each row of the table illustrates the different characteristics exhibited by the interventions in that stream, as they are structured to reflect the following, detaching and fluency stages.

The tutorial-based intervention (stream 1, Table 6.4) is regarded as a phase 1 intervention, guiding teams in a step-by-step manner to complete the main sections of a business case. A

mini-case study, a business case template and additional readings form part of this tutorial. Two masters students and the course lecturer acted as tutors during these tutorials while the students worked in their various teams to complete the tutorial. The case study and the process remain the same for the two subsequent tutorials (see Table 6.4) of stream 2. In this case however, the tutorials contributed concepts needed for the user requirements deliverables.

Table 6.4: Intervention Streams in a 3-Phased Approach

Stream	Concepts and Prior Knowledge	Case Study 1 and Tutorials	Case Study 2 and Pilot 2 Deliverables (D0)	Project Interim Deliverables (ID0)	Project Milestone Deliverables
		<i>Following</i>	<i>Following</i>	<i>Detaching</i>	<i>Fluency</i>
1	PM Lectures	Business Case	D01.1 and D01.2	ID01.1 and ID01.2	Business Case (M01.1)
2	Second year Systems Analysis	Use Case Points Estimate and Risk and Quality Management	D02.1 and D02.2	ID02.1 and ID02.2	User Requirements Document (M01.2)
3	Second year Systems Design	----	---	ID03.1, D03.2 and D03.3	Systems Specifications Document (M01.3)

Subsections of deliverable 1 (ID01.1 and ID01.2) refer to aspects of the business case and the project initiation statement, whereas subsections of deliverable 2 (ID02.1 and ID02.2) include the project definition statement and relevant Unified Modelling Language (UML) diagrams to represent the user requirements. Teams first practised these concepts by applying them to a second pilot project (see section 6.3.4). Once they had prepared and presented selected aspects of these deliverables to their peers, they gained more confidence to detach and transcend as they applied the same concepts in a different context to the deliverables of their own project. Dreyfus and Dreyfus (1986) confirm that as students gain experience they begin to understand the relevant context of subject material and recognise recurrent and meaningful patterns. These students begin to cope with real situations like preparing the deliverables for their own projects with some degree of fluency as they transcend from being novices through to becoming advanced beginners.

During the project manager meetings the interim deliverables are discussed and challenged and the completion of tasks in the project plan is monitored using a Gantt chart. These interactive feedback sessions act as a quality assurance mechanism and enable teams to improve the deliverables before compiling them into a final milestone deliverable (Table 6.4). Analytical rubrics are used in the dynamic assessment of interim deliverables as part of the continuous formal assessment over the duration of the course.

Less hand-holding happens in stream 3, and no following and detaching interventions precede the compiling of the subsections of deliverable 3 (ID03). Deliverable 3.3 constitutes a mock presentation in the second semester to gauge the individual teams' progress towards the completion of the build phase.

Evaluating experiences: During the planning stages of the intervention themes discussed in section 6.2, the importance of guided repetition and practise was highlighted, as well as the fact that students need to try out their contextual knowledge in order for it to become grounded and embodied (Maturana & Varela, 1987; Schön, 1983). In this theme these ideas were put into practice and as the students reported, it allowed them “to be able to interact with the business world and to carry out a real large project doing the deliverables step-by-step” (CE02, 2010).

Table 6.5: Average Marks for Documentation Deliverables in 2010 and 2011

Documentation:	Tutorials	Deliverables	Milestones	Final Project Mark
Phase:	<i>Follow</i>	<i>Detach</i>	<i>Fluency</i>	
	Average %	Average %	Average %	Average %
2010	68.99	68.63	71.21	66 2 teams > 80; 4 teams: 60-69 2 teams: 50-59
2011	76.42	61.02	72.06	67 2 teams > 80; 1 team: 60-69 3 teams: 50-59

Table 6.5 shows, quite surprisingly, how similar the marks for the different deliverables were in 2010 and 2011, despite vast differences in the teams and team dynamics during

these years as well as the more obvious lack of coding skills in 2011. The fact that the teams performed slightly better in 2010 than the teams in 2011 when comparing the individual marks for the final project and the overall distribution of these marks, could perhaps be attributed to these differences.

Reflections and learning: Maturana and Varela's (1987) phrase of "All doing is knowing and all knowing is doing" suggests that students need opportunities to try out their conceptual knowledge for it to become contextual or grounded and hence do-able in real life or knowledge-in-action (Schön, 1983). To be effective, this cannot be implemented as a once-off activity, but needs to be repeated for different situations and contexts. It is thus evident that *for transcendence to take place, conceptual knowledge needs to be transformed into contextual knowledge*. Reliance on theory or conceptualisation alone may limit problem solving abilities, as new or real-life problems are not always coherent or easily defined.

This strategy further assisted students to guard against a generic approach and to become *suspicious of method adherence*. Introna and Whitley (1997, p. 31) suggest that the "effective use of methodology itself depends on a broader, already present, understanding of the world, an understanding not to be found in one particular methodology".

6.3.4 Interventions for a Sound Technological Foundation

Introduction: All interventions under this theme refer to systems development with a specific focus on the implementation of software engineering principles and the development of a real-life information system from requirements to code. These interventions include coding lectures, coding workshops and the systems build phase of the team project (see Table 6.6). We believe that the driving force for learning and growth should be internal to every student: students should value being a resource, have confidence in their ability to acquire knowledge, and not be fearful of self-learning. For this reason interventions in this theme are structured to implement strategies such as experiential learning and project-based learning as effective means to teach programming principles and give students a sound technological foundation. This approach imbues students with an understanding of systems development projects that will allow them to mediate future environments with some level of confidence.

Ideas framework: From experience we know that students *struggle with abstraction and problem solving*. Because of their own lack of business experience, students often have difficulty in understanding business requirements. In addition, as discussed in section 3.4.4 and in Chapter 4, the abstraction involved when translating requirements into code presents a considerable challenge, more so since students often experience difficulties with fundamental coding principles. This is especially true in the case of IS students who are often less technically oriented than their counterparts in other computing disciplines, as IS courses generally involve less technical content. As a result students may be inadequately prepared for the technical demands of the capstone project and might resort to procrastination or avoidance of related tasks. These attitudes often manifest as a fear of learning to programme; or once basic concepts are mastered, a fear of tackling the more advanced concepts required in the systems development environment (Rogerson & Scott, 2010). Robins, Rountree and Rountree (2003) echo these concerns regarding the learning and teaching of computer programming in the Computer Science and Information Systems fields and the high attrition rates associated with courses of this nature. Jenkins (2002, p. 53) concurs, as mentioned in Chapter 4, that we cannot deny the fact that learning to program is challenging and hence students struggle with it. “It would seem that in order to teach more effectively, it is essential for educators to have an understanding of what it is about programming that makes learning it so troublesome for many students worldwide” (Rogerson & Scott, 2010, p. 148).

Over the past decade various methods have been implemented in the capstone project to encourage students to learn programming and to provide the necessary and effective support that is suggested by Robins et al. (2003). In line with D’Souza, et al. (2008) we believe that *a well-planned mentoring program* can help to restore students’ confidence in their programming abilities. We also agree with McCartney, Eckerdal, Mostrom, Sanders and Zander (2007) that practise, persistence, social networks, step-by-step instructions and a carefully designed coding framework are vital elements in guiding students in their systems development endeavours.

We further strongly support the idea that students should be *guided in the programming paradigm* to transcend from uncontrolled chaos, through controlled quality to crafted quality where students can take ownership and have full control over their systems

development endeavours. We believe that this transcendence can only be accomplished if an approach comprising multiple methods is implemented. This means that the most suitable approach must be selected for a specific implementation at a specific time or level to accomplish the desired objectives throughout the course (Caspersen & Bennedsen, 2007; Mead et al., 2006; Thomas, Ratcliff, & Thomasson, 2004). Various kinds of scaffolding form effective mechanisms for students to use as a base on which to build and enhance their technical skills. In designing the systems development interventions, great care is taken to provide clear directions, with a set purpose, using methods that allow students to complete the task whilst providing continuous and formative feedback and assessment and allowing for flexibility.

Programming can also be an *intensive group activity*. Cockburn (2002, p. 30) concurs that “although programming is a solitary, inspiration-based, logical activity, it is also a group engineering activity”. In this respect the project as a serious group activity is a key intervention in this theme.

Planning and methodologies: The interventions in this theme are structured to support students through the first three of Dreyfus and Dreyfus’s (1986) five stages of adult learning: Novice, Advanced Beginner, and Competent Performer. Each individual intervention also exhibits the characteristics of the 3-phased approach (following, detaching and fluency) depicted in Figure 4.4. Table 6.6 relates the characteristics of each particular intervention with the stage of adult learning where its use is most appropriate.

The interventions comprise special lectures to convey advanced programming concepts; the development of two pilot systems that build on a coding framework for an integrated, object-oriented, n-tiered system; a workshop week to get teams started on their individual projects; and finally the build phase of the project where each team takes complete control of their development process. The coding framework emphasises the difference between logical and physical architectures and helps to illustrate how n-tier architectures can help to decrease complexity in large systems. The framework further supports general software architectural aims which are widely known and practised such as minimal coupling, maximum cohesion, deployment transparency, and location transparency, as well as platform and language independence. This approach builds on the philosophy that well-

designed logical n-tier architecture will ensure that code is easy to read, understand and logically organised, and promotes code-reuse to facilitate easier maintenance and provide a better team development experience. A typical logical separation will be a user-interface layer, a business layer and a data layer, whereas the physical separation will depict an application spread over multiple machines, like a client, a web-server, an application server and a database server. Lhotka (2006) argues that if these physical architectures are poorly designed it can cause more damage than good. However, when carefully chosen, they can enhance performance, scalability, fault tolerance and security.

During the development phase students are required to identify and learn to use appropriate tools that will assist in designing elegant and efficient software solutions. Interventions are designed to adhere to Software Engineering Institute (SEI) guidelines and principles to improve software engineering practices by getting real-world experience in the five key focus areas of software development (Software Requirements, Design, Construction, Testing and Quality).

Quality is emphasised and special attention is given to utilising different approaches to validate and test the applications, which includes the creation of a comprehensive set of test cases for each individual team project.

Executing activities: In the programming interventions, students are introduced to problem-solving, coding and testing issues through an action learning cycle. As explained in Chapter 4, a series of seven workshops is designed to develop the first pilot system. A step-by-step approach is used to introduce the students to the coding framework. At every workshop in the series students are given a skeleton that usually comprises the solution of the previous workshop and a text document containing the step-by-step instructions for the enhancements to this particular solution. Every handout for the series contains the objectives for the workshop, a reference to the systems specifications, important aspects concerning this particular implementation, some assumptions, and the steps to complete the process. Great care is taken in the design to ensure that students will be developing a *working product that will run* at all times. Several opportunities during the process allow students to reflect, answer brief questions, test their application for given values or determine whether it does what it is expected to do at this stage. During these workshops

the emphasis is on working correctly and quickly, and on managing one's time carefully and effectively in order to submit a complete solution by the cut-off time. These workshops teach students to be alert, to focus and concentrate on the task at hand. The high attrition rates for programming suggest that students might try to avoid programming exercises if these practical exercises were given for homework only.

As described in Chapter 4, the second pilot system is designed to run concurrently with the first pilot system, but each of the four consecutive workshops for the second pilot is scheduled after every second workshop of the first pilot system. The hand-outs for this series only comprise short briefs about the business problem and the requirements that need to be included in each specific workshop. Although the students still find themselves in a secure environment where they can re-use the framework and the concepts of the two preceding workshops of pilot 1, they no longer follow step-by-step instructions, and are challenged to demonstrate their own understanding and expertise that will enable them to detach.

Table 6.6: The Different Phases and Stages of the Programming Interventions

Concepts and Theories-in-use	Pilot 1 and Tutorials	Pilot 2	Component 1	Project
Characteristics exhibited by the structure of the intervention (Cockburn, 2002)	<i>Following</i>	<i>Detaching</i>	<i>Detaching</i>	<i>Fluency</i>
Coding lectures and mentorship program	Series of 7 workshops	Series of 4 workshops	1-week workshop to kick-start the project	Autonomous systems development phase (Project)
The stage of adult learning addressed by the intervention (Dreyfus & Dreyfus, 1986)	<i>Novice</i>	<i>Advanced beginner</i>	<i>Towards competent performer</i>	

During both the pilot systems, the main aim is to develop and reinforce students' understanding of advanced programming principles and thus provide them with a good basis for commencing the development of their individual team projects. This process is kick-started by a workshop week where students can test the water and develop a first

component for their system. Weekly update reports are required in the second half of the year to keep the researcher and coordinator of the course updated with the progress of each team, and where necessary to address pressing issues. Tutors are also scheduled to provide hot-seat duties during this period. Although regular hot-seat duties are provided during the building phase and especially during the week before the hand-in date, students are mostly responsible for their own learning and research.

For the systems development team project students are expected to develop a comprehensive web-based system using a 5-layer logical architecture, with a presentation layer, user interface layer, business logic layer, data access layer and finally, the data storage layer. The focus is on a credible and convincing solution that not only demonstrates a good understanding of the business problem, but is also developed using sound business rules and processes. The final process of evaluating the project is discussed under theme 7, the culmination of the project experience, in section 6.3.7. Table 6.6 illustrates the role of the first two kernel theories (Figure 5.5) in the programming interventions.

The need to keep up with technology and the prospect of collaboration with a large mobile company encouraged a greater mobile focus during 2011. This resulted in additional lectures, seminars and a dedicated workshop on mobile technology. As a result of this opportunity, two of the projects in 2011 had an exclusive mobile focus.

Evaluating experiences: Coding remains a stressful exercise: “I find the Thursday lab sessions to be quite stressful when there is lack of support or errors in the code, but that’s a rare occasion, just quite hectic to finish it in the 4 hours (I normally do), but this is the only [negative] thing I can think of” (CE01, 2011). In addition students often reported that they need “more tutors especially when it is a challenging workshop” (CE01, 2010), or they suggested that it is necessary to “make sure the workshops are not too long and students are able to finish them while the tutors are around. Because some of us cannot do much without the help from tutors” (CE01, 2011).

