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Infusing critical thinking into an employability skills program: The effectiveness of an immersion approach

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Infusing critical thinking into an
employability skills program:
The effectiveness of an immersion approach

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December 2010

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USE OF THESIS

The Use of Thesis statement is not included in this version of the thesis.

Abstract

The demands of the knowledge economy have placed renewed emphasis on graduate employability and the development of higher-order thinking skills. Preparing graduates for the workplace requires new instructional approaches to develop a matrix of interrelated skills. This study investigates an immersion approach to developing employability skills with emphasis on the infusion of critical thinking skills in an undergraduate business degree.

The research is situated within the pragmatic paradigm and comprises a mixed methods approach. Analyses of project instructions, student reflections and test scores are presented in an explanatory case study in three parts: the infusion of critical thinking skills in a program that targets employability, the process of critical thinking within a community of inquiry, and the performance of students in a standardised critical thinking skills test after completing the first year of the program.

The study shows critical thinking skills to be central to the development of employability skills in an immersion approach and that the project tasks engaged students in a critical thinking cycle. Analyses of test results show that participants in the program outperformed nonparticipants, but that not all participants improved their own performance. Participants from non-English-speaking backgrounds achieved lower means, but still outperformed nonparticipants. It was therefore found that participation in the program can improve student performance in a standardised test, but also that test scores in a standardised test may not be an ecologically valid indicator of critical thinking skills development in authentic learning environments following an immersion approach.

The study provides new insight into the infusion of critical thinking skills in an immersion approach and makes explicit a model for employability skills development that will enable business education to deliver graduates who can participate effectively in the workplace of the 21st century.

For my mother

DECLARATION

I certify that this thesis does not, to the best of my knowledge and belief:

- (i) incorporate without acknowledgement any material previously submitted for a degree or diploma in any institution of higher education;
- (ii) contain any material previously published or written by another person except where due reference is made in the text; or
- (iii) contain any defamatory material.

Signed.....

Date.....

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Chapter 1: Introduction

1.1 Chapter overview

Chapter 1 presents the background and context of the study, highlighting the centrality of critical thinking in developing employability, and outlines the theoretical context of the research (section 1.2). It explains the relevance and significance of the research (section 1.3) and lists the research questions and main research elements (section 1.4). Section 1.5 provides a broad overview of the methodology, and section 1.6 describes the structure of the dissertation. A summary of chapter 1 is provided in section 1.7.

1.2 Background and context

Virtually every business or industry position that involves responsibility and action in the face of uncertainty would benefit if the people filling that position obtained a higher level of the ability to think critically. ... Critical-thinking skills offer the greatest chance of success for creating and adjusting to change (Halpern, 2001, p.284).

This study relates to the development of critical thinking skills following an immersion approach. The context for the study is an employability skills program in undergraduate business education. The program was introduced against the background of the skills agenda which has been driven by a growing demand for graduates who have the capabilities they need to succeed in the workplace of the 21st century. To highlight the relevance of the study within the context of higher education, this section first provides a brief outline of recent national and international initiatives relating to the skills agenda and then considers the centrality of critical thinking skills in the development of employability.

1.2.1 The skills agenda

The skills agenda is broad and spans virtually all sectors of economic life and all areas of educational enterprise, pre- and post-secondary, including the preparation of school-leavers for the workplace, on-the-job training initiatives, vocational training, and higher education. For several decades, higher education has recognised the need for graduates to possess a range of generic skills and attributes in addition to knowledge of their discipline, and most

universities now have clearly articulated the attributes considered desirable for their graduates. Since the 1990s, a number of commissions and committees of inquiry internationally have placed generic skills within an employability framework in response to and recognition of the demands of the new economy. In addition to curricular demands, the majority of these investigations addressed wide-ranging terms of reference, including policies and funding models which fall outside the scope of this study.

Two prominent initiatives in the United States of America included the report of the American Society for Training and Development (ASTD) (Carnevale, Gainer & Meltzer, 1990) followed by the project of the Secretary's Commission on Achieving Necessary Skills (SCANS 1991). In Europe a joint declaration by ministers of education in 1999 set in motion an initiative that came to be known as the Bologna Process. Although the main purpose was to establish the European Higher Education Area, a report by the European University Association to the Bergen Conference in 2005 (Reichert & Tauch, 2005) put a clear emphasis on graduate employability. Employability has since been the topic of a number of follow-up seminars held under the auspices of the Bologna Follow-up Group (BFUG) (a group consisting of ministerial representatives of all member countries as well as a large number of other stakeholders), including the Bled seminar (Vukasović, 2004) and a seminar titled "Enhancing European employability" held at the University of Wales in Swansea in 2006.

In the United Kingdom the National Committee of Inquiry into Higher Education (NCIHE) made recommendations on higher education development (purposes, shape, structure, size and funding) "to meet the needs of the United Kingdom over the next 20 years" (Dearing Report 1997). The report stated that "*employers emphasised to us in their evidence the importance of high level analytical skills. The development of such skills characterises higher education, and should continue to be one of its primary purposes* (Dearing Report, 1997, Ch.9).

In Australia the skills agenda gained momentum with the release of the government report *Backing Australia's ability* in 2001, and the report *Employability skills for the future* (Commonwealth, 2002) following a joint investigation by the Business Council of Australia and the Australian Chamber of Commerce and Industry which resulted in the development of an Employability Skills Framework. Also in 2002, the Higher Education Group of the then Department of Education, Science and Training published the Australian Business Education Study (ABES, 2002). Part of objective 2 of the ABES is particularly relevant here, namely to "evaluate the quality of business education in terms of graduate employability" (ABES, 2002, Ch.1, p.2).

The ABES study (2002) reported a number of drivers for change in business education, including information and communication technologies, globalisation and blurring of disciplinary boundaries. In addition, “convergence of knowledge and flatter management structures in business require business graduates to have acquired a holistic understanding of business operations, indicating the need for greater integration of disciplines in business courses” (ABES, 2002, p.xi). Flexibility is identified as important in terms of articulation and entry and exit points, but not at the expense of the “need to provide for planned and progressive skills/competency development” (ABES, 2002, p.xii).

There was consensus among stakeholders that “generic and lifelong learning skills are ... of primary importance”, but that a three-year business degree did not allow sufficient time for students to acquire the necessary generic skills. Stakeholders were also of the opinion that “embedding ... generic skills into business programs and progressive student mapping of their skills acquisition result in more effective skills acquisition within a business context” (ABES, 2002, p.xii).

In considering the implications of convergence and continuity of knowledge, the Australian Business Education Study identified a number of challenges, including the need “to transform the nature of business education radically to respond to the changing nature of business knowledge that integrates generic skills, discipline knowledge and cross-disciplinary and [a] holistic view of business, so as to prepare students for corporate responsibilities that transcend traditional functional boundaries”, and “to transform business education by developing a ‘process-centred curriculum’” (ABES, 2002, p.xvii).

These events and employer demands for “work-ready” graduates prompted the introduction in 2007 of the Employability Skills Development Program (ESDP) into a three-year undergraduate business degree. The ESDP comprises four core units developed to incorporate employability skills as set out in the *Australian national employability skills framework* (Commonwealth, 2002) and provides the context for this study, which locates the development of critical thinking skills within a matrix of employability skills.