The duration of the coding workshops was often cited as the most negative aspect of the capstone course and comments like “workshops long :D” (CE02, 2011) and make “the programming sessions less time-consuming” were given. However, some other students did

admit that “the tutorials on lips and codex were very helpful” (CE02, 2010) and that the “coding part is HUGE and it would be awesome to have more time for it. Should almost be an extra course” (CE01, 2011).

In the course evaluations valid arguments were raised that the workshops should include more web design and new mobile technologies, for example, “lab pracs and lectures in first semester were of little help. Consider teaching more relevant stuff, i.e. more on web-design, mobile, real-life [current] coding principles” (CE02, 2011); “have a workshop on how to use servers” (CE02, 2010) or “the 4-hour Thursday workshops, ... were nowhere near the level of complexity that our systems in the project were. Please improve the workshops to cover more vigorous content” (CE02, 2010) and “the 5-hour coding tuts on Wednesdays should be more interactive” (CE01, 2010). The emphasis of the coding framework for the workshops was predominantly on object-oriented technologies and detailed understanding of data access processes, whereas students preferred to use technologies that would hide that complexity (one workshop on these technologies was given). In addition the systems that students developed in the last 2 or 3 years became progressively more web-based, and the need for new technologies is indeed a reality in the fast changing IS environment. For these reasons a greater mobile focus was introduced in 2011.

The workshops were fundamentally structured to expose students to a systems approach and students commented that they found “the practical experience of building a system” (CE02, 2011) invaluable (most positive aspect of the course) when designing and building their systems. Also, “it was really helpful to get practical experience of building a system and I generally enjoyed this part of the course” (CE01, 2011) or further, “we managed to pull off a system that initially seemed too big, by implementing what we have learned” (CE02, 2011). “LINQ – amazing. Learned n-tier coding finally” (LL01, 2011). Comments like these emphasised that students took note of the way the workshops were structured.

It did however become clear that in addition to declining student numbers, the coding skills of students were deteriorating. The class of 2011 was the smallest in the past decade and Table 6.7 shows that the average for the coding exam steadily decreased since 2006 (except for a 2% raise in 2010). Some students claimed that “... having a poor coding foundation. I think that really plays a significant role” (PIP01, 2012). In addition they “did not know most

things in the beginning. I believe that this was because 2nd and 1st year IS did not prepare us enough for this” (CE02, 2010), or again that it is necessary to “emphasize more on coding so that the 3rd year project is not as difficult, to people who are new to coding” (CE02, 2010). The initial low marks of the 2011 group could also perhaps be attributed to the fact that the coding language was changed in 2011 from Visual Basic to C#, although most students supported this change.

On a more positive note, the averages given in Table 6.7 indicate that despite starting with a relatively low mark for their mini-project, the class of 2011 improved their coding skills significantly and obtained a slightly higher average for their final coding presentations than the class of 2010. This could perhaps also be attributed to the dedicated tutor who was contracted to assist the teams with coding problems in 2011.

Table 6.7: The Different Phases and Marks for Coding Deliverables

Coding	Mini-Project	Workshop Pilot 1	Workshop Pilot 2	Code Presentation	Coding Exam
	<i>Alignment</i>	<i>Follow</i>	<i>detach</i>	<i>Fluency</i>	<i>Assessment</i>
	Average %	Average %	Average %	Average %	Average %
2010	59.41	64.28	72.15	65.26	56
2011	36.96	59.09	64.82	67.83	50
					2006: 65 2007: 69 2008: 59 2009: 54
	<i>Individual</i>	<i>Team</i>	<i>Team</i>	<i>Team</i>	<i>Individual</i>

Reflections and learning: The aim is that while working through these workshops, students learn to *conquer basic coding issues* that were previously problematic. *Advanced concepts* of the OO paradigm like encapsulation, inheritance and polymorphism are also revisited and implemented in the coding framework. Students have to experience how these structures are used in the context of a system and learn how to identify independent classes of objects and build them into components. These components are then used to create different levels of abstraction and build integrated environments that can handle interdependencies between objects or collections (sets) of objects. The framework ensures that each component or class has a well-defined public interface that will facilitate easy

communication with the objects of that class, as well as allowing them to behave as expected. Through the implementation of advanced data structures students are able to recognise the difference between the physical and the logical representation of the data. Despite the above efforts, it seems that a poor coding foundation still limits the nurturing of effective coding skills as indicated by the following comment: “We had many ideas and innovative solutions, but we were hindered by our ability to code which was not made solid from 1st and 2nd year” (CE02, 2011).

The competence of an IS professional is reflected in the effectiveness with which *analysis and design specifications can be translated into code*. “Modern software practices call for the active involvement of business people in the software process” (Roussev, 2003, p. 349). This means that IS professionals must be able to interact with business experts and apply problem-solving skills in developing possible solutions. It is thus of great importance that programming forms a core component in an IS course to ensure that students acquire the necessary programming skills to be able to design a system that can be translated not only into a rigorous software solution, but also one that has improved usability and adaptability characteristics (Kroeze et al., 2011). Students felt that coding skills would give them “a competitive advantage” (CE02, 2011).

The intention of the two pilot systems was to provide students with coding skeletons and a framework for *developing integrated object-oriented n-tiered systems* that they can utilise again and again for subsequent software development. “In the software world, the easiest way to reduce overheads is to increase re-use, and the best way to get re-use out of an architecture (both design and coding) is to codify it into a framework” (Lhotka, 2006, p. 33). However, as seen in the previous section, students requested that *more current technologies* should be incorporated in the workshops – “Workshops didn't really relate to project coding requirements. Not to say that the information learned isn't valuable” (CE02, 2011). They also commented that the structure of the coding workshops should be addressed to make the content more interactive and stimulating. The length of the workshops should also be more balanced to avoid that “the workshops are tedious and although maybe necessary ... they should be shorter and mixed with some more exciting current development tools and training” (CE02, 2011). The most frequently cited negative aspect of the course was the length of the workshops; however, this subconsciously taught

students to persevere and many of them spent long hours working consistently on their own projects. It remains is a difficult and complex task to choose an appropriate framework and create a workshop series that will be challenging, balanced and address most of the aforementioned issues.

Furthermore, the intention was that the development experience should stimulate *students' imagination in the planning and thinking* about risks, resourcing and timing of these projects, to cultivate a better understanding of “the complex world of lived experience from the point of those who live in it” (Kroeze et al., 2011, p. 382). In this respect the students felt that they learned to reflect and “extrapolate meaning out of the experience...knowing [themselves] yourself ... reflecting on [their] your personality” (Profile ST18, 2011).

6.3.5 Interventions for a Reflective Practice

Introduction: The interventions in this theme form the cognitive core of the entire network of interventions and are constructed to highlight the need to inspire learning and make sense of project phenomena. Flexibility instead of a rigid adherence to specific processes is thus highly valued. As such this pedagogical approach focuses on the acquisition of competencies through reflexive learning, that is, the “circuitous, self-revisiting” of activities undertaken in pursuit of creating a better understanding in a complex environment of individuals, communities and cultures. Carefully designed reflection points emphasise the application of knowledge and encourage students to engage in their own learning. Mingers (1991) concurs that cognition refers to both the acquiring of knowledge and the application of knowledge.

Ideas framework: *Learning often occurs through experience.* “Learners first need to undergo a particular experience and then, upon reflecting upon that experience, extrapolate learning from it” (Kroeze et al., 2011, p. 382). Learning of this nature is important to new practitioners for once they enter the world of practice, no matter how hard they try to apply theoretical criteria or use advanced analytic techniques, they are confronted with technical, cultural, moral, and personal idiosyncrasies which defy categorisation.

Reflection constitutes the ability to uncover and make explicit to oneself what one has planned, observed, or achieved in practice. In line with Llewelyn’s (2003) statement that

theories aid reflection, reflection when applied using theoretical lenses, can assist learners to make sense of their experiences. When experience is aided by reflection in this manner, students are taught to become reflexive learners, better equipped to act intuitively and appropriately in context-dependent situations. Mezirow (1990, p. 2) argues that although “thoughtful action is reflexive” it is different from acting reflectively. Reflection in thoughtful action requires a pause, a moment of conscious reflection–in-action, to re-assess and reconstruct meaning which is a vital element in the creation of cognitive structures that will promote transcendence.

Cognitive structures are thus created and re-created in an infinite cycle through recurrent practices. As stated in section 2.3.2, *cognition is not a separate process*; it is ongoing and inherently tied to existence, with no difference between doing and knowing, and knowing and doing. At the same time, the embodied minds of human beings anticipate situations with unique embodied reactions and perceptions. The experiences of human beings are classified within their memories using a system of concepts, analogies and metaphors, and it is further possible to develop a vocabulary to aid understanding of the concepts, analogies and metaphors used to negotiate experiences.

During the initial stages of learning and practice, the relation between mental intention and bodily act is quite underdeveloped - one may know what to do mentally, but may not be able to physically execute the intention (Merleau-Ponty, 1962). As one practises, the connection between intention and act eventually disappears as they merge into one state. This state of en-action can be described as neither mental nor physical, but as a specific kind of mind-body unity, one with our existence and our understanding, resulting in what is called *embodied cognition* (Varela et al., 1993).

Planning and methodologies: The interventions under this theme comprise both team and individual activities. The team activities consist of a synopsis, a presentation and a tutorial. The individual activity comprises a reflective essay, as well as individual interviews held at the start and the end of the course, which are of integral importance to this theme although they are actually part of the first and the last themes. Selected readings form the basis of this intervention theme, and act as theoretical lenses to stimulate reflection and provide students with the necessary concepts to relate experiences in the first half of the project,

thus bringing them closer to a state of en-action. This reflective practice leads students to appreciate not only the uniqueness of their own interpretation patterns, but also those of their team members. The core theories, concepts and analogies provided by these readings help individuals to make sense of and negotiate the attitudes, actions and experiences of themselves and their team members (Table 6.10).

Language can make an important contribution towards exhibiting embodied cognition and appreciating en-action. Maturana and Varela (1987) claim that consciousness is only accessible through language and the use of concepts, theories and analogies. Argyris (1991) argues that teaching people how to reason about their behaviour in new and more effective ways requires a breakdown of the defences that block learning. The use of theories, concepts, metaphors and analogies thus enables individual students to reason about their own and their team's behaviour and help them to express significant experiences using a specific vocabulary. It presents a reflection of how they think and not only how they feel (Argyris, 1991), and allows them to see how language is embodied and how communication causes transformation instead of just being a means to package information.

Executing activities: In the reflexive learning exercise students are introduced to the conceptual readings by means of team presentations. Each individual team prepares the reading allocated to them, submits a synopsis, and presents the key ideas of that specific reading to their peers. A group tutorial is then used to provide a platform for discussion and reflection using concepts from all the readings, which enables teams and individuals to consolidate and internalise theoretical concepts and relate these to their own project experiences thus far. All these activities are assessed and contribute to the final course mark. The individual reflexive essay requires students to report on four significant experiences related to the project that intrigued them, fascinated them, or caused them some concern during the first semester. For this essay they need to utilise the concepts offered by the different readings to negotiate and make sense of their experiences. Tables 6.8 and 6.9 provide some indication of the vast effect these opportunities for reflection had on students during the 2010 and 2011 delivery cycles of the capstone course.

Table 6.8: Excerpts from Student Profiles of 2010

Stud	Student Reflection	Elements of transcendence
ST1	Past experiences have <i>helped me grow</i> and realize how to become more at ease with myself and fellow peers...become <i>like a family</i> ...ability to <i>challenge</i> and <i>not just accept</i> what is given to me,...in the process of discovering <i>exactly who I am</i> and accepting myself. Will enjoy working in the real world on real-life projects... in the process of reflecting on this phenomenon . <i>Maturity and respect ...adapt easily</i> ...not let <i>unimportant items</i> get in the way of our goals. Worried about coding...when time comes you are kind of <i>not so scared</i> and kind of just need to jump into the deep end. <i>A lot of things you teach yourself</i> .	Self-awareness, respect and maturity, experiences and growth, learning and skills, confidence to be able to cope
ST4	<i>Responsibility for learning</i> belongs to the student...an experience in which one is able to <i>grow as a person</i> and as an IS professional. <i>Satisficing</i> ...explanation need only be explicit enough to get our point across...creativity is both realistic and based on logic...comes to opening up to <i>new ideas and possibilities</i> . <i>Teamwork</i> ...not pleasant to have fighting within a group, without it, progress is stumbled...now <i>resolved the situation</i> somewhat significantly...to develop a higher standard of work, more coherent deliverables and allowed us to work faster with more efficiency... New experiences... broadened the horizons...truly developing as a person ...grow a lot as a <i>developer and on analytical thinking</i> ...self-taught a lot more than I thought [versus spoon-feeding]. Course is truly a gateway to bigger things in the future...great experience...stepped into what I want to go into in terms of my career and I think I got a <i>good feel of what work feels like</i> ... I think we have matured a bit .	Self-awareness, growth, skills, behaviour, experiences and confidence
ST12	Concepts...taught in lectures come in to play... <i>not going to sit back</i> and let it pass me just like that...express ourselves without fear of intimidation... <i>express myself more professionally and confidently</i> ...greater <i>understanding of what we are doing</i> ... <i>collective responsibility</i> which means more work can be done in half the time...enabled me to <i>adapt and develop</i> ... <i>continuously learning</i> ...lead to my <i>growth</i> as an individual both morally, personally, psychologically, and emotionally, as well as cognitively. I have come to better <i>understand my strengths and weaknesses</i> ...acknowledge my fears especially... learnt to reflect .	Commitment, learning, growth, experience, skills and competence
ST18	<i>Understanding</i> of the system is evolutionary... Understanding is not a precondition of design but rather intertwined throughout... <i>tolerance and appreciation</i> of other group members... repeat the procedure so they can be innate and instinctive... <i>extrapolate some meaning out of the experience</i> ... knowing yourself...reflecting on your personality	Self-awareness, behaviour, interdependence, learning, embodied cognition
ST19	Doubts about certain group members...gap of communication...until it was too late. Through my <i>experiences</i> I have learnt to understand the “experience” through the use of various theoretical concepts, these concepts will forever be instilled in my mind and used in the future . Through this experience I met new people... it’s amazing... <i>skills that I have learned</i> with regard to coding and group work.	Uncertainty, experience, learning, skills, and embodied cognition