1.2.2 The centrality of critical thinking in developing employability

The concept of employability has a variety of meanings, ranging from the rate of employment of graduates (hence as an indicator of institutional success) to the characteristics of an individual graduate (Harvey 2003). Employability may also be used to indicate the “the relative chances of finding and maintaining different kinds of employment” (Brown, Hesketh & Williams, 2002).

Yorke (2006, p.8) proposed a working definition which saw employability as

a set of achievements – skills, understandings and personal attributes – that makes graduates more likely to gain employment and be successful in their chosen occupations, which benefits themselves, the workforce, the community and the economy.

In defining employability, the Centre for Research and Evaluation (CRE, n.d.) at Sheffield Hallam University in the UK, cautioned that “employability is not just about getting a job”.

Employability is more than about developing attributes, techniques or experience just to enable a student to get a job, or to progress within a current career. It is about learning and the emphasis is less on 'employ' and more on 'ability'. In essence, the emphasis is on developing critical, reflective abilities, with a view to empowering and enhancing the learner” (CRE, para 2, "Defining employability", n.d.)

The program in this case study is aimed at such “critical, reflective abilities” that enable and enhance learning and skills development.

Curtis and McKenzie (2001, pp.4-8) reviewed the wide range of terms used to describe the characteristics that employers value in graduates. They came to the conclusion that “*employability* signals a connection to the world of work that is dynamic and long-term in nature ... [and] also signals some of the qualities needed for success in work and life as a whole” (Curtis & McKenzie, 2001, p.8). Internationally, growing lists of skills that employers find desirable have been produced. There is little variation among these, and only a degree of difference in the emphasis that different employment sectors place on skills areas (Harvey, Moon & Geall, 1997).

The rationale for this research stems from a view of higher-order thinking skills (and critical thinking in particular) as enabler for developing employability skills, for transferability of such skills, and for continuing further development of employability skills across the lifespan. Critical thinking or higher-order cognitive skills enable individuals to participate actively in knowledge development and to become independent lifelong learners (Tsui, 2002, p.740; MacLellan, 2004, p.2).

The development of thinking skills has long been considered to be a core outcome of education and a stated objective of higher education (Dewey, 1910, pp.27-28; Tsui, 2002). How then do critical thinking skills relate to employability and the skills identified as necessary to

ensure employability? The table below identifies the skills or skills groups listed in employability initiatives that can be interpreted as relating to critical thinking.

Table 1.1: Thinking skills components of employability

	Organisation	Skill group or type	Skill-specific ability
USA	American Society for Training and Development (ASTD)	adaptability skills	problem solving, thinking creatively
USA	Secretary's Commission on Achieving Necessary Skills (SCANS)	thinking skills	thinking creatively, making decisions, solving problems, seeing things in the mind's eye, knowing how to learn, and reasoning
EU	Bologna process	other transferable skills	autonomous learner and the capacity to approach new issues higher level cognitive abilities
UK	National Committee of Inquiry into Higher Education (NCIHE) (Dearing Report)	employability skills	high-level analytical skills problem identification and solving
UK	Centre for Research into Quality	personal attributes cognitive skills	intellect ability in critical analysis
AU	Mayer Report	key competencies	analysing information solving problems
AU	Australian Chamber of Commerce and Industry and the Business Council of Australia	employability skills	problem-solving skills

In listing the skills that have been made explicit within employability skills initiatives, it becomes clear that extracting cognitive or thinking skills from lists that address skills at such a high level of generality does not make clear the interrelated nature of skills and gives no indication of how competence or ability in one or more skills will enhance ability in another skill. Nor does viewing thinking-type skills in isolation offer insight into the complexity of critical thinking ability and its role in supporting and enabling the acquisition of other employability skills.

In order to clarify the role of critical thinking ability in the development of other listed employability skills, it is therefore necessary to view employability as a framework of interrelated skills.

The development of the ESDP was informed by the key skills set out in the Australian National Training Authority's employability skills framework (Commonwealth, 2003) and the eight key employability skills areas identified in the framework:

(1) communication skills that contribute to productive and harmonious relations between employees and customers;

(2) team work skills that contribute to productive working relationships and outcomes;

- (3) problem-solving skills that contribute to productive outcomes;*
- (4) initiative and enterprise skills that contribute to innovative outcomes;*
- (5) planning and organising skills that contribute to long-term and short-term strategic planning;*
- (6) self-management skills that contribute to employee satisfaction and growth;*
- (7) learning skills that contribute to ongoing improvement and expansion in employee and company operations and outcomes; and*
- (8) technology skills that contribute to effective execution of tasks*

The interrelated nature of skills can be explained conceptually by considering each of the groups of skills above and presenting the line of reasoning that supports the view of skills as being interdependent.

Communication skills (1) are pivotal in ensuring successful teamwork (2), and reciprocally skills in working as a team (2) will enhance communication skills (1). The one skill is therefore a necessary condition for the other. Similarly, initiative and enterprise (4) cannot be applied effectively without the necessary planning and organising skills (5), while conversely, planning and organising skills (5) without the ability to show initiative and enterprise (4) would be unlikely to lead to enhanced employability or career success. In similar vein, learning skills (7) would be dependent on self-management skills (6) and vice versa. Given the nature of communications, teamwork, planning and learning in the 21st century, proficient application of all these skills in practice will be highly dependent on technology skills (8).

Problem-solving skills (3) are of specific interest to this case study, and can be said to underpin many of the other skills and to be requisite in enhancing the outcomes resulting from the application of all other skills. So while it is possible to acquire and exhibit some measure of communication (1) or teamwork skills (2), or enterprise (4), planning and organising skills (5), their value would be limited by an inability to solve problems encountered in the process. Self-management (6), learning (7) and technology skills (8) are equally in an interdependent relationship with problem-solving ability (3).

Figure 1.1 illustrates the interrelated and interdependent nature of employability skills.