Table 6.9: Excerpts from Student Profiles of 2011

Stud	Student Reflection	Elements of transcendence
ST1	<p>Raise our game on the spot and rethink <i>our commitment to the project... 'satisficing' concept</i> made this experience understandable...<i>shared and familiar syntax to communicate software development ideas...gained a lot of competence...project</i> was very stressful at first, especially...learning all the technologies...<i>desire to learn is more important than feasibility...the tortoise wins the race...trying to do a very professional job for our project...in hindsight project management was very important and we didn't do a very good job...anything that's simplistic...not making anything more complicated than it needs to be...I'm very confident...somewhere between conscious incompetence and conscious competence...learn with experience and reflection...well I like the concept of learning. About theory to practice to knowledge and the whole reflection. From unconscious incompetence to conscious competence...Constantly trying to learn from my mistakes...concepts about higher learning...very important to me. Not to be a simpleton who doesn't reflect on anything.</i></p>	<p>Experience, learning, skills, reflection, competence and continuous learning</p>
ST4	<p>Hoping to <i>learn a lot...bit scared...how we were translating the information given to us...understood a concept in my head...very difficult to communicate to the others... higher stage of learning and have the confidence to change procedures...drop the argument and move on...team interactions more enjoyable...biggest learning in the bunch of skills that I have picked up...I will learn a lot faster and I enjoy the learning process...trying over and over...feeling fairly confident, uhmm. I might not know exactly how I'm gonna get to, you know the end. But at least now I know I've done it...Get the learning done as soon as possible and aah not...don't focus on things that are unnecessary...It instils the sort, practice of reflection with this course and the other courses that I do...think it just kinda <i>changed the way that I thought about things...a lot of it we have to learn ourselves and find out ourselves.</i></i></p>	<p>Anxiety, learning, experience, skills, behaviour, confidence, reflection and competence</p>
ST6	<p><i>Fears and expectations are I guess coding...learn from our experiences and use these theoretical lenses, we make sense of what was done...satisficing...found that having a significant time constraint meant that we knew we could not achieve perfection...I know that from now on, in everything I do, I will be taking time to reflect on my experiences, understand them and <i>learn from them...very enriching and very good learning experience this year...learn how to communicate a bit better and learn how to manage your time and learn how to determine what is important up front and what is not important...testing definitely...you cannot do enough testing...now I'm a lot more competent...more confidence in my abilities...different ways of solving a problem.</i></i></p>	<p>Fears, experiences, learning, skills, confidence and competence</p>
ST12	<p><i>Biggest fear is the project...not to limit ourselves...passion and drive for IS have been stretched to the limit and my mind opened to new ideologies and philosophies on project management...real-life problem with all the complexities involved...a tremendous learning curve...this priceless experience is nothing without reflection...team development dynamics was that of perseverance... team stuck together and grew stronger as a unit...I look at the way I was coding and the way I'm coding now. I'm totally on a different level...coding workshops...didn't understand them until I actually started working on my own project and getting to know what exactly is going on and...taught me perseverance and not to give up...now I'm very confident...I actually feel good about myself and I say to myself...I'm now much more equipped to deal with this year [2012]!</i></p>	<p>Anxiety, behaviour, growth, learning, experience, skills, confidence, coping and competence</p>

Evaluating experiences: In order to evaluate the experiences of this theme in terms of the theory of coherent practice, a profile of each student was extracted from the various interviews done and the essay that was submitted as part of the coursework. Tables 6.8 and 6.9 provide excerpts from some of the profiles obtained during 2010 and 2011 (complete versions of these excerpts can be found in Appendices 1 & 2).

At the beginning of 2012 additional interviews were conducted with approximately 70% (16/22) of the class of 2011 students, who were returning for further studies. These profiles provided profound evidence that reflective practice had played an integral role in the transcendence of the students: “awareness is no longer enough if one is unable to upon reflecting, learn something from the experience so as to move forward and do things differently in the same or similar experience in the near future” (Profile ST14, 2011). As further evidence of transcendence, another student claimed that we were

not only developing, but also adapting to certain changes and the pressure that is imposed upon us by our sponsor and mostly our project manager, as well as the time limit. These changes are there to help us learn more, since learning is a recurring process and every day I am really grateful ... [and] I have also learnt that in life it is important to embrace a challenge as an opportunity to exercise my skills as part of a team and have fun whilst I am doing it ... trust ... collective responsibility (Profile ST14, 2010).

Although students were open to guidance, they also developed sufficient capabilities to take responsibility for their own learning and obtained “that strong desire to learn more, which I feel I have attained” (Profile ST14, 2010). It was clear that the experience was intense, the learning significant and the personal change profound:

I think third year shaped me as a person ... at first I said the resilience empowered me, but that type of resilience where you almost have no hope, but you keep on going ... I think that's probably my IS foundation ... forcing me to be aware of my level of confidence and the power that comes with being aware of all of that (Profile ST14, 2011).

Reflections and learning: Nurturing students in the *acquisition of a vocabulary that is focused on doing, explaining, understanding, believing and being* seemed to be a step in the right direction to cultivate reflexive practitioners who will also be thoughtful in action. Some of the readings, like the six thinking hats of de Bono (1995) for example, facilitated productive debate, seeking alternatives whilst also assessing their feasibility and logistics in a positive manner. During the different interventions it was fascinating to observe how effortlessly students managed to apply these readings as theoretical lenses to provide them with concepts to relate experiences and to stimulate reflection. The set of theoretical lenses became what Argyris and Schön (1974, p. 6) refer to as a theory of practice, which comprises “of a set of interrelated theories of action that specify for the situations of the practice the actions that will, under the relevant assumptions, yield intended consequences” as mentioned in Chapter 2. The application of these theories of action brought about the *state of en-action facilitating the reconstruction of meaning* that we refer to as embodied cognition and which we argue, nurtures reflexive practitioners. Table 6.10 summarises the intended outcomes for the respective readings.

The application of theoretical lenses also helped students to develop *the capability of multiplicity in thinking*. They developed a willingness to be challenged, openness to new ideas and new ways of thinking. Winter and Szczepanek (2009) advocate that this new mindset of project practitioners helps people to deal with the complex realities of projects and encourages them to follow a pragmatic and reflective approach, consciously seeing projects from multiple perspectives.

Moreover students realised that *reality for each individual is a unique experience* and that effort is needed to re-orientate oneself, or to understand the orientation of others. The theoretical lenses thus guided students to make sense of these realities, creating a shared understanding within the team and an awareness of the rich reflexivity that could, by taking full advantage of existing opportunities, characterise the every-day real-life within projects.

The interventions and readings further emphasised that *perfect communication is impossible* and that communication is transformative rather than the passive transfer of information (Cockburn, 2002). Students became acutely aware that communication was

essential and that the effect of communication was more important than the means of communications.

Table 6.10: Theories of Action to Facilitate Embodied Cognition

Reading used as a Theoretical Lens (Theory of Action, (Argyris & Schön, 1974))	En-action	Embodied Cognition
The Team Maturity Model (Tuckman, 1965)	empowers to	embrace evolution towards performing phase.
The Six Thinking Hats (De Bono, 1995)	encourage and equip to	utilise benefits derived from different perspectives or provoke different perspectives
Parsing Patterns & Shared Experiences (Cockburn, 2002)	equip to	<ul style="list-style-type: none"> • manage imperfect communications • make sense of experiences • gauge transcendence
Game of Invention (Cockburn, 2002)	develops	an ability to set up for the next game – <i>satisficing principle</i> .
Methodologies (Cockburn, 2002)	emphasise that	team success depends on cooperation, communication and coordination (<i>concept of interdependence</i>).
Against Methodism (Introna & Whitley, 1997)	to understand	the boundaries of method, the impact that contexts has on the choice and use of methods and to appreciate the values inherent in methodology that come with the understanding of the history of methodology.
Rethinking IT Project Management (Sauer & Reich, 2008)	to confirm	the multi-process view of IT projects and to create awareness that PM is a dynamic process in need of constant re-assessment .
Metaphors and Mental Models: Sensemaking and Sensegiving in Innovative and Entrepreneurial Activities (Hill & Levenhagen, 1995)	to cope with and make sense of	ambiguities and uncertainties in the business and social environments. Conceptual models aid understanding and enhance communication through proper articulation.
Teaching smart people to learn (Argyris, 1991)	to enable	to reason about one's own behaviour in a way in a way that can bring about changes in behaviour or attitudes.

The *satisficing principle* (Cockburn, 2002; Simon, 1969) allowed students to identify the point where some task had been done “sufficient-to-purpose” and that it was necessary to move on. They realised that ideologies of perfection and rigid adherence to process had to be scrutinised as one student commented: “I don't think ANYONE in the group would allow us to argue for 30 minutes again on what shade of red to use ... !”

Through the *metaphors evidence of transcendence emerged* as the following quote indicates: “especially myself ... has gone through these stages of following, detaching and to some extent fluency ... better my performance as an individual” (Profile ST5, 2010) and as practices became second nature and embodied, students showed further that they were working towards what Merleau-Ponty (1962) would call *maximum grip* in the sense that “experience so far has been one of assimilation and learning ... applying these skills and delivering a quality product ... I know I can do things on my own” (Profile ST21, 2010).

6.3.6 Interventions to Provide a Real-World Perspective

Introduction: The interventions of this theme are constructed to provide students with windows to the real world. This metaphor is derived from the quote of Sydney J. Harris who claims that “the whole purpose of education is to turn mirrors into windows”. In this spirit special opportunities are created by liaising with alumni (all previous IS students) and with organisations that employ many IS graduates, to give students some experience of the work environment within those organisations.

Ideas framework: The idea is not only to expose students to a work environment, but also *to illustrate the relevance of the course content* and the implementation of concepts and constructs taught in the everyday practice of real-life projects. We argue that this will provide students with an appropriate context in which to grow their confidence and passion to further develop their skills.

Students may also find *it easy to relate to a mentorship programme* driven by alumni working in industry. The familiarity of the alumni with the capstone course and the approach and relevant processes it entails, enables them to compile a series of advanced topics in collaboration with the course coordinator (researcher) to address important areas or issues that do not receive sufficient attention during the course.

Planning and methodologies: The interventions in this theme comprise the presentation of two cases studies and a mentorship program. The mentorship programme comprises a number of sessions, each of which is attended by representatives from different teams. To ensure that students derive maximum benefit from these sessions, each group of students is tasked to prepare a technical presentation and demo of a selected topic covered during the

mentorship programme and present this to their peers. This program takes advantage of the shared experiences of the various alumni who contribute, and students benefit from the wealth of additional experience and knowledge they have accrued in the workplace. In 2011 the mentorship program was extended to incorporate quality assurance sessions at another company, and the technical presentations were replaced by the mobile sessions discussed under theme 4. An outreach project at a school for mentally retarded children was included as the final topic in the 2010 series.

Executing activities: The series of interventions in this theme usually commence with the presentation of case studies by alumni who run successful entrepreneurial ventures and/or by representatives of organisations who are implementing projects that have a significant impact on society (for example, a large disaster management system that is deployed world-wide). Although these visitors share their experiences and thoughts from very different perspectives, these ideas still complement one another and demonstrate to the students what it means to be committed and passionate. In the case of presentations by alumni, the individual stories often illustrate how the coherent practice of the capstone course has served as a foundation of skills and business knowledge that empowered them to exploit new opportunities.

A second intervention in this theme is a mentorship programme comprising four three-hour sessions presented at the offices of an organisation in industry. Each student team attends one of these presentations. Topics are selected that give students valuable information on how to tackle advanced concepts and where to look for more information, and the presentation also includes a demonstration of one or more of these advanced concepts. Subsequently each team then prepares a demo and presentation on one of the concepts covered, which requires them to assimilate the content and share the knowledge with their peers, thus exposing everyone in the class to a number of related but different concepts. In 2011 another similar intervention with the focus on quality assurance was organised by alumni and hosted at a different organisation.

In 2010 an outreach intervention was organised as a fun event in the form of a “paint-party”, where students joined forces with learners of the Leap Project to paint murals for a community school for mentally disadvantaged children in a nearby township. The “LEAP

Science and Maths School was started in 2004 with the aim is to create a model that could begin to address the inequalities in the South African education system” (<http://www.leapschool.org.za/>). The idea behind this intervention was not only to paint the murals, but also to enable IS students to promote and advertise Information Systems as a possible career option to the learners of the Leap Project.

Evaluating experiences: Although the interventions in this theme are not assessed, students find the real-world contact world exciting, as shown by the following comments made in the course evaluations in response to being asked what they liked about the course: “The excursions (workshops with a company)” (CE01, 2010) and “everything i.e. the interactions with an industry company. People that went through the course” (CE02, 2011).

Reflections and learning: Although the interventions of this theme are subject to change depending on availability of resources, they all contribute to the significant outcome of providing confirmation that *method flows from understanding* and that it is only through proper understanding that we will be able to use and choose the best tools and techniques to address the situation of concern (Introna & Whitley, 1997).

Students who were encouraged by the case studies, posited that it gave them confidence that the processes applied in a capstone course can serve to empower. The interesting accounts of the case studies, often by entrepreneurs who are ex-IS students, made students set aside their concerns and fear of the unknown, changing their mindset in anticipation of the real-life experiences that lie ahead of them.

The alumni students at the hosting organisations went to great lengths to make the mentoring programmes an experience that the students would remember. The sessions showed the students that many different options or motivations existed for doing things in a certain way—they demonstrated a wide range of perspectives, but at the same time gave students a good grounding (foundation) to start from. The fact that the presentation content came from peers in industry also gave it an added dimension of credibility. All the topics addressed contributed to the foundations of important components of the third years’ upcoming project, still to be explored further. Students rated their overall experience of these presentations and the content delivered very highly, but also commented that

although the presentations were well organised, the concepts were quite new, and they were not yet able to understand everything. As these presentations happened early in the year, this was to be expected. In 2011 the quality assurance presentations with the other host company however happened during the second half of the year, while the students were busy with the build phase of their own projects. These sessions emphasised the importance of maintaining quality throughout the project experience.