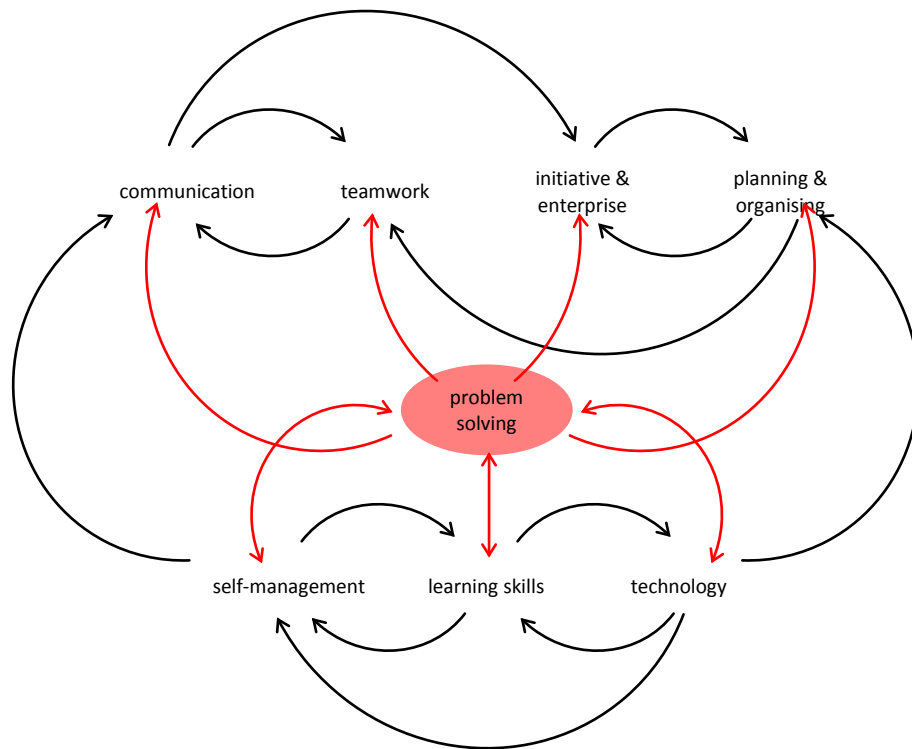


Figure 1.1: The interrelatedness and interdependence of skills

While not all cognitive processes should be regarded as critical thinking, which is “one among a family of closely related forms of higher-order thinking, along with, for example, problem-solving, decision making, and creative thinking” (American Philosophical Association, 1990, p.5), the proposition in this study is that skills such as problem-solving and decision making are not merely “closely related” to critical thinking, but are indeed dependent on the ability to think critically. Critical thinking should therefore be viewed as “an over-arching concept encompassing problem solving and creative thinking” (Garrison, 1991, p.290).

As cognitive ability can be said to support acquisition and performance of employability skills, and no skill exists as an isolated entity divorced from other skills or abilities, employability should be regarded as a *framework or matrix of interrelated skills*.

The research problem therefore arises from the need to establish whether a program aimed at developing employability skills without explicitly focussing on critical thinking can enhance critical thinking skills in practice, how this would take place, and how effective such an approach would be.

1.2.3 Theoretical context

Much of the literature on critical thinking skills has emanated from the fields of philosophy and psychology, but thinking skills and cognition as general terms permeate all areas of teaching and learning as core processes in education, and are viewed within the broad field of teaching and learning from different perspectives, each with its own emphasis on aspects of “thinking” in the educational experience. It is useful to delineate the primary perspectives as belonging within the academic traditions of (1) philosophy, where thinking is viewed in terms of “the theory of mind” and of “knowledge”, in contrast to (2) the traditions in psychology, which is concerned specifically with understanding the development of thinking as it relates to the cognitive process of learning, and (3) the field of sociology where the focus is on the structure and function of educational systems and practices, all of which have influenced perspectives on thinking (Moseley, Baumfield, Elliott et al, 2005, p.9).

This study is concerned with the development of critical thinking skills within undergraduate business education and specifically within a program intended to develop employability skills. The context involves a confluence of perspectives, and as such is not confined to a single theory of learning or academic tradition. In some respect it is informed by views from all three perspectives on “thinking” in the educational experience. While it is not *about* the nature of knowledge in a purely philosophical sense, it is informed by the perspectives on thinking that have emanated from the field of educational philosophy, and this study holds a view of knowledge as a perpetual goal that is not conclusively achieved within a few years of studying discipline “content”. It is not *about* a single or even a specific group of learning theories, such as social constructivism, social constructionism or situated cognition, nor does it exclude learning theory, but it relies on the theoretical base, including Vygotsky’s (1978) sociocultural theory of cognitive development that underpins the approach to facilitating learning within a collaborative learning environment. It is not *about* educational systems in a social context, and yet it is couched within the social demands made of education in the 21st century.

The approach to skills instruction and the framework used in analysing the program being investigated in the current study are aligned with a theory of *collaborative constructivism* which views teaching and learning from a transactional perspective. Learning is viewed as both an internal process of meaning making and a collaborative or social process of constructing and confirming knowledge (Garrison & Anderson, 2003, p.12). The transactional perspective reflects a unified notion of learning, where individual meaning or understanding is confirmed through interaction within a collaborative process of knowledge construction.

1.3 The research problem and the significance of this study

Research into the development of critical thinking has resulted in a rich and mature literature, especially since the critical thinking movement gained momentum in the 1980s. This study explores critical thinking skills development in a context that differs from conventional approaches to critical thinking skills instruction in terms of both its curriculum structure and its pedagogical approach.

Over the past decade, authorities in the field of critical thinking have been questioning the usefulness of traditional approaches to teaching critical thinking, advocating more authentic models of instruction in the light of persistent concerns over transferability of skills acquired within stand-alone (bolt-on) units or courses in critical thinking. A theoretical base for adopting an immersion model is emerging from the literature (Prawat, 1991; Angeli & Valanides, 2009), and more comprehensive and contextualised approaches are emerging in practice (Livingston, Soden & Kirkwood, 2004). While the value of such approaches is becoming clear, they are generally resource intensive and may not be feasible across all areas of higher education. One way to moderate the expenses associated with the desired (authentic, student-centred) approaches to instruction is to devise programs that cover not only critical thinking skills, but that are an effective response to the demand to produce graduates who possess the employability skills demanded by the 21st century workplace.

Along with different conceptualisations of critical thinking, approaches to critical thinking skills instruction differ from a curricular or structural perspective (*where* critical thinking skills are taught) and from a pedagogical perspective (*how* critical thinking skills are taught).

Structurally, critical thinking skills are frequently taught in stand-alone or “stand-along” modules (Halpern, 2001, p. 270) or integrated into subject-specific units of study (Halpern, 2001; Livingston et al, 2004; Hatcher, 2006). In this study, the employability skills development program (ESDP) presents a third approach that is best described as an immersion approach (Prawat, 1991; Angeli & Valanides, 2009).

From a pedagogical perspective, critical thinking skills instruction has traditionally taken the form of direct and systematic instruction in the principles of formal and/or informal logic (the general or standard approach). Increasingly, however, a variety of approaches to integrating critical thinking skills instruction into discipline-based units of study is emerging (the integrated approach), where critical thinking skills are highlighted or taught explicitly in one or more units within a course, and instructional approaches fall somewhere along a continuum from instructivist to constructivist strategies (Dunn, Halonen & Smith, 2008).

The program in the current study adopted a third approach, an immersion approach, in which a range of skills are developed through a process of guided discovery and learning is largely experiential and collaborative. As such it is distinct from both the direct instruction approach and the predominantly content-driven, individual-learner focus of subject-specific instruction. The collaborative learning model provides an opportunity to explore a novel context for the development of critical thinking, which is often viewed as a largely individual construct.

Much of the currently reported research into critical thinking skills development is based on individual units of study, either in a specific field of study (for example Maricle 2003; Burbach, Matkin & Fritz, 2004; Dunn et al, 2008) or in units specifically designed to teach critical thinking skills (eg Halpern 2001; Hatcher 2006). In other studies interventions were conducted for the specific purpose of testing the effectiveness of different approaches (Kuhn, Shaw & Felton, 1997), but did not involve an examination of integrated curriculum components. A number of studies have looked at specific aspects of cognition within group contexts. For example Schoenfeld (1987) focused on *problem-solving* in mathematics education and Moshman and Geil (1998) considered collaborative *reasoning*, while King and Kitchener's (1994) research targeted *argumentation*. The current research provides a novel opportunity to investigate the development of critical thinking skills in the context of a broader skills framework within a collaborative learning environment.

Section 1.3 sets out the research questions and subquestions to be answered in this study, and section 1.4 provides a brief description of the methodological approach adopted.

1.4 The research questions

While a skills-based, experiential approach can ensure that the curriculum meets the demands for work-ready graduates, the problem with knowing how effective such approaches are is twofold:

- Measuring the effectiveness of critical thinking skills instruction is problematic, whichever model of instruction is adopted (Halpern, 2001).
- Where evidence shows gains in critical thinking ability when instruction includes collaborative or cooperative learning environments, little is known about which aspects of such models influence the development of critical thinking skills (Livingstone et al, 2004, pp.28 & 31).