6.3.7 Interventions to Culminate the Capstone Experience

Introduction: Interventions of this theme are structured to draw the capstone experience to a close; in addition, they are aimed at providing a sound foundation for the future. According to Cockburn (2002) software development is a cooperative game of invention and communication. In this game the primary goal is to deliver a useful, working system, but the secondary goal is that of setting up for the next game. In the life of an IS student at UCT this will typically be the fourth year course where a similar, but more advanced systems development project is a key requirement. It could also be the fourth year research project or the start of a new IS career in industry.

Ideas Framework: The intention of this theme is to bring closure to a year that might have been in the words of the students: “a tough ride”, “traumatic”, “a very different, huge learning curve, but also a fun challenge” (CE02, 2011). The intention is to enhance students’ sense of self-worth and competence and instil a sense of pride through an EXPO, an open-day event where projects are show-cased to industry, schools and the wider public. This event presents team members with an opportunity for a different kind of reflection through the presentation of their individual systems. It is also a time to test the students’ “understanding of what [they’ve] we’ve been learning throughout the whole year ...” (PI02, 2011).

Planning and methodologies: The culmination of merging theory and practice as the students themselves claim: “lots of theory is good, but put a bit of practice to it, it just makes it exceptional!” (Profile, ST20, 2011).

Executing activities: Interventions in this theme comprise the delivery of a shrink-wrapped product, a live presentation of this product to a panel of examiners, a code demonstration, a

final sponsor evaluation, showcasing the project to industry and learners at an annual EXPO, a 'lessons learnt' report and a final coding exam. The final course evaluation and the second interview have already been dealt with in the other themes. The shrink-wrapped product would contain a DVD with electronic versions of the application, installation files and documentation. The final improved version of the complete documentation compiled throughout the year comprises: a business case, user requirements document, systems specifications, test cases and a user manual. These are also included as hard copies in the final product. Comprehensive rubrics are used to separately evaluate the live demonstration of the project and the code. In the evaluation of the overall project different aspects are considered such as: the user interface, security, the robustness and integrity of the system, its scope and functionality, the overall solution and the elements of innovation. In the coding evaluation, aspects like the effectiveness, readability and maintainability of the code are considered. The level of complexity also plays a role, while students are still expected to adhere to good programming practice and a balanced approach. In most cases the teams do extensive research on additional external components that they wish to include in their applications or on alternative options and better methods for enhancing their solutions.

The EXPO is a fun event where learners from nearby schools, industry and the wider public come to view the projects. Third year students participate in the setting up for the event, designing flyers and posters, inviting guests, and acting as guides on the day of the event in addition to manning their own stalls. The day ends with a prestigious formal function, where the top third year and honours (fourth year) projects are usually presented.

The lessons learnt report gives students a final opportunity to reflect on their real-life experiences as a team. Extensive research is done annually to develop a case study for the final coding exam that will comprehensively test students' problem solving abilities, their analytical and critical thinking skills, and their ability to extract and abstract requirements and translate these concepts into code within a completely new context.

Evaluating experiences: In their lessons learnt reports, teams in 2010 perceived their project success criteria as being able to deliver a fully functional system that is practical and useful, and going beyond what the sponsor asked for by the hand-in date (except for

exceptional situations the hand-in date is not negotiable). Some teams also felt that commitment to the overall goal was an achievement and one team was proud that their coding skills were enhanced and reached heights that they never imagined would be possible. They felt that it was a very fulfilling experience and “an invaluable experience. The learning curve was massive” (CE02, 2010). They experienced “massive personal growth” (PI02, 2011) and felt it was the “biggest learning curve I [they] ever did in my [their] life [lives]” (PI02, 2011). In 2011 the student teams were mostly proud that they could solve a business problem to specifications, addressing the business problem effectively and successfully delivering the core functionality, because they understood the user requirements. One team reported that they were most proud that they could build a very creative system which was still very close to the idea they imagined in the beginning (LL01, 2011).

The biggest lesson learnt from this experience by most teams and in both years, was effective time management and the art of starting as early as possible: “Never put work off, work early and hard”, “time management is very important in ensuring a project’s success” or “keep to deadlines, set short-term goals” (LL01, 2010). Communication with team members and other stakeholder remains an important issue: “Communication and a good rapport between the team members ensure that moral is high” (LL01, 2010). In 2011 a few teams also mentioned that scope management should be a cardinal concern: “1. Scope 2. Scope 3. Managing team members” or “Follow scope. Key functionality – most important” (LL01, 2011).

In general, most teams felt that for the *next game* they would start early, set small deadlines, have the end in mind and focus on that which will add value to the systems, not ignoring the importance of good communication with all stakeholders.

Reflections and learning: The *deep involvement of the learning experience* presented by the capstone course enables students to go beyond the immediate requirements of their professional degree as they gain understanding of their own ideals which influence what is noticed and experienced.

This is a real get-at-what-you-put-in-course. We are given so much exposure, but without climbing in and digging deep, many of the seeds sown will fail to grow. This project provides the perfect place to grow as much as you are willing to (CE02, 2011).

In one of the lessons learned reports a team commented that

we learnt to be extremely innovative and resourceful in order to get what we wanted. We felt this was a good platform to become independent and explore our capabilities in order to reach the end goal. We also taught ourselves and the limited availability of tutors helped us to think on our own and to persevere (LL01, 2010).

A deliberate process of *creating awareness*, not only encourages involvement, but also allows students to become conscious of the possible causes of their own behaviour and that of their team members and emphasises the liberating effect that the right behavioural patterns can have. “The experience of the real-life project; it changes the way you think about people and how to work well with a team” (CE01 2011).

Commitment and attitudes are not enough to bring about change, people value acting competently and their self-esteem is intimately linked to performing consistently and performing effectively. However, with “the right commitment and attitudes learning automatically follows” (Argyris, 1991, p. 4). *Learning becomes a catalyst for real change* and it is necessary to create a learning environment conducive to change. The students agreed that the capstone course created a “period of learning new things about yourself and your abilities. However, working in a group is even more rewarding as we get to learn and adapt from each other” (Profile ST24, 2010). They also appreciated the change in their abilities and stated that:

the team comprised members who were generally not confident about coding, but as time went on, our coding skills were enhanced and we reached some heights we never thought we would reach. Just the ability to do our own research and develop our own program was a

very fulfilling experience and we feel this itself was success (LL01, 2010).

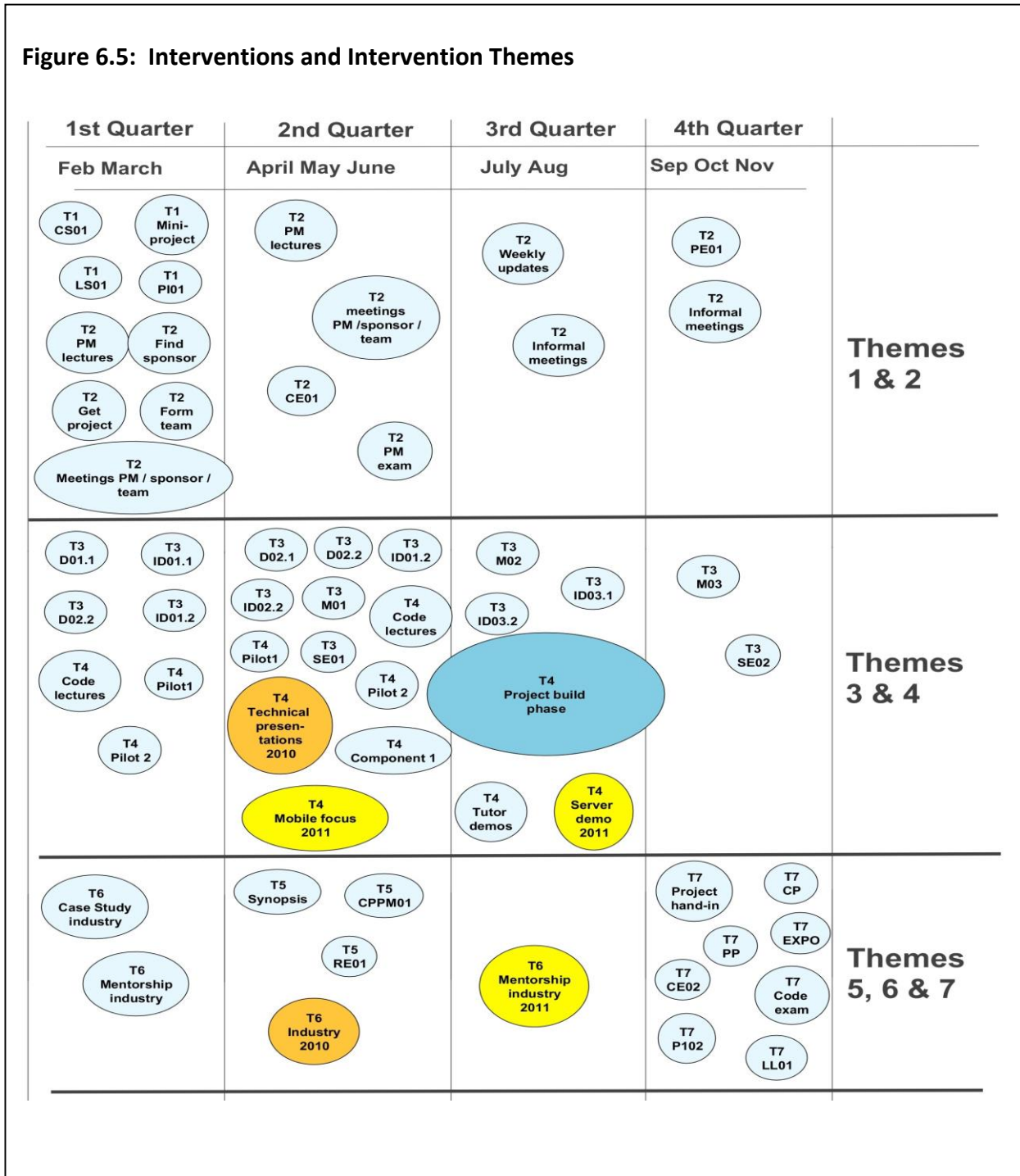
Ultimately, however, *competence* is built through the reconstruction of meaning. Mezirow (1990) argues that when we make sense of an experience the meaning becomes learning through our interpretations and reflections. As said before, students have learned how to make explicit what they planned, observed, or achieved in practice, which is indicated by the following quote:

I have experienced all the different levels of listening, and have discovered that, even the simplest learning technique is imperative for the growth of my documentation and coding skills. There is no way to jump steps, it would simply be impossible because new methods are not learned easily, they need to be practised and understood before they can become second nature ... learned valuable lessons and reasons behind the experiences ... necessary for myself and my development group to grow ... Expertise ... yeah, it's more life experience, it's quite a bit better ... I have changed (Profile ST22, 2010).

6.4 Summary

In this chapter I discussed the seven action experiments as they were executed to provide rigour to the research process and to validate the theory. For this purpose the experiences of the students during the activities of each experiment were evaluated and reflected upon. This formed part of the plan implemented in order to validate observations made and actions taken in the 2010 and 2011 delivery cycles of the capstone course, building upon what had been done in the previous decade. Maturana and Varela (1987) argue that “we are continuously immersed in [a] network of interactions, the result of which depends on history.” Nevertheless, although “we are historically conditioned, as social agents we can change our way of both perceiving and acting, using such tools as consciousness and socio-analysis” (Raelin, 2007, p. 497). Ultimately, when we change our ways, learning is not simply a function of how we feel, but also a reflection of how we think (Argyris, 1991).

Figure 6.5 depicts the landscape of all the interventions; it illustrates when the interventions take place and to which themes they belong. The project build phase is particularly significant as it spans over three quarters of the year. (Note that the specific year was only indicated if the intervention did not occur in both 2010 and 2011).



Source: Researcher’s own construct to exhibit the course structure and timeline

7 Conclusion

Theories are nets cast to catch what we call “the world”: to rationalize, to explain, and to master it. We endeavour to make the mesh forever finer and finer.

(Popper, 2002, p. 38)

7.1 Introduction

Throughout the chapters in this thesis, I have tried to give a comprehensive account of the search to find an alternative and hopefully a better approach to prepare students (IS majors in this case) for professional practice, empowering them to fulfil their roles with competence, whilst also equipping them for lifelong learning. I claimed that this was a critical endeavour and supported this claim with various statements from the literature confirming that a *crippling shortage of skills* of excellence still exists in the ICT industry today (Harris, 2011; Richards et al., 2011; Lotriet et al., 2010; McMurtrey et al., 2008; Roberts & Wiseman, 2008). I further argued that the dilemma is not only to find out *what* should be done to address this issue, but it is incumbent to find plausible ways of *how* it should be done (see Chapter 1). It is also important to be able to explain *why* some processes and methods are likely to deliver better results than others.

In attempting to find answers to these questions, I not only faced a persistent problem, but was also confronted with the reality of being able to achieve only a satisficing solution (Simon, 1969), the finding of a *better alternative* and the challenge of explaining *why* this would be the case. These issues and the growing pressure to infuse theory with practice, brought me to a point where I realised the need to consider: “How might theory and practice be united in an epistemology of practice, both as a basis of learning as well as a basis for performance?” (Raelin, 2007, p. 504). At that point I had no choice but to turn my focus towards exploring relevant theories that could support an alternative approach and provide mechanisms for understanding, explaining and prescribing relevant actions. This

approach manifested as a design problem and DSR was selected as the most appropriate solution-oriented or problem-solving paradigm as shown in Chapter 5. My hope was that research in this paradigm might lead to a systematic creation of knowledge about and with design where theory can be used in the process to build theory.

Figure 5.3 thus illustrates how a “framework for understanding, executing, and evaluating IS research combining behavioural-science and design-science paradigms” (Hevner et al., 2004, p. 79) was applied as a three-tier framework for this research environment, comprising an environment or problem space tier, an IS research (design science) tier and a knowledge base tier.

The presence of a *relevance cycle* links the contextual environment tier of the research project with the design science activities in the design science tier (Hevner, 2007). In this way the requirements obtained from the environment tier can be tested in the evaluation phases of the research artefacts in the design science tier. The *rigour cycle* connects the design science activities of the middle tier with the knowledge base of the third tier that incorporates the foundations and processes that will inform the research. The central *design cycle* represents an iterative process between the development and evaluation of the artefacts within the middle tier, when weaknesses may be identified in either the abstract (theory) or concrete artefact leading to re-assessment and refinement where necessary (Hevner, 2007; Hevner et al., 2004). For any DSR project it is of the utmost importance that all three cycles are present and explicitly defined (Hevner, 2007).