To examine the proposition that critical thinking skills can be developed through units of study targeting employability skills, it is necessary to answer the following two research questions:

RQ1 *How does the immersion approach followed in the program provide opportunities for developing critical thinking skills; and*

RQ2 *How effectively does participation in an employability skills program develop students' critical thinking skills as measured in a standardised test?*

In order to answer research question 1 it is necessary to examine the opportunities for developing critical thinking skills that are provided in the program as well as how students engage in the tasks that provide such opportunities. This raises two subquestions:

RQ1A How is critical thinking skills development infused into learning activities during the first-year of the ESDP (employability skills development program)?

RQ1B How do students engage in a critical thinking process during the learning activities undertaken in the first year of the ESDP (employability skills development program)?

To answer research question 2, this study will compare the performance of multiple groups in a standardised critical thinking skills test (the California Critical Thinking Skills Test, Form 2000) in four contrasts to address the following four subquestions:

RQ2A Do testtakers perform better in the CCTST after participating in the first year of the program than at the start of the program?

RQ2B Do testtakers who have participated in the first year of the program perform better in the CCTST than students who entered the program in the second year?

RQ2C Do testtakers from English-speaking backgrounds perform better in the CCTST than students from non-English-speaking backgrounds?

RQ2D Do students from English-speaking backgrounds show greater improvement in CCTST performance after participating in the first year of the program than students from non-English-speaking backgrounds?

In answering the research questions, this study will provide insight into how critical thinking skills may be infused into and implicitly developed in an employability skills program. Examining how students engage in critical thinking in the first year of the program will make explicit the features and elements that can promote critical thinking in an immersion approach. Measuring student performance in the CCTST will show whether any anticipated development of critical thinking skills within an immersion approach would be reflected in standardised testing.

Figure 1.2 provides a graphic presentation of the field of study and key elements of the research. Section 1.5 that follows outlines the methodology adopted in this study.

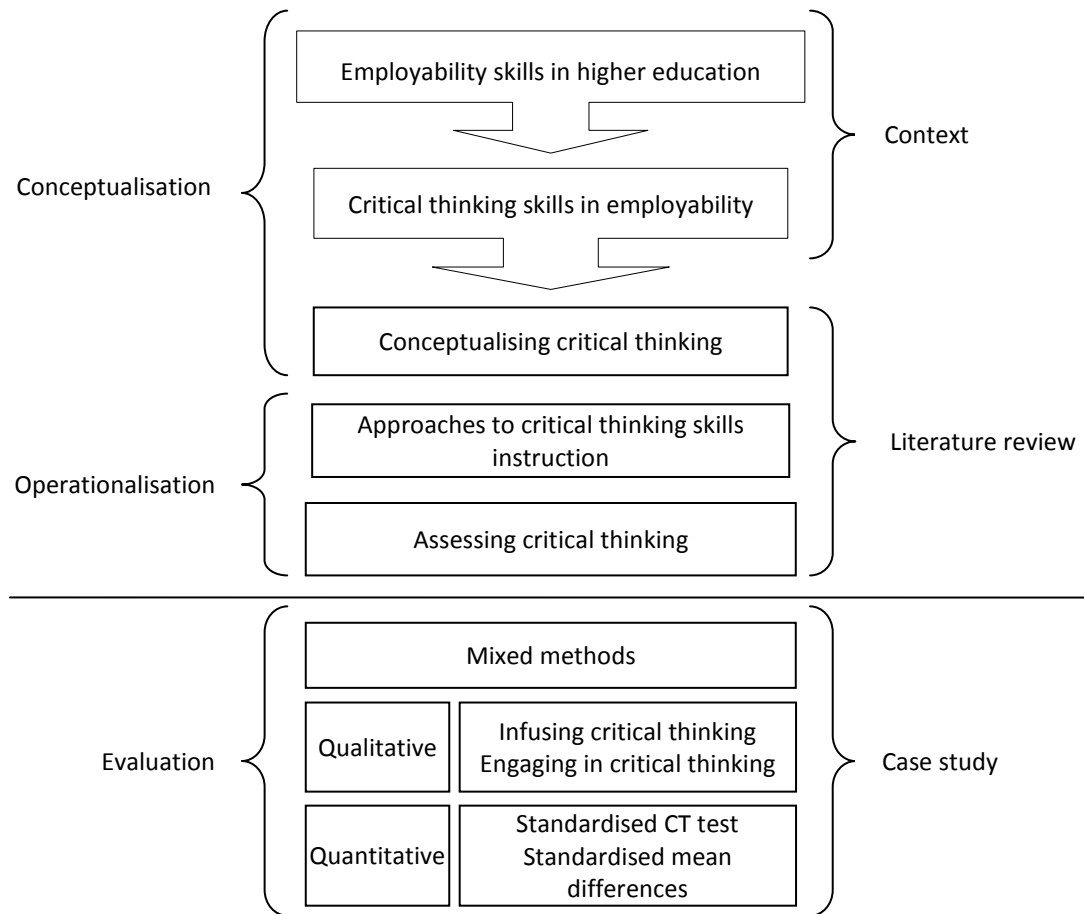


Figure 1.2: Research elements

1.5 Methodology: A mixed methods case study

The methodological and epistemological stance adopted in the study is situated within the pragmatic paradigm of mixed methods research, comprising both qualitative and quantitative strategies. The pragmatic approach recognises the intersubjective nature of the research process, applies abductive reasoning in linking theory and data, and relies on transferability in drawing inferences from data (Morgan, 2007).

The research design is an explanatory case study (Yin, 2009), and the population consisted of undergraduate business students enrolled in the employability skills development program (ESDP) which has been briefly described in section 1.2. The unit of analysis is the first year of the program which comprised two semester-long units of study, with four projects

(qualitative) and student scores in a standardised critical thinking skills test (quantitative) as embedded units of analysis.

Qualitative data have been collected through unobtrusive measures and consisted of program documentation, project instructions and written student reflections. Quantitative data have been obtained from a convenience sample of voluntary participants and comprise results in the California Critical Thinking Skills Test (Form 2000) (CCTST).

An instrumental analysis approach has been adopted in the qualitative analyses which are based on theoretical assumptions or propositions. The case study is presented in three parts and the interpretive approach is step-wise explanation building:

- Part 1: the context
- Parts 2A, 2B and 2C: the explanatory analyses and effect size calculations
- Part 3: integrated interpretation of qualitative and quantitative findings.

The qualitative component of the case study is made up of two analyses in order to answer the two subquestions in the first research question: Part 2A is a categorical task-level analysis of the four projects to explain how critical thinking skills have been infused into the ESDP by comparing the nature of the tasks with the types of tasks that develop critical thinking (Facione, 1990), and Part 2B is a contextualising analysis of student reflections to examine how students engaged in a process of inquiry that represents a critical thinking cycle (Garrison, 1991; Garrison & Anderson, 2003).