Strong arguments are therefore essential to serve as proof of the relevance and rigour of this research endeavour in support of the design activities for developing and evaluating the artefacts. Following on from this, the design cycle will be discussed as justification for the proposed theory.

7.2 The Claim for Relevance

The fundamental purpose of design science is to improve the environment by building and introducing new and innovative artefacts (Simon, 1969). With more specific relevance to this study, design science is also about recognising new opportunities to improve practice even before a problem is identified (Iivari, 2007).

According to Hevner (2007) the relevance cycle introduces design science research in a particular context by not only providing the requirements for the research, but also defining the acceptance criteria that can be used in the evaluation of the research results. In the context of the capstone course, comprehensive requirements were established and refined during the different iterations of the evolution phase. The conceptual framework for a coherent practice (Figures 5.5 & 5.6) could be utilised to depict the intended outcomes and acceptance criteria for the course, and assisted in the creation of a plan that included themed experiments to evaluate the artefacts and thus also the research endeavour as described in detail in Chapter 6. The field testing was then conducted during the two delivery cycles of 2010 and 2011. Figure 6.5 provides an illustration of all the interventions that were executed within the different themes and within the specific timelines.

Table 7.1: Student Profile Excerpts - Comments on Relevance

Stud	Comments Year 2010	Stud	Comments Year 2011
ST2	Learned a variety of techniques and I already can relate to most of them ... you basically learn that you can actually just do anything from scratch...	ST2	I am so amped about new projects like I am working quite hard at the moment on projects of my own ... work towards my weaknesses and improve them ... believe in myself ... no matter what I wanna do in life, I will be able to do it and I do also now know, how to work hard ... ability to analyse the situation, analyse what needs to be done, what's the correct procedure.. was a great experience, and I'm very stoked we had that ... helping me now in other groups that I'm in... social groups.
ST4	Course is truly a gateway to bigger things in the future.	ST5	... one can break free of these methodologies in order to gain greater insight into a problem ... more confident to break away from standard methodologies.
ST9	Do not feel my life is threatened in any way ... feel more confident that I can do it.	ST10	...nothing is as scary as it feels, you know, and it's always manageable ... like bite, bite, bite. Every problem can be solved and if it cannot be solved it's just because you don't have enough information ...
ST10	Consistently managed to resolve issues together ... Discovering business requirements and this becomes more and more natural.	ST15	There were a lot of aspects and values that actually apply ... actually learn from theorists and what they've said and you apply them to a project.

In Chapter 4 I noted that alumni commented on the fact that the structure of the projects they are currently working on is very similar to the structure encountered in their university projects, an aspect which made them much more confident. Ample evidence of improvement to the *students' environment*, which shows for example that their experiences

were beneficial, boosted their confidence and can be applied in different contexts, can be found in student profiles created from the reflective essays and interviews. Some of the comments referring specifically to the relevance of the course are summarised in Table 7.1.

Table 7.2: Alumni (2006 – 2009) - Third Year Experience

Stud, Year	Do you feel the foundation given to you by your third year was adequate enough for you to start in industry?
AST1, 2006	The honours year for me really cemented the learning of the first 3 years and rounded off our degree as well as provided further experience of working under pressurized situations.
AST2, 2006	I think third year was an adequate preparation for working in industry, but I definitely feel that honours solidified the experience.
AST3, 2007	I definitely think so. It gives you an understanding of what is entailed with analysis it knows what the job is, what you have to do and it gives you that core set of skills.
AST4, 2007	No. Yes. Let me think about the reason I say no and yes. I am saying no. I mean you could say I think I would have been fine... I think I would have needed a lot more coaching and development in my first year of work, but I think honours gives you that, yeah.
AST5, 2008	It was more than adequate. When I started working, I was thrown into the deep end and I coped quite well. It wasn't just 3rd year that helped me; it was my UCT experience in its entirety that fully equipped me to take on tasks at hand...
AST6, 2008	Third year is a solid foundation for any entry level Information Systems IT job. However for my career and for one to be able to have the skills needed to do business analysis, one needs to do the IS honours degree.
AST7, 2009	I think in terms of moulding my thought processes into a sort of systems thinking dynamic definitely, I think at a finer level though it is not really...
AST8, 2009	Yes, I definitely think so, doing honours for me was just in terms of getting a broader understanding of the IS body of knowledge...

In addition, to provide further evidence of relevance, interviews were conducted with 45 alumni who had done the course during the emergent phase in 2006-2009 and who had already been working in different organisations for several years by the start of 2012. Some excerpts from their replies to the question of whether they felt the foundation given to them by their third year was adequate enough for them to start in industry are summarised in Table 7.2. Most of the alumni commented that the fourth year (honours year) was

important to solidify their third year experience and knowledge. Although one student commented that: “we found third year the most career defining year, we found honours to be a breeze after third year” (AST9, 2007). The significant changes that students are confronted with in the third year can create high levels of anxiety. In the fourth year, when they do another project, this is not the case and the learning becomes exponential and the results rewarding.

The evaluations and reflections of each experiment provide profound evidence of what worked well and what could still be improved. These results can assist to refine or improve subsequent deliveries of this course, or aid the design of other exit-level courses where the same approach is implemented.

7.3 The Claim for Rigour

livari (2007, p. 56) argues that “the explication of practical problems to be solved, the existing artefacts to be improved, the analogies and metaphors to be used, and/or the kernel theories to be applied are significant in making the building process disciplined, rigorous and transparent”. This view is also held by Gregor (2006) who states that the integration of different sources of evidence and different types of theorising is necessary for a study to satisfy rigorous academic standards.

It is thus evident that to ensure rigour in design science, an extensive knowledge base provides an essential source of evidence (Hevner, 2007). In the case of the capstone course the recursive process of building expertise was a meaning-making activity grounded in the construction and reconstruction of knowledge over the years. This involved (as explained in Chapter 4) the conducting of empirical research studies, the planning and compiling of research papers, the continuous refining of processes and methods, and the search for better explanations, better solutions or better approaches. This rigorous and systematic accumulation and dissemination of knowledge resulted firstly in the construction of a conceptual framework, secondly in the construction of an initial theory for coherent practice and thirdly in evaluating the capstone experience, testing and further refining the theory during the delivery cycles of 2010 and 2011. However, the most important breakthrough leading to the development of a conceptual framework was the identification

of sound kernel theories to aid the restructuring of interventions and to guide the meaning-making activities like understanding the transcendence of students and explaining and interpreting competence development and embodied cognition. Iivari (2007, p. 56) argues that “the term design theory should only be used when it is based on a sound kernel theory”, and Gregor (2009, p. 5) contends that “the unambiguous establishment of design knowledge as theory gives a sounder basis for arguments for the rigour and legitimacy of IS as an applied discipline”.

In addition, student feedback provides clear evidence that the use of the special readings (Table 6.10) as theoretical lenses nurtured a reflective practice and enabled the students to negotiate their experiences, especially in terms of team activities. For example, one student reflected that

becoming consciously aware of my own way of thinking has enabled me to actively attempt different methods of thinking ... communicate properly ... high level of emotional investment ... brings up a life lesson I'm continuously learning... adapt to situations (Profile, ST2, 2011).

Further evidence of the value of reflection and the significant role the reflective practice fulfilled in the students' development and growth can be found in Tables 6.8 and 6.9.

7.4 Justification of the Theory – Design Cycle

Hevner (2007, p. 90) argues that “the internal design cycle is the heart of any design science research project”. It is where the recursive processes of constructing the artefact, evaluating its effectiveness and then using the feedback for further refinement of the design, are situated. Simon (1969) refers to these iterative processes as the generation and evaluation of design alternatives until a satisficing alternative is obtained. The interconnectedness of theory and practice was truly manifested during the iterative process of constructing a capstone course and using theory to build the theory that underpins the concrete artefact.

Scholars like Sutton and Staw (1995, p. 378) contend “that theory is the answer to questions of why”. For this reason, “strong theory delves into underlying processes to understand the

systematic reasoning for a particular occurrence or non-occurrence”. They further contend that “strong theory stems from a single or small set of research ideas” that can be used to “build a logically detailed case” and exhibits “both simplicity and interconnectedness” (p. 377). When building theory, researchers are often “forced to make trade-offs between generality, simplicity and accuracy and are challenged to write logically consistent and integrated arguments” (p. 372).

Table 7.3: Research Questions, Theory Propositions and Themes

#	Questions	Propositions (P) (P1 – P11)	Themes
1	What interventions are necessary to create an integrated environment that will fuse practical experiences with theoretical concepts?	P1; P2; P3; P4	Themes 2,3,4,5, 6
2	How can this set of carefully structured interventions be used to grow competence through an as-lived project experience, where the growing of competence involves the encouraging of deep approaches to learning and the nurturing of transcendence?	P3; P4; P5; P10	Themes 2,3,4,5, 6
3	How can a reflective practice nurture an interactive environment that will influence students towards acquiring a vocabulary that focuses on doing, explaining, understanding, believing and being, and aid them to make sense of their experiences?	P3; P4; P5	Theme 1, 5 & 7

Gregor (2002, p. 13) argues that the development of “theory should be seen as a continuum, and theorising as a process of interim struggles where people intentionally inch towards stronger theory”. In addition to the fundamental research question defined in Chapter 1 and restated in the introduction to this chapter, three sub-questions consistently drove the research effort over the past decade, leading to the definition of a conceptual framework at the end of the emergent phase and then subsequently to refine and strengthen the initial theory. Table 7.3 depicts an alignment of the research questions, the propositions of the theory (Table 5.1 & Table 7.4) and the action experiments (themes) in Chapter 6 that were executed to provide answers to the *how* and the *why* questions.

Table 7.4: The Theory of Coherent Practice
(Adapted from Table 5.1 and Gregor and Jones (2007))

#	Component	Component description	
1	Purpose and scope	The Theory of Coherent Practice is a framework that prescribes how a set of carefully designed interventions can be constructed and implemented to empower IS majors. In this case empowerment implies the development of competence sustained by lifelong learning.	
2	Constructs	Skills; experience; behaviour; deep approaches to learning; transcendence; competence; lifelong learning; embodied cognition and maximum grip. Concepts are illustrated by Figure 5.4 & Figure 6.1.	
3	Principles	The conceptual framework for a coherent practice is depicted by Figure 5.5 & Figure 5.6.	
4	Artefact mutability	The approach can be used to underpin and develop other exit level courses. For example, the implementation of the diploma in Business and Systems Analysis (BASA), a postgraduate diploma course (PGDIP) at UCT, commenced in 2011. Further changes should be considered to adapt the technology platform to become more dynamic and easily flexible to incorporate current technologies and trends.	
5	Propositions	1. Structured interventions are necessary to create a student-centred interactive and integrated environment.	Most important and beneficial course (CE01,2010); Tutorials were good and helped a lot to understand (CE01,2010); Structure of the course is excellent (CE01, 2011).
		2. Structured interventions are necessary to guide repetition and practice, build competence and enable transcendence.	Great learning experience (CE01,2010); Project allows for guided freedom (CE01, 2010).
		3. Theoretical lenses can help students to make sense of their experiences, getting in touch with dissonances and guiding conscious reflection while executing the interventions.	Various theoretical concepts, these concepts will forever be instilled in my mind and used in the future (Profile ST19, 2010).
		4. Guided reflective practices in a capstone course facilitate interactive team collaboration and communication.	Teamwork is of an importance (CE01,2010) Developed a unified understanding ... re-invoking experiences ... vocabulary within our team (Profile ST8, 2010).
		5. Guided reflective practices in a capstone course facilitate integrated experiential learning and constitute essential triggers for transcendence.	Learn to reflect (Profile ST12, 2010).
		6. The ongoing guided reflective practices in a course that facilitate integrated experiential learning will develop reflexive learners.	Learn with experience and reflection...well I like the concept of learning (Profile ST1, 2011)
		7. Embodied cognition is a result of guided reflection and transcendence.	Phew, over confidence, I'm over confident ...taken competencies and embody them in other aspects of my life... we were working with our imagination (Profile ST2, 2011).
		8. A learner is likely to experience a state of being unconsciously competent when embodied cognition has taken place.	I'm very confident now...somewhere between conscious incompetence and conscious competence (Profile ST1, 2011).
		9. Reflexive learners are both unconsciously and consciously competent.	For example see Appendix 1 and 2: Profile ST25, 2010 and Profiles ST19 & ST2, 2011
		10. All reflexive learners are lifelong learners.	I feel quite competent, like there's still a lot to learn though...doing new things (Profile ST3, 2011)
		11. Lifelong learning sustains (IS) competence.	There is never an end to learning new things (Profile ST24, 2010)
		12. Unconscious competence builds confidence, commitment and passion and nurtures innovation, all of which are necessary to empower IS professionals.	I feel very confident...really empowered me quite a lot ... taken competencies and embodied them in other aspects of my life... (Profile ST2, 2011).