Part 2C of the case study presents the quantitative analysis using multiple comparison groups in four contrasts of interest. To assess the development of critical thinking skills among participants in the employability skills program, a standardised critical thinking skills test was administered and the results analysed to measure the standardised mean difference between student scores at the start of the program (pretest) and scores after completing the first year of study (two units) (posttest). A second comparison was conducted between the posttest scores of students who had completed the first year of the program and a cohort of students who entered the program in the second year. This use of multiple comparison groups is strongly advocated in the literature (Halpern, 2001, p. 275). As the *Test manual* for the CCTST raises language ability as a factor in test performance (Facione, Facione, Blohm & Giancarlo, 2002) two further contrasts explore the performance of students from non-English-speaking backgrounds in the CCTST. Standardised mean differences in group performance (effect sizes) are reported.

1.6 Thesis outline

The thesis follows a standard structure with a review of the literature presented in chapter 2, the methodology in chapter 3, the analyses in chapter 4 and final conclusions in chapter 5. The case study has been incorporated into chapter 4 which has been structured to accommodate the qualitative and quantitative components. This section outlines the main components of each chapter.

Chapter 2: Literature review

The literature review is aligned with the need to consider critical thinking in terms of its conceptualisation, operationalisation and evaluation.

Section 2.2 reviews the conceptualisation of critical thinking from a number of different perspectives, including a general educational perspective (Dewey, 1910; Brookfield, 1990; Garrison, 1991; Gabennesch, 2006 and others) in which critical thinking is conceptualised as a complex process, and a cognitive skills perspective which views critical thinking in terms of a series of micrological skills that underlie thinking strategies (Halpern, 2001). This section also briefly explores the role of self-regulation from a metacognitive perspective (Kuhn & Dean, 2004). A number of consensus statements have emanated from attempts to arrive at an agreed definition of critical thinking. Here the emphasis is on the expert consensus statement published by the American Philosophical Association in the Delphi Report (APA, 1990) which provides the framework for conceptualising critical thinking in the current research. Given the collaborative nature of the learning process in the ESDP, this section finally considers the role of collaborative critical thinking as a concept that is associated with the collaborative constructivist perspective that provides the theoretical basis for this study.

A review of the literature shows that differences in how critical thinking is conceptualised are also reflected in approaches to critical thinking skills instruction. Section 2.3 considers critical thinking as central to the education enterprise and reviews different curricular and pedagogical approaches (including the general, integrated/infusion and immersion approaches) and the features of instruction that the literature identifies as enhancing critical thinking skills development.

Section 2.4 then looks at key considerations in the assessment of critical thinking, including the use of standardised tests.

Other studies in the field of critical thinking research are reviewed in section 2.5 in terms of the particular conceptualisations of critical thinking and the nature of the interventions. It further considers the types of measures employed in critical thinking research.

The review of the literature concludes with an overview in section 2.6 of the key aspects of critical thinking skills development that have emerged from the literature and identifies areas not covered in the existing body of research and which are addressed in the current study.

Chapter 3: Methodology

Chapter 3 presents the research methodology, which follows a pragmatic approach. The research design is an explanatory case study and the study employs a mixed methods research strategy.

Section 3.2 presents the justification for mixed methods research. To justify the methodological approach, this section considers the emergence of pragmatism as alternative paradigm which reconciles the traditional divide between quantitative and qualitative approaches, and their associated epistemological stances, within mixed methods research. It presents the methodological approach and the research process model in terms of the main considerations that have influenced the mixed methods research design.

Section 3.3 sets out the research methods. It provides details of the explanatory case study design, defines the parameters of the case, and sets out the data collection and analysis strategies.

Validity, reliability and generalisability are considered in section 3.4. Section 3.5 outlines the ethical considerations and section 3.6 discusses the limitations of the study.

Chapter 4: Case study

The case study has been divided into three parts:

Part 1 describes the context of the case. The context is an employability skills development program (ESDP). The main unit of analysis is the first year of the ESDP, with the projects within the first year and student performance on a standardised critical thinking skills test serving as embedded units of analysis. Section 4.2 outlines the aims and principles of the program and provides details of the curricular approach in the program. This description is considered in the discussion in Part 3 of the case study to establish how it fits with the established view of immersion approaches to teaching critical thinking skills.

Part 2 is explanatory and contains the analyses and findings. An explanation of the interpretation and summary of the findings follow the analysis in each component (Liamputtong, 2009, p.318) to make explicit the line of reasoning and to facilitate explanation building.

The case study covers the key areas in relation to critical thinking identified in the review of the literature and includes:

- (1) a broad conceptualisation of critical thinking and how critical thinking skills have been infused into the employability skills development program that provided the context for the case study (part 2A)
- (2) a detailed account of how students in the program engaged in the critical thinking cycle (part 2B)
- (3) measurement of improvement in critical thinking based on a standardised critical thinking skills test (CCTST) (part 2C)

Part 3 contains the discussion that integrates the qualitative and quantitative components in drawing meta-inferences based on the findings.

Chapter 5: Conclusions and implications

Chapter 5 concludes the study by considering the implications of the findings. In drawing conclusions based on the results obtained, this chapter builds on the interpretations and discussions incorporated into the case study presented in chapter 4.

It provides an overview of the results obtained and draws conclusions on the basis of the integrated findings that have been presented in part 3 of the case study in chapter 4. It addresses rival explanations identified in the case study and considers the implications of the study in relation to current practices in critical thinking skills instruction and assessment as well as approaches to research in critical thinking skills development. It also identifies limitations and other questions that remain unanswered in the field of critical thinking skills instruction.

The structure of subsections has been set out in diagrams at the start of each chapter.

1.7 Summary

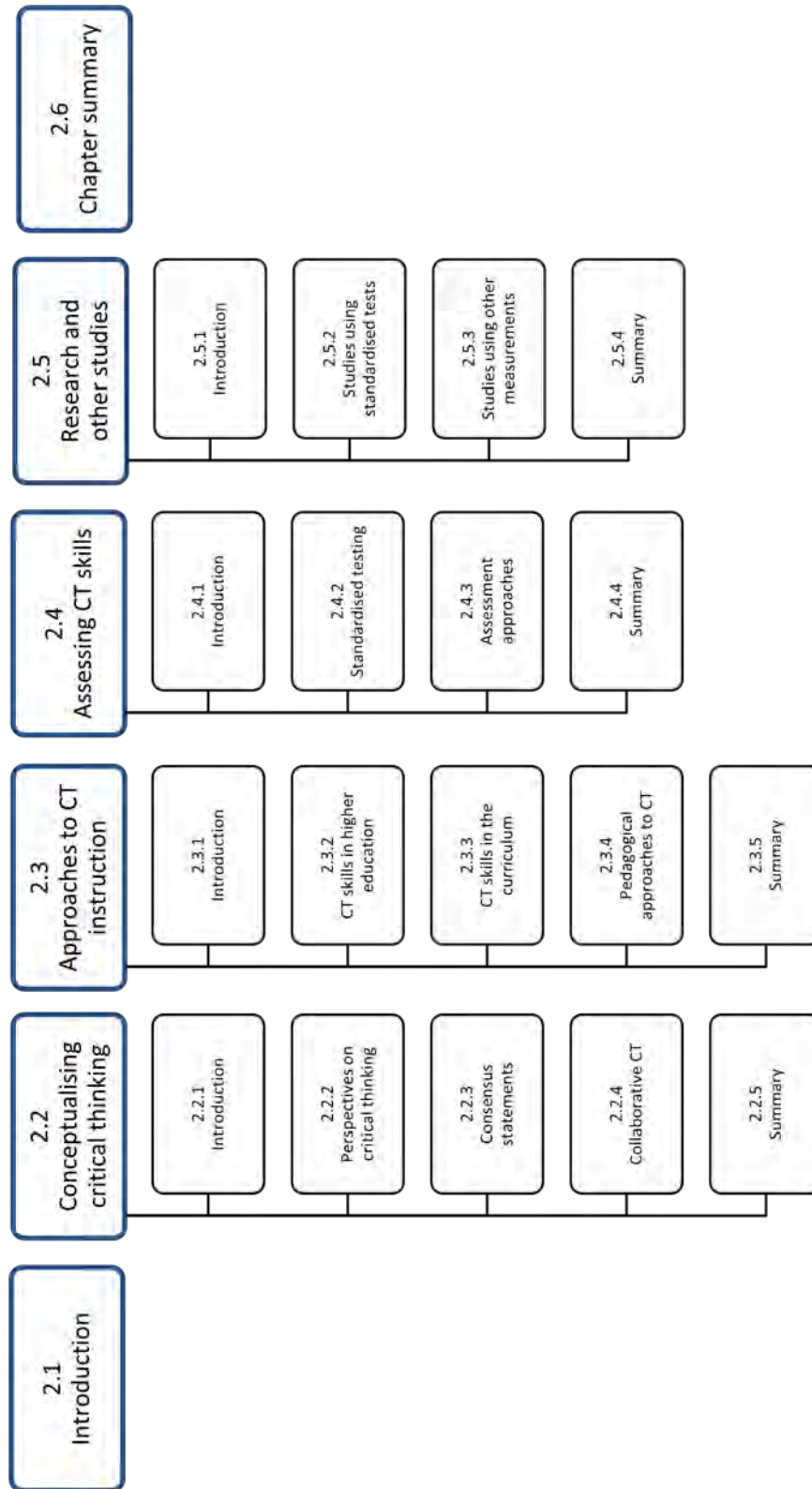
This chapter provided the background and context for the research. It outlined the growing demand for graduates to be equipped for the knowledge era and highlighted the prominence and relevance of critical thinking skills in higher education worldwide.

This study aims to show how critical thinking skills can be infused into an employability skills program and how students engage in critical thinking while undertaking projects that target a matrix of interrelated employability skills.

Methodologically the study adopts a pragmatic approach that provides the paradigmatic framework for a mixed methods study. The case study design accommodates both qualitative and quantitative components and provides the structure to ensure inferential rigour when combining methods from what has traditionally been regarded as incommensurable paradigms and epistemologies. The qualitative component of the case study adopts an instrumental approach to content analysis using pattern-matching techniques and will provide rich descriptions and in-depth explanations of how critical thinking has been infused into the ESDP. Analysis of student reflections will show that a model of inquiry developed as conceptual framework for establishing cognitive presence in online deliberations can be equally valid when gauging how students engage in a critical thinking cycle in a face to face context. The quantitative analysis will follow the latest recommendations to report effect sizes and confidence intervals, and will make use of multiple comparison groups.

The conclusions to be drawn from the case study will offer insight into critical thinking skills instruction within an immersion approach that has not been studied in depth before, and will moreover provide information that can guide practice in preparing graduates for the workplace of the 21st century.

Chapter 2: Literature review



2.1 Introduction

The background and context of the study have been outlined in Chapter 1 and highlighted the developments in higher education that have brought attention to the need for higher education to adapt to changes in the work environment and the types of skills that employers and the workplace demand. It identified the key skills and established the link between key employability skills and the centrality of critical thinking in the development of employability. Within the broad field of study, the literature review focuses on the conceptualisation, development and assessment of critical thinking skills in undergraduate education.

The development of critical thinking skills has long been considered one of the main purposes of education, and the importance of developing critical thinkers is not contentious. Historically, the methods employed by Socrates in Ancient Greece can be said to have been aimed at developing thinking skills. At the start of the 20th century, educators such as Dewey (1910) and Sumner (1906) advocated a central role for the teaching of critical thinking in higher education. Several decades later, in the 1960s, critical thinking appeared as an objective in education policies, and in the 1980s it was first included as an express goal in government policy for higher education in the United States (Gellin, 2003, p.746). This provided the impetus for the “critical thinking movement” in the United States, and soon critical thinking skills development became part of the stated objectives and now appears in the graduate attribute frameworks of almost every institution of higher education worldwide.

The pervasiveness of critical thinking as objective in higher education has generated an extensive literature as different disciplines defined and redefined the concept together with varying connotations in different contexts. Within the broad scope of the literature on critical thinking, this review focuses on specific aspects, authors and studies, and draws on the debates, views and approaches to critical thinking skills instruction in different contexts.

The review of the literature on **conceptualising critical thinking** is intended to make explicit the wide range of views and areas where no clear agreement has been reached among researchers and practitioners. Different conceptualisations of critical thinking and related terms are reviewed in section 2.2. Section 2.2.2 will show that from a more general educational perspective (Dewey, 1910; Brookfield, 1990; Garrison, 1991; Gabennesch, 2006 and others) critical thinking is viewed as a complex process, which can be distinguished from the cognitive skills perspective where critical thinking is defined in terms of a series of cognitive skills that underlie thinking strategies (Halpern, 2001). In recent times, the role of self-regulation in critical thinking has become more prominent, and section 2.2.2 also looks briefly at the role of metacognition in critical thinking. In the search for a common platform to

support viable approaches to developing critical thinkers in higher education, a number of consensus statements have emerged, and these are reviewed in section 2.2.3, with emphasis on the Delphi Report (APA, 1990), which provides the framework for conceptualising critical thinking in the current research. From the collaborative constructivist perspective that is fundamental to the current study, section 2.2.4 reviews the literature on collaborative critical thinking.