Table 7.5: The Theory of Coherent Practice (continued)
(Adapted from Table 5.1 and Gregor and Jones (2007))

#	Component	Component description																																	
6	Justificatory knowledge (kernel theories)	<ol style="list-style-type: none"> 1. Levels of listening: follow, detach & fluency (Cockburn, 2002). 2. Stages of behaviour: novice, advanced beginner, competent performer, etc. (Dreyfus & Dreyfus, 1986). 3. Embodied cognition (Maturana & Varela, 1987). 4. Maximum grip (Merleau-Ponty, 1962). <p><i>Considerably one of the most exciting years yet...building bridges...the communication gap (imperfect communication) to become smaller...especially myself as the project manager[leader], have gone through these stages of following, detaching and to some extent fluent. As we moved from sponsor meeting to sponsor meeting...the sponsor's understanding of the project has improved as well as the group's understanding... better our performance as a group...better my performance as an individual (Profile ST5, 2010).</i></p>																																	
7	Principles of implementation (prescriptive statements) Figure 5.2 (Kuechler & Vaishnavi, 2008)	<table border="1"> <tr> <td style="text-align: center;">Prescribed action</td> <td style="text-align: center;">→</td> <td style="text-align: center;">Goal</td> </tr> <tr> <td>Develop mechanisms for understanding; explaining and prescribing relevant actions</td> <td></td> <td>Support for an alternative approach</td> </tr> <tr> <td>A focus on project phenomena.</td> <td></td> <td>To better highlight and address the complexities inherent in human interaction.</td> </tr> <tr> <td>A framework for coding practices – controlled quality.</td> <td></td> <td>Sound foundation for progressing towards crafted quality.</td> </tr> <tr> <td>Meaning making activities to make sense of experience (knowledge-experience cycle).</td> <td></td> <td>Learning and making perspectives (Mezirow, 1990).</td> </tr> <tr> <td>Reflective practice – conscious reflection-in-action (Schön, 1983).</td> <td></td> <td>Reflexive learner who will be able to pause very briefly in action and think 'why'-knowing-in-action.</td> </tr> <tr> <td>A synthesis of theory and practice (Raelin, 2007). All practical action is based on some knowledge of theory (Winter & Szczepanek, 2009).</td> <td></td> <td>Thoughtful practitioners.</td> </tr> <tr> <td>Experience profound influence of working in teams.</td> <td></td> <td>Personal development – growth.</td> </tr> <tr> <td>Think and reason more effectively about behaviour (Argyris, 1991).</td> <td></td> <td>Double-loop learning – experience value of practical knowledge.</td> </tr> <tr> <td>For transcendence to take place conceptual knowledge should be transformed (Mezirow, 1997).</td> <td></td> <td>Contextual knowledge.</td> </tr> <tr> <td>Adherence to method should be avoided</td> <td></td> <td>Agility to change - Innovative and creative solutions</td> </tr> </table>	Prescribed action	→	Goal	Develop mechanisms for understanding; explaining and prescribing relevant actions		Support for an alternative approach	A focus on project phenomena.		To better highlight and address the complexities inherent in human interaction.	A framework for coding practices – controlled quality.		Sound foundation for progressing towards crafted quality.	Meaning making activities to make sense of experience (knowledge-experience cycle).		Learning and making perspectives (Mezirow, 1990).	Reflective practice – conscious reflection-in-action (Schön, 1983).		Reflexive learner who will be able to pause very briefly in action and think 'why'-knowing-in-action.	A synthesis of theory and practice (Raelin, 2007). All practical action is based on some knowledge of theory (Winter & Szczepanek, 2009).		Thoughtful practitioners.	Experience profound influence of working in teams.		Personal development – growth.	Think and reason more effectively about behaviour (Argyris, 1991).		Double-loop learning – experience value of practical knowledge.	For transcendence to take place conceptual knowledge should be transformed (Mezirow, 1997).		Contextual knowledge.	Adherence to method should be avoided		Agility to change - Innovative and creative solutions
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Adherence to method should be avoided		Agility to change - Innovative and creative solutions																																	
8	Expository instantiation	Several deliveries of capstone courses or similar exit level courses																																	

Table 7.4 and Table 7.5 represent a more refined version of the theory than was given in Table 5.1. Although the first four components of this theory did not change much, it

became necessary to extend the other components as valuable and more detailed information was obtained during evaluation of the artefact in the 2010 and 2011 cycles as discussed in Chapter 6. Component 5 lists the testable propositions of the field and as such represents “a design exemplar that needs translation to a specific problem at hand to be used and tested” (Gregor & Jones, 2007, p. 327). The interconnectedness of these propositions is clearly “reflected in the logic of relationships among” them (Argyris & Schön, 1974, pp. 4,5).

Component 6 of the theory provides the justification knowledge that indicates how the concrete artefact should behave and can be judged. For this purpose kernel theories can be used for both product and process (Walls et al., 2004, 1992). Component 7 as shown in Table 7.5, lists the principles of implementation of the theory which are also reflected in the propositions of the theory. The principles of implementation provide the prescriptive statements and their intended goals for the implementation of the theory in practice (Kuechler & Vaishnavi, 2008) and show how “process and product are inextricably linked” (Gregor & Jones, 2007, p. 329). Finally, component 8 identifies the “viable artefact” (Hevner et al., 2004, p. 83) produced by this research in the form of the instantiation of a capstone course.

7.5 Contributions

The most noteworthy contribution of this research is undoubtedly *the way in which the power of theory is manifested* during the development of the prescriptive theory (abstract artefact) and the design and implementation of the concrete artefact it underpins. A prescriptive theory is a theory for design and action (Gregor, 2009, 2006, 2002). Throughout this thesis, the role of theory has been crucial and theory has been used to conceptualise, to articulate and to facilitate the creation of contextual knowledge. The conceptual framework (Figure 5.5 and Figure 5.6) proved invaluable in the thinking process, since it acted as a bridge (Leshem & Trafford, 2007) between the kernel theories for explaining student transcendence, and the actions related to the design and the implementation of the design (see Figure 5.2). In addition, the synthesis of the kernel theories and the theories used as theoretical lenses to negotiate student experiences and facilitate meaning and sense-making, formed a matrix of interconnectedness. On the one

dimension the kernel theories, borrowed from the social sciences, were used to explain and govern the design process (Walls et al., 2004). On the other dimension the theoretical lenses formed an integral part of the reflective practice and provided a unique vocabulary for students to negotiate their experiences. The “vocabulary to convey the exact idea ... Collaboration with my group members ... aided my understanding ... I would be the type of person to embrace these personal qualities as a team player ... ” (Profile ST24, 2010).

The theoretical perspectives and methods suggested by the different theoretical lenses displayed *progressive coherence* and provided a further opportunity towards for enhancing the concrete artefact. Barret and Walsham (2004) name progressive coherence as a tactical approach in the structuring of intertextual coherence where a network of researchers are linked by common theoretical perspectives and methods in constructing a contribution. This same concept of progressive coherence is also illustrated by the implementation of the DSR paradigm and the linking of the contributions of various scholars in DSR in this research.

Locke and Golden-Biddle (1997) further contend that a contribution in practice should reflect the socially constructed nature of scientific knowledge. This assertion is based on two key premises: “knowledge cannot be known separate from the knower, and knowledge is a meaning-making activity enacted in particular communities” (Barrett & Walsham, 2004, p. 294; Orlikowski & Baroudi, 1991). In the specific case of the capstone course at UCT, the researcher and the students formed an integral part of all interventions. The students appreciated the collaborative and “very supportive” (CE02, 2010) environment and found that “the energy and approachfulness was awesome” (CE01, 2010). This helped to create an environment where all could participate actively, make sense of and derive meaning from influences and outcomes. This in turn informed the practice and resulted in *embodied cognition*, despite students being “hugely scared” (Profile ST22, 2010) at the beginning of the course (Profiles ST6, ST22, 2010; Profiles ST3, ST5, ST12, 2011).

Scared ... huge task ... we effectively combined our different parsing patterns, in order to create a more complete experience in our minds ... I am able to recall the experience better ... understanding a concept and producing satisfactory artefacts ... one of the most interesting and hardest experiences that I have had ... amount of learning, was quite

amazing how much my knowledge and learning has just grown dramatically (Profile, ST3, 2011).

The prescriptive theory emerging from this study was used by the researcher's supervisor to design and develop a programme for graduates from a range of disciplines who were previously unemployed (BASA course). The focus of the curriculum established for this one-year programme is to educate graduate students as innovative professionals. The success of this programme can be demonstrated in pragmatic terms: on completion of the 2011 programme, 36 out of 40 students immediately found permanent employment. As a result, the programme was delivered again in 2012 and a further cohort is planned for 2013. The course outline which has been built on the theory emerging from this study is reflected in pages 3-6 of Appendix 3. Appendix 4 contains a related media release that included the student stories from the 2011 cohort.

7.6 Limitations

With a different cohort of students every year it is not always possible to predict or prepare for team issues and other problems that might occur. The same actions will not always trigger the same reactions and it is vital to be able to adapt strategies to accommodate any changes. Although these factors pose limitations and challenges that sometimes need urgent attention, they also create enlightenment and great possibilities for innovative solutions. In addition, the volatile world of software development is a daunting one and significant changes are not always as easy to achieve, since problems often need to be constructed from ill-defined and fuzzy requirements (Schön, 1983) and practices and programming platforms need to be changed on a regular basis to keep up with the dynamic and evolving nature of the discipline.

The researcher is an insider to this study. In her role as teacher, project manager, mentor, evaluator, facilitator, coach and often also as confidante, she has been intensely involved with the evolution of the course, the development of the theory, and the student body for more than a decade. To ensure objectivity and rigour it thus became necessary to rely more heavily on theory to guide and inform the decision-making and content of this report.

Although IS is an interdisciplinary field (Walsham, 2012), it is not always possible to give sufficient recognition to the individual disciplines from which we borrow. As Putnam (1999) argues, there may well be other kernel theories or other processes that could replace those used here; if so, they should contribute in a similar fashion to the intertextual coherence of existing elements and effectively fulfil their roles as explanatory components.

7.7 Conclusion

In closing, I would like to echo the words of one of the students confirming that this journey was not only about the development of a theory and a capstone course. It was also a period in which to

charge and learn with all our might as there is not much time ... along with the charging I have gained a hand full of valuable experiences that will not only help shape my future career as an IS graduate, some of these experiences will also help shape me as a person. Must keep thinking about the bigger picture and not just yourself ... new mindsets as well as inter-people skills ... I guess that's how I changed ... just having to pick myself up again ... I am finding it quite a hard process in life (Profile ST3, 2010).

Gregor and Jones(2007, p. 326) contend that

the lack of theories about IT artefacts, the ways in which they emerge and evolve over time, and how they become interdependent with socio-economic contexts and practices, are key unresolved issues for our field and ones that will become even more problematic in these dynamic and innovative times.

This account of the capstone course and the underpinning theory for coherent practice endeavours to address these issues. It also provides evidence that the capstone course is about a “willingness to adapt...more than just the project itself, it [is] was about learning people...do away with perceptions...see the strong characteristics of people” (Profile ST25, 2010).

Finally and most importantly, the leadership role in an organisation depends on vision and judgement as well as influence and drive (White, 2004) and ultimately students should walk away with a vision and a perspective that the: “university taught me to think. It made me learn to think for myself, and how to think for myself and most importantly how to think on my feet” (Alumni AQ01, 2006 in Van der Merwe et al., 2010).

8 References

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Appendices

Appendix 1 – Profile Excerpts 2010

Interventions for a Reflective Practice to Nurture Reflexive Practitioners

Student profile excerpts - 2010

Stud	Student Reflection	Elements of transcendence
ST1	Past experiences have <i>helped me grow</i> and realize how to become more at ease with myself and fellow peers...become <i>like a family</i> ...ability to <i>challenge</i> and <i>not just accept</i> what is given to me; ...in the process of discovering <i>exactly who I am</i> and accepting myself. Will enjoy working in the real world on real-life projects...in the process of <i>reflecting</i> on this phenomenon. <i>Maturity and respect</i> ...so far have worked well together... <i>adapt easily</i> ...not let <i>unimportant items</i> get in the way of our goals. Worried about coding...when time comes you kind of <i>not so scared</i> and kind of just need to jump into the deep end. <i>A lot of things you teach yourself</i> .	Self-awareness, respect & maturity; experiences and growth, learning and skills and confidence to be able to cope.
ST2	<i>Flexible learning approach</i> ...team members specialize on tasks that are suited to their natural talent...the function came together very nice. <i>Shared experiences</i> improve the understanding...learned a variety of <i>techniques</i> and I already can relate to most of them...you basically learn that <i>you can actually just do anything from scratch</i> and all the information is there and just being able to find it and understanding it and then using it.	Learning, interdependence, experiences, confidence to be able to cope and skills.
ST3	...charge and <i>learn with all our might</i> as there is not much time...along with the charging I have gained a hand full of <i>valuable experiences</i> that will not only help <i>shape my future career</i> as an IS graduate, some of these experiences will also help <i>shape me as a person</i> . Must keep thinking about the <i>bigger picture</i> and not just yourself... <i>new minds-sets</i> as well as <i>inter-people skills</i> ...I guess that's how <i>I changed</i> ...just <i>having to pick myself up again</i> ...it's quite a...I don't know...I am finding it quite a hard process in life.	Learning, experiences, behaviour, skills and cope
ST4	<i>Responsibility for learning</i> belongs to the student...an experience in which one is able to <i>grow as a person</i> , and as an Information Systems professional. <i>Satisficing</i> ...explanation need only be explicit enough to get our point across...creativity is both realistic and based on logic...comes to opening up to <i>new ideas and possibilities</i> . <i>Teamwork</i> ...not pleasant to have fighting within a group, without it, progress is stumbled...now <i>resolved the situation</i> somewhat significantly...to develop a higher standard of work, more coherent deliverables and allowed us to work faster with more efficiency...opened me up into <i>new experiences</i> and <i>broadened the horizons</i> ...truly developing as a person... <i>grow a lot as a developer and an analytical thinking</i> ...self-taught a lot more than I thought [versus spoon-feeding as student mentioned]. Course is truly a gateway to bigger things in the future...great experience...stepped into what I want to go into in terms of my career and I think I got a <i>good feel of what work feels like</i> ...I think we have <i>matured</i> a bit.	Self-awareness, growth, skills, behaviour, experiences and confidence
ST5	<i>Project is going to be a big one</i> . Don't want to be in a group with people like me, because I won't learn much. Considerably one of the most exciting years yet... <i>building bridges</i> ...the communication gap (imperfect communication) to become smaller...especially myself as the project manager[leader], have gone through these <i>stages</i> of 'following, detaching' and to some extent 'fluent'. As we moved from sponsor meeting to sponsor meeting...the sponsor's <i>understanding of the project has improved</i> as well as the group's understanding... <i>better our performance</i> as a group... <i>better my performance</i> as an individual.	Anxiety, growth, behaviour, learning, skills and transcendence
ST6	A lot of work... difficult <i>daunting</i> ... harness my creativity...to experience the practicality and simplicity of the creative process...team had to <i>adapt</i> to the issue	Anxiety, behaviour, skills, learning,