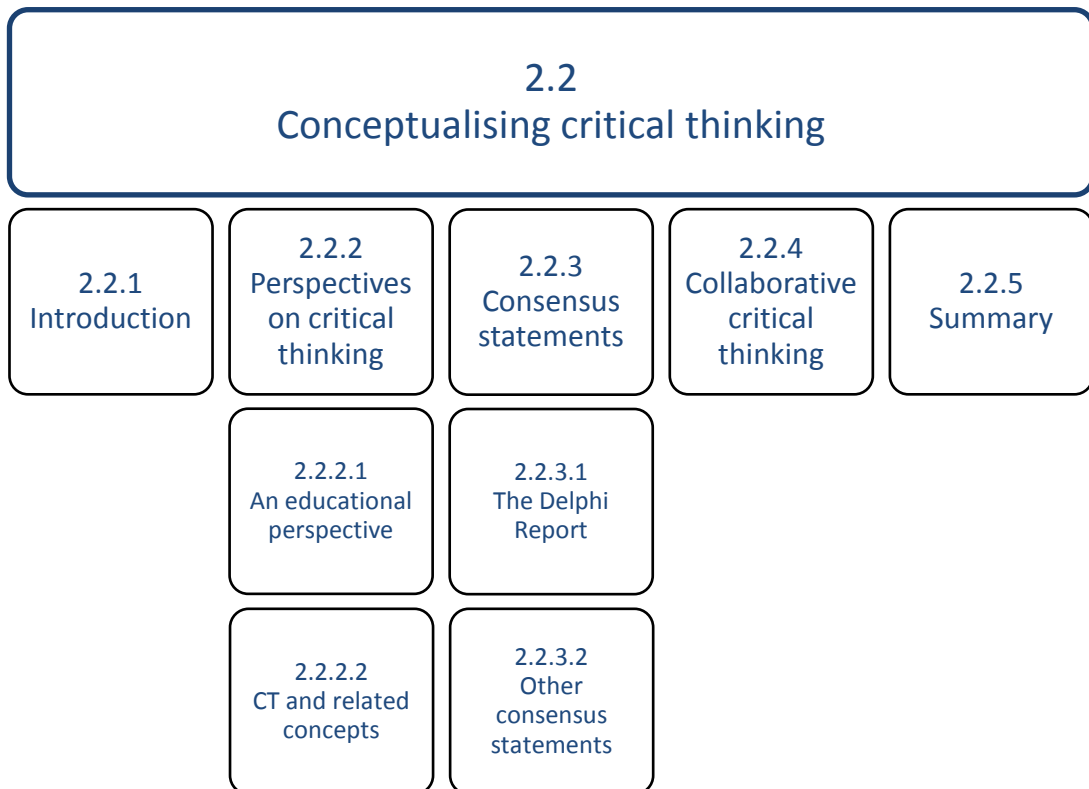
The malleable nature of critical thinking as concept has not only given rise to many different definitions, but different conceptions of critical thinking have resulted in different **instructional approaches**. Section 2.3 first looks at the central role of critical thinking within the higher education enterprise (section 2.3.2) and then reviews different perspectives on *where* in the curriculum critical thinking skills should be taught (section 2.3.3), including the general, infusion and immersion approaches. Section 2.3.4 considers *how* critical thinking skills should be taught by reviewing different pedagogical approaches that have been presented in the literature, highlighting the features that have been shown to enhance critical thinking skills development.

Just as different conceptualisations of critical thinking lead to different approaches to developing critical thinking skills, a variety of measures have been applied in assessing and evaluating the effectiveness of critical thinking instruction. Section 2.4 reviews the prevailing methods adopted in **assessing critical thinking** skills development within the educational context by considering the use of standardised tests (section 2.4.2) as well as other approaches and considerations in thinking skills assessment that emerge from the literature (section 2.4.3).

Section 2.5 explores **related research** by reviewing a number of other studies. It provides the theoretical base for this study by making explicit the different conceptualisations and implementations of critical thinking skills instruction and interventions. It also expands on the evaluation and assessment of critical thinking by reviewing studies that employed standardised testing (section 2.5.2), on the one hand, and studies that employed other measures (section 2.5.3).

The conclusion (section 2.6) provides an overview of the key aspects that have emerged from the literature, and distinguishes those aspects that have not been covered in the existing body of research and which are addressed in the current study.

2.2 Conceptualising critical thinking



2.2.1 Introduction

Traditionally, critical thinking has been conceptualised as a specialist area of instruction, most often associated with studies in formal or informal logic or reasoning, demanding knowledge of distinctive terminology and determined by the application of complex sets of rules. This may have contributed to the “mystified state” of critical thinking scholarship referred to by Minnich (1990) and Halonen (1995) (Lawrence, Serdikoff, Zinn, et al, 2008). This review of the literature on conceptualising critical thinking does not address critical thinking as *a discrete area of study*, and focuses instead on critical thinking as a *competency* and a *disposition* or “habit of mind” which is aligned with the perspective in this study.

There is no generally agreed upon definition of critical thinking as *a single concept* and the literature abounds with a multitude of definitions that have been the source of much debate surrounding the development of critical thinking skills. While the pivotal role of thinking skills is recognised by both researchers and practitioners, in many instances researchers have even avoided using the term *critical thinking* because it is hard to define with precision and difficult to measure (Kuhn & Dean, 2004, p. 268). One result has been that a number of related terms

and concepts have been incorporated into the concept of critical thinking, which has added to the complexity of defining critical thinking. Livingston, Soden and Kirkwood (2004, section 4, p.12-17) commented on the use of a number of terms in the studies and interventions included in their review, including higher-order thinking/thinking skills/thinking, cognitive skill, critical thinking, metacognition and self-regulation.

In order to deal with the complexity of critical thinking as either a single or a compound concept, theorists, researchers and practitioners in different disciplines have further proposed a variety of taxonomies or frameworks of thinking skills (Moseley, Baumfield, Elliott, et al, 2005). In their report to the Learning and Skills Research Centre (in the United Kingdom), Moseley, Baumfield, Higgins, et al (2004), provided a comprehensive framework for the classification of thinking skills based on their evaluation of 35 taxonomies from the literature, including the framework published in the Delphi Report of the American Philosophical Association (APA, 1990).

It would be difficult to pursue the development of thinking skills in educational practice unless there is a common terminology, or at least a commonly understood meaning of critical thinking that can be used to communicate about critical thinking.

This section will review a number of definitions of and perspectives on critical thinking that have been offered in the literature, including long-established definitions (such as those offered by Dewey, 1910; Peters, 1972; McPeck, 1981; Ennis, 1985; Siegel, 1988, and Lipman, 1991), and a number of perspectives on conceptualising critical thinking (eg Garrison, 1991; Halpern, 1997; Moseley et al, 2004; Halx & Reybold, 2005, and Gabennesch, 2006) (subsection 2.2.2). Subsection 2.2.3 considers some of the consensus statements that have attempted to draw together different definitions and conceptualisations (Facione, 1990a; Jones, Dougherty, Fantask & Hoffman, 1997), with specific attention to the expert consensus statement provided in the Delphi Report (APA, 1990), which has been adopted both as a working definition and as framework for instrumental analysis in this study. The final subsection (2.2.4) reviews the concept of collaborative critical thinking, as this has direct relevance to the collaborative nature of instruction in the context of this study.

2.2.2 Perspectives on critical thinking

In reviewing the literature surrounding definitions of critical thinking, this section highlights the view that this proliferation may stem from the variety of epistemological positions from which both theorists and practitioners conceptualise critical thinking. It explores in more detail the educational perspective which originated in the work of John Dewey (1910)..

Moseley et al (2005) distinguished among philosophical, psychological and sociological perspectives and recognised that traditions such as politics, cognitive neuroscience and neuropsychology have added their own perspectives in recent times (p.9).

Moseley et al (2004) earlier noted that definitions of critical thinking were usually offered from either a psychological perspective or a philosophical perspective. From a psychological perspective, descriptive definitions of critical thinking specify “cognitive skills and the mental processes involved in different aspects of thinking, often equating them with the *higher-order* categories of Bloom’s taxonomy” so that good critical thinking involves proficiency at “mental processes such as analysing, inferring, evaluating” (Moseley et al, 2004, p.8). This appears similar to the view of critical thinking that Livingston et al (2004) classified as the *cognitive skills* model of transfer. The need for transferability is addressed in section 2.3.4.1.

The philosophical perspective, on the other hand, offers a normative definition that links critical thinking with values, so that it “essentially means ‘good thinking’” (Moseley et al, 2004, p.8).

Moseley et al (2004) defined thinking skills as

expertness, practical ability or facility in the process or processes of thinking (processes that occur spontaneously or naturally, or which are acquired through learning and practice) (Moseley et al, 2004, p.6)

They qualified their definition by pointing out that “having a skill implies that most performances are of a high standard and are adapted to the requirements of particular situations” and noting that the concepts of skills and ability overlap.