	of the time constraints...to be <i>analytical, creative and intuitive</i> . Encourages the student to <i>formalise their own approach</i> to complete a task at hand. Did not expect that our friendships within the class would actually <i>grow stronger...people skills</i> that we learned along the way...it was unexpected...foundation I have learned...with the concepts...and just taking a way a <i>fresh understanding...to roll with the punches</i> and just to <i>push through</i> when the team is very, very difficult...there are always people to help.	experience and learning to cope.
ST7	A <i>lot of work</i> ...type of marathon...significant experiences that have changed many <i>perceptions that I had of myself</i> , my group and even the project...more similar to an Iron Man race. What we actually observe is already biased...being sufficient-to-purpose...experiences have <i>impacted my life</i> and the <i>project experience</i> as a whole... <i>different skills</i> or disciplines in the course of these different events...individuals' <i>proficiencies complement</i> another.	Self-awareness, behaviour, experience, skills, perseverance and coping.
ST8	Creativity as one's ability to create: Discrepancies and fallouts...progressively <i>close this gap</i> ...develop a <i>unified understanding</i> ...re-invoking <i>experiences</i> ...vocabulary within our team...helped us a lot in communicating our ideas... <i>mutual understanding</i> in terms of norms...[re-define creativity as:] one's vision and one's <i>ability to achieve that vision</i> ...as you progress you acquire more and more skills. I have learned a lot... gained <i>people skills, leadership skills, time management</i> even will like the <i>stress part</i> - I have learned how to <i>deal with situations</i> .	Experiences, growth, interdependence, cop and competence
ST9	Going to be quite <i>challenging</i> ... always <i>take our project manager's advice</i> ... my <i>ability to communicate</i> and work together in my group improved... Do not feel my life is threatened in any way... software development can be related to a <i>game</i> ... <i>learned a lot</i> about myself... <i>have changed</i> ... <i>feel more confident</i> that I can do it.	Uncertainty, follow, growth, learning change, confidence
ST10	The understanding of the scope... <i>understanding</i> I feel will come with <i>experience...value of our ideas</i> and the feedback we get is far more constructive than before... speaking the <i>same language</i> ...we consistently managed to <i>resolve issues together</i> but were struggling to bring the rest of the group to the same level of understanding... <i>shared experiences</i> allow people to have a <i>common understanding</i> ...significantly influence [of] communication. Certain level of conflict is vital for good software development... <i>justify any standpoints</i> . <i>Set certain standards</i> and we met them... <i>discovering business requirements</i> and this becomes more and more natural...need to manage <i>my time a lot better</i> ...it's a very <i>intense</i> course	Experience, behaviour, interdependence, skills and empowered
ST11	Very <i>demanding</i> in terms of time...problem that is slowly receding as we spend more and more time together... <i>shared experiences</i> then aid the <i>understanding</i> amongst group members... <i>major learning experiences</i> ... <i>Communication</i> ... essential... alleviating the miscommunication...been a learning experience that has given me as a person so <i>many tools</i> ...able to first of all <i>recognize our mistakes</i> so that we can improve upon them. Surprising to see things <i>come together</i> ... producing the piece of work and putting it together with another person's piece of work... it's a <i>good process</i> .	Time, experiences, learning, skills, behaviour and enlightenment
ST12	Concepts we are taught in lectures come in to play... <i>not going to sit back</i> and let it pass me just like that... express ourselves without fear of intimidation... <i>express myself more professionally and confidently</i> ...greater <i>understanding of what we are doing</i> ... <i>collective responsibility</i> which means more work can be done in half the time...enabled me to <i>adapt and develop</i> ... <i>continuously learning</i> ...lead to my <i>growth</i> as an individual both morally, personally, psychologically, and emotionally, as well as cognitively. I have come to better <i>understand my strengths and weakness</i> ...acknowledge my fears especially... learnt to reflect.	Commitment, learning, growth, experience, skills and competence
ST13	Importance of having a <i>critical thinker</i> cannot be under estimated...project management techniques and skills that have been taught to us in the beginning part of this year have <i>empowered</i> us greatly...rest of the course was equipping us to <i>deal with the project</i> and everything was aimed at helping us with the project...good...rich and rewarding. <i>Coding skills</i> that were like a whole lot of our project...learned everything from scratch... we only kind of mastered them at the end. <i>Matured a lot</i> ...do a lot of hard work for a sustained period...handle pressure... <i>learned a lot</i> about dealing with <i>people</i> ... <i>trust</i> each other...know <i>each</i>	Behaviour, learning, skills experience, coping, and empowered

	<i>other's strength.</i>	
ST14	A lot of time... <i>Interdependence through teamwork</i> ...know each other's skills, attitude, behaviour, strengths and weaknesses...Intragroup conflicts are also involved...certain point in time a team gets to its maturity stage... <i>share a common understanding</i> ... new parsing patterns for developing these certain stages...The nature of the games determine how serious it is and what outcomes I will gain from it. How I play is very important especially if it will affect other members of my team. I have also learnt that in life it is important to <i>embrace a challenge as an opportunity</i> to exercise my skills as part of a team and have fun whilst I am doing it... <i>trust... collective responsibility</i> ... <i>Not only developing but also adapting</i> to certain changes and the pressure that is imposed upon us by our sponsor and mostly our project manager as well as the time limit. These changes are there to help us learn more since <i>learning is a recurring process</i> and every day I am really grateful... strong desire to learn more, which I feel I have attained... changed in ways that I have actually <i>gained confidence in myself</i> .	Anxiety, experience, skills, learning, behaviour, maturity and confidence
ST15	To survive...learnt to <i>respect each other's opinions</i> ... we are now interdependent...This course has made me understand myself better by helping me to identify my weaknesses and strengths. This self-realization makes me a better teammate and moulds me towards being a project manager... not make the challenges and setbacks discourage me to grow... <i>matured more as a team player and with my skills</i>	Anxiety, self-awareness, skills, experience, growth and maturity.
ST16	<i>Not good at programming</i> ...set my bar high...gone through experiences that will be part of my history for a life to come... <i>learned so much</i> already through this project and the theories presented to us...It is all about <i>growing and maturing</i> ...extra effort in everything that I do...challenging... <i>serious learning curve</i> ...take away coding knowledge and working in teams and solving differences and conflicts.	Fear of programming, learning, behaviour, experience and skills
ST17	<i>shared experience</i> ... <i>three levels of methodologies</i> ... <i>developed</i> this ability and creativity is actually part of my ordinary thinking...provocation... <i>passionate about IS</i> ...I enjoyed working with our sponsors and developing a system... yeah this is what I want to do for the <i>rest of my life!</i>	Stages of development, embodied-cognition, passion and confident
ST18	<i>understanding</i> of the system is evolutionary... Understanding is not a precondition of design but rather intertwined throughout... <i>tolerance and appreciation</i> of other group members... repeat the procedure so they can be innate and instinctive... <i>extrapolate some meaning out of the experience</i> ... <i>knowing yourself</i> ...reflecting on your personality	Self-awareness, behaviour, experience and learning.
ST19	Doubts about certain group members...gap of communication...until it was too late. Through my <i>experiences</i> I have learnt to understand the "experience" through the use of various theoretical concepts, these concepts will <i>forever be instilled in my mind and used in the future</i> ... through this experience I met new people... it's amazing... <i>skills that I have learned</i> with regard to coding and group work.	Uncertainty, experience, learning, skills and embodied-cognition
ST20	Goal was almost missed and we would have lost the game... luckily <i>communication by group members picked up</i> ...all... <i>started making sense</i> ...that's what I took away and taking the <i>theory and seeing how it was actually applied</i> without me knowing it in our project and pretty much this year and this project have been the <i>best experience of my life</i> .	Experience, learning and embodied-cognition
ST21	phase of testing each other's tolerance... <i>communication does not have to be perfect</i> as a gap will always exist...appropriate action...overall contribution that the project makes...requirements and functionality has changed drastically... <i>Experience so far has been one of assimilation and learning</i> ...applying these <i>skills and delivering a quality product</i> ...I know <i>I can do things on my own</i> ...as an individual it <i>made me stronger</i> ...help me moving forward and <i>pull through</i> .	Learning, behaviour skills, experience, embodied-cognition, confidence and cope
ST22	Hugely scared...I have experienced all the different levels of listening, and have discovered that, even the simplest learning technique is imperative for the growth of my documentation and coding skills. There is no way to jump steps, it would simply be impossible because new methods are not learned easily, they need to be practiced and understood before they can become second nature... learned valuable lessons and reasons behind the experiences... necessary for myself and	Growth, learning, experience, behaviour, skills – awareness perhaps not embodied yet

	my development group to grow... Expertise...yeah its more life experience its quite a bit better but this project has definitely taught me how to work in a team... I have changed.	
ST23	expecting to be difficult...common understanding and narrow the gap...willing to learn from the other...important characteristic of the team was the willingness to adapt... person's lifestyle does effect the project... more than just the project itself it was about learning people...do away with perceptions...see the strong characteristics of people,	Anxiety, experience, life-skills and, learning
ST24	Vocabulary to convey the exact idea... Collaboration with my group members... aided my understanding... I would be the type of person to embrace these personal qualities as a team player... period of learning new things about yourself and your abilities; however working in a group is even more rewarding as we get to learn and adapt from each other. Most importantly, there is never an end to learning new things as during the systems process you are often encountered with unfavourable and unforeseeable situations and there is a need to adapt and deal with these situations.	Experience, behaviour, learning, skills and coping
ST25	extrapolate learning from my experiences...ceativity is more like a skill, that anyone who is willing to embrace it can learn... base our reasoning and conclusions on past experiences and lessons learned.	Learning and experiences

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Appendix 2 – Profile Excerpts 2011

Interventions for a Reflective Practice to Nurture Reflexive Practitioners

Student profile excerpts - 2011

Stud	Student Reflection	Elements of transcendence
ST1	<p>Raise our game on the spot and rethink <i>our commitment to the project...‘satisficing’ concept</i> made this experience understandable... <i>shared and familiar syntax to communicate software development ideas...</i>like the project management part...project was really fun as well and <i>I learned a lot</i> and actually made a real system and it was not boring...some people can't be managed... <i>gained a lot of competence...</i> project was very stressful at first specially during learning all the technologies...<i>desire to learn is more important than feasibility...the tortoise wins the race...</i>trying to do a very professional job for our project...hindsight project management was very important and <i>we didn't do a very good job...</i>poor job with project management, we did a poor job of time management... anything that's simplistic and not making anything more complicated than they need to be... <i>I'm very confident now...somewhere between conscious incompetence and conscious competence...learn with experience and reflection...</i>actual experience is more important than theory...being willing to thing out the box...<i>well I like the concept of learning. About theory to practice to knowledge and the whole reflection. From unconscious incompetence to conscious competence...Constantly trying to learn from my mistakes. And move higher along...concepts about higher learning are very important to me. Not to be a simpleton that does not reflect on anything...Well the readings definitely helped to reflect on past experiences because before that I had never heard of the concept reflection. Although I did reflect on things I didn't do it consciously.</i></p>	<p>Experience, learning, skills, reflection, competent and continuously learning</p>
ST2	<p>Teamwork is so important... opened my eyes to the complexity of the <i>multi-dimensional phenomena that is a team...</i> valuable lesson I learned... <i>Becoming consciously aware of my own way of thinking</i> has enabled me to actively attempt different methods of thinking... communicate properly... high level of emotional investment and they feel passionate... trap of defensive reasoning...brings up a life lesson <i>I'm continuously learning... adapt to situations...</i> group interactions something I feel very confident...<i>really empowered me quite a lot...</i> not spending enough time [coding]... immediately but a lot of people on the back foot. They did not understand how important that is... I learned how to code as well.. I am quite stoked... <i>so much more confident...</i> I am so amped about new projects like I am working quite hard at the moment on projects of my own... I feel so amped about IS and about the future and its awesome...work towards my weaknesses and improve them...<i>belief in myself...</i> no matter what I wanna do in life I will be able to do it and I do also now know, how to work hard... <i>felt quite competent, and especially when comparing myself to students from other universities. Who had already done their honours project. I'd see we were levels above them...</i> ability to analyse the situation, analyse what needs to be done, what's the correct procedure, to get to the end, working with the end in mind. All of these things we were levels above the others. Uhhh, how much confidence? <i>Phew, over confidence, I'm over confident...taken competencies and embody them in other aspects of my life...</i> we were working with our imagination... was a great experience, and I'm very stoked we had that... helping me now in other groups that I'm in... social groups.</p>	<p>Learning, skills, experience, behaviour (adapt), confidence and embodied cognition</p>
ST3	<p><i>Scared... huge task... incomplete communication...</i>we effectively combined our different parsing patterns, in order to create a more <i>complete experience</i> in our minds...I am able to recall the experience better...I am able to recall the experience better... understanding a <i>concept and producing satisfactory artefacts...</i>one of the most interesting and hard experiences that I have had but definitely worth it...<i>amount of learning was quite amazing</i> how much my knowledge and learning has just <i>grown dramatically...</i>documentation not only coding and stuff...working environment was very productive... know your teammates well and their</p>	<p>Experience, learning, growth, challenges – step-by-step – then competence</p>

	strengths...someone that kind of <i>challenges</i> you and always brings new things to the table...look at the negative things that you might not see...third year taught us... <i>project kind of like a step by step... I feel quite competent</i> , like there's still a lot to learn though... doing new things.	
ST4	Hoping to <i>learn a lot... bit scared...</i> we would never be able to grasp the <i>complexity of this project</i> ...understand our sponsor's perspective and how we were translating the information given to us...understood a concept in my head but found it very <i>difficult to communicate</i> to the others...higher stage of learning and have the <i>confidence to change procedures</i> ...Satisficing means understanding that we will <i>never reach a perfect solution</i> ...drop the argument and move on... team interactions more enjoyable...the best sort of opportunities... <i>skills</i> that the course teaches you in terms of problem solving and the thinking behind things...biggest learning in the <i>bunch of skills</i> that I have picked up...I will learn a lot faster and I enjoy the <i>learning process</i> ...trying over and over...feeling <i>fairly confident</i> , uhmm. I might not know exactly how I'm gonna to get to, you know the end. But at least now I know I've done it...Get the learning done as soon as possible and aah not. Don't focus on things that are unnecessary...It installs the sort, practice of reflection with this course and the other courses that I do...think it just kinda <i>changed the way that I thought about things</i> ...a lot of it we have to <i>learn ourselves</i> and find out ourselves.	Anxiety, learning, experience, skills, behaviour, confidence...through reflection and competence
ST5	nervous about <i>having to learn a whole new languages</i> ...studied programming before so I am sure I will...shifted from a very <i>individualistic perspective, to a much more group orientated idea</i> ...learnt not to assume that not everyone I attempt to convey a message to understands exactly what I mean...one can <i>break free of these methodologies in order to gain greater insight into a problem</i> ...more <i>confident to break away from standard methodologies</i> .	Behaviour, transcendence and confidence
ST6	<i>fears and expectations are I guess coding... learn from our experiences</i> and use these theoretical lenses, we make sense of what was done... satisficing...found that having a <i>significant time constraint meant that we knew we could not achieve perfection</i> ... I know that from now on, in everything I do, I will be taking time to reflect on my experiences , understand them and <i>learn from them</i> ... very enriching and very good learning experience this year... learn how to <i>communicate</i> a bit better and learn how to <i>manage your time</i> and learn how to determine <i>what is important</i> up front and what is not important... testing definitely, I don't think you cannot do enough testing...now I'm <i>a lot more competent</i> ... more <i>confidence in my abilities</i> ... different ways of solving a problem.	Fears, experiences, learning, skills, confidence and competence
ST7	Looking forward... very, very hard... <i>very excited...going to grow</i> ...transformation of energy and emotional involvement of everyone, myself included...*complexity* of the situation...through a very collaborative effort...*value creation*... brings in the concept of sense making and sense giving...produce the functionality (although not actually on the real technology) we stand a <i>greater chance of conveying the concept effectively</i> ...operated the <i>satisficing principle</i> ... quickly jump for one process to the next...proved invaluable...helped me to better understand my own reaction to "overwhelm"...to <i>recognise the forces at play</i> ... and its almost <i>given me more confidence</i> to get something...team work and skills and I had to up my game a little bit... <i>a lot of skills</i> on understanding or conceptual stuff but there is a gap between the technical things we <i>learned to do and the things we actually need to get done</i> ... a lot of lessons learned and where you go wrong from third year and <i>massive personal growth... throw out all those mistakes</i> and save time.	Expectations, learning, skills, behaviour, confidence
ST8	Related to communication in our group was <i>respect...valuable experience</i> to learn as we now understand that requirements are defined... <i>not using time efficiently</i> ...At least now I know some of the <i>challenges faced when implementing an I.S project</i> ...course prepared me for the work place...combined everything from first year IS up until third year...I experienced working in a project, working with team members and also working under pressure...I think <i>it helped me grow to be able to understand people's view</i> and thoughts not only the concerned about my own opinions but to give others a chance and to have different opinions and to understand each other rather than settle with one way rather than getting angry if your opinion was not taken... <i>I learned a lot</i> ... learned that it is difficult to manage people...it's not like an easy task to be a team leader... <i>won't underestimate time</i>	Experience, growth, learning busy detaching

	because we started our project late.	
ST9	Very <i>confused with the coding</i> ...not very comfortable with coding... <i>reflecting on our experiences from tasks done in our project</i> ...methodologies in order to cope with developing our systems development project and learn important lessons and skills...we had a lack of skills... <i>what I have learned out of this project is that people have different goals and we don't all that the same goal</i> ...I got frustrated a lot and I felt like this thing is taking over my time but then I realized that it was crucial for my growth...learned a lot, I learned to be patient...more compassionate.	Experience, learning and growth
ST10	<i>Thinking patterns</i> when it comes to problems solving...defensive reasoning comes natural to most educated people...Productive reasoning forces you to acknowledge...results of <i>productive reasoning</i> is tangible, as discussions tend to be more focused, more honest and more productive resulting in less time being wasted. The group in general <i>experiences a greater sense of learning</i> and communication due to productive reasoning...not being afraid to take up <i>new challenges and try new things</i> ...and you are in the deep end but the key is to start kicking and swimming and that is what we have taken away...not to be afraid of new things... just about <i>applying yourself and putting pedal to the medal</i> ...nothing is as scary as it feels you know and its always manageable...skill and certain aspects very quickly and therefore you know have a <i>certain skill set</i> that is helpful and useful...like bite, bite, bite. You know like, you just have to every little problem that comes I try to overcome it...every problem can be solved and if it cannot be solved it's just because you don't have enough information...far less anxiousness about the whole concept...You know it gave a certain level of pride not just like, I was somewhere involved with it you know...as for my <i>competence it's continuously growing</i> .	Behaviour, experience, learning, skills, coping and confidence, action and practice and competence
ST11	A lot of change in me.....kind of do or die...to address issues from all angles... <i>common ground</i> to work from...everyone stepped up to their parts and it was great to see my team grow as a whole...to <i>notice about my own personality</i> ...the techniques that we learned along the way I think just managing I think I might be <i>able to be a team leader next year</i> ...Understanding, patience with team members, there is a level of pushing each other... <i>push to the limits and finding the limits of the team members</i> ...Teamwork is very difficult...didn't really work out that well, but it was a <i>good experience</i> ...project management it gives you a strong background...your requirements weren't set in stone.	Anxious, behaviour, experience and skills
ST12	<i>Biggest fear is the project</i> ...not to limit ourselves... <i>passion and drive for Information Systems</i> has been stretched to the limit and my mind opened to new ideologies and philosophies on project management...real life problem with all the complexities involved... <i>a tremendous learning curve</i> ...this priceless experience is nothing without reflection...team development dynamics was that of perseverance...monumental stumbling block due to the loss of our team member... <i>team stuck together and grew stronger as a unit</i> ...looked at the end product and what we were trying to achieve...quite a journey for me...to take away a lot of things from this year and from team dynamics, to the actual content of the work...I feel like what I have done better is probably my <i>coding abilities</i> ...with team dynamics I have grown a lot...close to detaching...disappointed with my overall mark but I can see beyond it that there are a lot of things that I have taken out of the course that are not specifically related to the marks...trying to enjoy myself although it did get pretty rough...I look at the way I was coding and the way I'm coding now. <i>I'm totally on a different level</i> ...coding workshops were a bit harsh...didn't understand them until I actually started working on my own project and getting to know what exactly is going on and. It made sense late in the term...taught me perseverance and not to give up... <i>now I'm very confident</i> ...I actually <i>feel good about myself</i> and I say to myself...I'm now <i>much more equipped</i> to deal with this year!	Anxiety, behaviour, growth, learning, experience, skills, confidence, coping and competence
ST13	They can never see themselves as incorrect...defensive reasoning they acts of embarrassment and guilt will not have a positive impact... <i>Communication is key</i> yet as expressed...don't always communicate coherently unless we have an experience to relate back to...this course it just teaches you to be a grown up... <i>rough year and the project takes 90% of your life away</i> and it was <i>yeah it was</i>	Learning, behaviour and growth

	worth it...you learn so much now that you think back at first it was like wow.	
ST14	<p>Push myself and <i>learn in a different way</i>... team now has a greater sense of direction...lack of shared experiences and awareness of each members thinking mannerisms almost lead to the destruction and inefficiency of a beautiful hard working and incredible team...<i>Bridging the communication gaps</i>...lack of trust due to another member of team failing to always deliver...to <i>inexplicable grow and become a better team player</i> and a person in the ever changing circle of team work and that of life...<i>awareness is no longer enough if one is unable to upon reflecting, learn something from the experience so as to move forward and do things differently in the same or similar experience in the near future</i>...uhmm I hated coding in fact... more of a business analyst and aah, designer type of girl...I have more than my aah, <i>coding and developing expertise</i>. I think third year shaped me as a person...at first I said the resilience empowered me but that <i>type of resilience where you almost have no hope, but you keep on going...I think that's probably my IS foundation...forcing me to be aware of my level of confidence and the power that comes with being aware of all of that</i>. Uhmm, I'd say it's increased a lot, you know because I think experience shapes you and my third year experience definitely shaped me...<i>was saying, you know those readings they empowered us a lot. You know and made us aware of ourselves and the things that we go through</i>...shown mechanisms of how to deal with yourself when you at that stage...not all of us are exposed to certain things in life and not all of us are taught the same way, so that was a huge shortfall...<i>I think that's why my experience was so much more intense...We came out strong but I'll still question...several ways of getting up Mnt Kilimanjaro. We don't always have to take the hardest route, but that was our fate.</i></p>	Learning, skills, acute awareness of level of confidence and intense experience
ST15	<p>...bunch of slackers...can integrate other skills...<i>constant review of ones experiences</i>, rehashing the concepts learned and analyzing their relevance...<i>concept of satisficing...try our best to be better than "good enough"</i>... felt I had now earned the teams respect...working towards a <i>shared vision of the goal</i>...reflexive learning lectures/workshops were not just academic lessons- <i>but life lessons</i>...peaking about my skills with design...<i>experience has helped me grow to be much better than what I was...believe that the jump from second year to third year was actually exponential in the fact of the concepts and knowledge applied was much more, much more important I would say in my third year</i>...Kosheek's project management. I remember a lot of it was quite profound. There were a lot of <i>aspects and values that actually apply</i>...actually learn from theorists and what they've said and you apply them to a project...really enjoyed working in a group, team, even though we had our blunders. In the end we all <i>high fived and hugged</i>. It was a <i>good experience</i>.</p>	Experiences, growth, skills, behaviour and confidence
ST16	<p><i>Learning to program in real life situations</i>... for fears...logic of the programming...amount of work to be done...We did not actually think in depth of how we could put through the core ideas that made our system...<i>better relationships with my peers as I have come to understand them better...Experiences can only be interpreted through our understanding of them</i>...for long periods of time, you got to work constantly...Even though we struggled and we were chucked in the deep end like ya, it was invaluable. <i>Not only to the skills we learned for project development but also skills for life</i>...the project it's not all about coding there's a lot more other factors...<i>research and</i> I think that, that, that's the part that all of us underestimated...but by the end of the project you look back and you're like "What was I doing? I didn't know anything!"... <i>we've got the experience from doing our first project, we know what can happen...every team will have its problems. Uhmm, it doesn't matter if your chilled or if you intense you'll have your problems...the camaraderie that we had. Ya, it's definitely something that I'll miss...That was amazing.</i></p>	Behaviour, experiences, learning, skills and confidence
ST17	<p>Wanting to be here for a very long time...but I am scared...to share more <i>experiences parsing patterns</i> will begin to become somewhat streamlined...everything was for the team now... but it was my team members and their backgrounds have to become my backgrounds...feeling angry at her incompetence...But also forgiving her and loving her through it...experience that was life changing, well not life changing but altered my vision of things.. our final</p>	Anxious, experience, behaviour, skills and competence

	<p>mark, and it was 57...came to realize was that no mark or end result would have made the tough experience better at that point...resistant to the guidance that you wanted to give..."I can figure it out myself...But at the end I realized...Only in the IS department do we work so closely with people.. <i>being open to being guided in your work and being honest</i>...think I'm prepared because I've gone through the whole process...my <i>people skills were really sharpened last year</i>, so it's different going in this year. Ummm. My <i>perspective is so different; I'm ready to be wowed</i>...my <i>competence in graphic user interface design really sky rocketed within a short space of time</i>...in my group I learnt that even though I wanted to do a certain activity, there are different backgrounds and different sort of state of minds to consider. It means we as people all interpret things differently, that always causes incomplete communication.</p>	
ST18	<p>Fearing the coding section...I thought I would feel comfortable...<i>underestimated the theory behind challenges and difficulties of working in groups</i>...</p>	awareness
ST19	<p>I <i>learned a ton</i> about coding, I learned so much, all those things that go into building a website and coding...learned a lot about group work...<i>learned a lot</i> about what actually IS is about... all the different steps that you follow to build a system...<i>personal skills that you feel you developed</i>...bits of work coming together in the end and it was a great piece of work and that is a success...learned a lot about myself and what I am capable of and yeah...I get a <i>sense of satisfaction</i> when I get it to work...learned a <i>lot of patience</i> from those meetings... gave us a lot of direction...<i>if there's something that I don't understand I think that I can...pick it up. relatively...easily!</i></p>	Behaviour, skills learning, capabilities, competence and experience
ST20	<p>Second time so it's <i>quite challenging</i>...keen to get a new group... keen to learn C#...did not have complete trust in the capabilities of each member...we use different form of expressing things that are hard to tell others... this year I will be doing more openly...explain it and re-explain it...<i>It's like, don't give up, or don't...also part of the problem, instead of making myself part of the solution</i>...[Do you think the third year prepared you – given you more confidence?] --Definitely! Definitely!...we did lots of programming last year, and it was more of a <i>guided experience</i>...started withholding some of the steps of how we should do the stuff and try and apply what we have been learning...<i>our own intuitive thinking, creativity</i> and so on...Testing our <i>understanding of what we've been learning throughout the whole year</i>...Good of theory, lot's of theory is good but put a bit of practice to it, it just makes it exceptional.</p>	Challenging, behaviour, guided experience and learning (understanding)

A complete version of this document can be obtained from the author –
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Appendix 3 – PGDIP – BASA 2011 Course Outline

Appendix 4 - PGDIP - BASA 2011 Student Stories

Appendix 5 – Table of Contents for Analysis Documentation

(Available as electronic attachments from the Main Library at UCT as well as from the author, elsje.scott@uct.ac.za)

1. **Alumni** - (2006-2010)
 - Ratings, Third Year Experience
 - Factors, Graphical analysis
2. **Course Evaluations** - (2006-2008,2010-2011)
 - Scores of 2nd semesters; 2006- 1st & 2nd semester
 - Rubrics for first and second semesters
 - Statistical analysis of scores
 - Responses to questions
3. **Examples of selected rubrics used for assessment**
4. **Lessons Learned** - (2006-2011 ; questions 1-5)
 - Responses to questions
 - Scores and graphical analysis
5. **Life Skills**
(2010)
 - Tutorial
6. **Marks**
(Exemplars for 2010 & 2011)
 - Summary of marks
 - Graphical analysis
(Exemplars for 2006-2011)
 - Overview for Coding
 - Overview for Documentation correlation with position in class & conflict
7. **Peer Evaluations** - (2006-2011)
 - Summary
 - Factors
 - Graphical analysis
8. **Surveys** - (2005-2006; 2008-2011)
 - Questions 1-7
 - Comments on questions 1-7

- Graphical analysis on questions 1-7
- Graphical analysis on hard skills ratings
- Graphical analysis on soft skills ratings
- Graphical analysis on participant ratings