Halpern (1997, p.4), approaching critical thinking from the perspective of *cognitive process* instruction, pointed out that although definitions of the term critical thinking proliferate, they tended to be similar in content, and proposed a simple definition that encompassed the main concepts:

Critical thinking is the use of those cognitive skills or strategies that increase the probability of a desirable outcome. It is used to describe thinking that is purposeful, reasoned, and goal directed – the kind of thinking involved in solving problems, formulating inferences, calculating likelihoods, and making decisions when the thinker is using skills that are thoughtful and effective for the particular context and type of thinking task (Halpern, 1997, p.4).

Halpern further noted that the “critical part of critical thinking denotes an evaluative component ... [as a] constructive reflection of positive and negative attributes ... [as well as]

evaluating the thinking process". She highlighted the *purposeful* nature of critical thinking. Although her conceptualisation was aligned with a view of critical thinking as cognitive skills, it also included an evaluative component, although such evaluation would be focused on the "thinking task" or "thought processes", in other words thinking strategies, rather than informed by or subjected to the thinker's worldview or values.

The term "cognitive skill" is used frequently in the literature and this was also the case in the studies and interventions that Livingston et al (2004) reviewed, where the term was used to refer to "a mental process such as classifying, inferring, generalising or questioning". Such mental processes are often considered to be translatable or transferable, and are therefore similar to the notion of generic thinking skills. They offered a definition from Lipman (1991): "Critical thinking is thinking that can be assessed by appeal to criteria", and argued that "people who are thinking critically might be expected to use criteria they can justify when they make decisions to do things one way rather than another" (Livingston et al, 2004, p.14).

Many of the studies in the review by Livingston et al (2004) did not offer specific definitions, but used the term *higher-order thinking* to represent some features of thinking skills, cognitive skills or critical thinking, and often used the terms *cognitive skill* and *thinking skill* synonymously (Livingston et al, 2004, p.14).

Their analysis of empirical studies in teaching general thinking skills and thinking skills instruction incorporated in existing curricula (discrete programs and integrated programs, respectively, which are discussed in section 2.3) showed that such programs typically used the term *thinking skills* as meaning "translatable mental processes". Such mental processes are deemed translatable in that they are re-usable in other tasks. On the other hand they noted that programs in which the main aim was to improve students' thinking ability within a specific subject used the more general term "thinking", so that there was no assumption that the thinking skills acquired would be translatable to other domains, and transfer to other domains was not a specific aim of such programs (Livingston et al, 2004, p.12-13). Halpern's view of critical thinking as directed, purposeful thinking *within a specific context* therefore does not appear to assume re-usability or transferability of critical thinking skills.

Gabennesch, from a sociological perspective, saw the view of critical thinking as cognitive skills as insufficient (Gabennesch, 2006, p.39), and this is discussed further in section 2.2.2.1. The roles of values and dispositions in critical thinking are addressed in section 2.2.3 when reviewing the Delphi Report consensus statement (APA, 1990) and other consensus statements that bring together divergent conceptualisations of critical thinking.

2.2.2.1 A broader educational perspective

The many definitions of critical thinking may be ascribed to the fact that practitioners and theorists most often conceptualise critical thinking to reflect the epistemological stances of their various disciplines. In an address to the 31st Annual Adult Education Research Conference in 1990, Stephen Brookfield noted that there were as many definitions of critical thinking as there were definers, and attributed the widespread use of the concept of critical thinking and its adoption as “intellectual standard bearer” to its malleability and the fact that conceptually it can be adapted to and redefined for the purposes of whoever is using the concept. As concept, it has been linked to political and ideological convictions, and its use has even given rise to claims of pillage from “guardians of intellectual traditions such as critical social theory, psychoanalysis and analytic philosophy” (Brookfield, 1990, p. 25).

Brookfield (1990, p.27) questioned whether critical thinking need necessarily be linked to a specific ideological outlook such as critical social theory or logical positivism or be grounded in a single intellectual orientation such as the psychoanalytic, philosophical or socio-political disciplines, and asked: “... how can we develop a language to describe critical thinking which connects to the daily reality of adult education practice? A language which neither oversimplifies complex concerns, nor renders them unintelligible.” In Brookfield’s view, research and practice in the field of adult education were strengthened by the eclectic nature of the field and enriched by the many intellectual and practical perspectives that adult educators bring to their field. He saw it as a distinct advantage that adult educators need not confine or define their endeavours within a single tradition or discipline, as “... essentially we trample joyfully over all intellectual terrains, as long as they help us facilitate learning” (Brookfield, 1990, p.29).

The educational perspective, as adopted in this study, is informed to some extent by other fields, but situates its conceptualisation of critical thinking skills within a specific learning context rather than a subject-specific context. Brookfield cautioned that “critical thinking as a central purpose for adult education should not be confined to only one intellectual tradition. Placing such constraints on the advocacy of critical thinking may be conceptually neat, but it does not begin to fit the inchoate messiness of adult education reality” (Brookfield, 1990, p.27).

It has been suggested that “much of the work on critical thinking represents a reformulation and perhaps an explication of Dewey’s reflective-thinking cycle” (Garrison, 1991, p.292), and for this reason, this section looks first at Dewey’s conceptualisation of critical thinking and

related commentary, and then considers such reformulations and related concepts, and the views that remain prominent in the literature.

Dewey (1910) used the term “reflective thought” rather than critical thinking, and described it by distinguishing three types of thought (or thinking) (1910, pp.2-4):

- The first is “everything that comes to mind, that ‘goes through our heads’” (Dewey, 1910, p.2) – idle thinking or simply being conscious of something. This is the kind of thinking that McPeck (1981) classified as involuntary thinking, and to which Moseley et al (2005, p.10) referred as a “stream of consciousness”.
- The second are thoughts about anything that is not directly observed or perceived through the senses (seen, heard, smelled, or tasted). This type of thinking contains a “note of invention, as distinct from faithful record of observation”. Such thoughts are not deemed to be reflective, because although they are not necessarily disjointed, “they do not aim at knowledge, at belief about facts or in truths”. They are about something imagined.

Dewey’s reference to a “note of invention” is worth noting, as it can be considered to have been included in other conceptualisations and thinking skills frameworks as a distinctive “creative thinking” element. Moseley et al (2005, p.10-11) referred to this aspect of Dewey’s description as “thinking as imagination or mindfulness”.

Garrison (1991, p.288) referred to Gordon’s (1988, p.52) definition of a thinker as a person who “enters the realm of inner dialogue, ideas or pure concepts ... and hopes to return to the world of appearances with a broader understanding and a more perceptive wisdom”. Although Garrison considered the separation of the critical thinking process from the objective world to be an important characteristic of the critical thinking process (p. 288), he saw it as only a minor difference when compared with Dewey’s definition of reflective thought, that is, Dewey’s third type of thinking.

- Thirdly, Dewey noted that the term *thought* may be used to refer to “beliefs that rest upon some kind of evidence or testimony”. While recognising that in some instances such beliefs may be accepted without deliberately considering the grounds (which may be adequate or not) that support them, he saw critical thinking as truly evident in those instances where “the ground or basis for a belief is *deliberately sought* and its adequacy to support the belief examined” [emphasis added] (Dewey, 1910: pp.1-2). Dewey called this process *reflective thought* and stated that this was the only type of thinking that was educative in value (p.2). Reflective thought is aimed at creating knowledge (p. 3) and is

characterised by an ordered sequence or train of thought where related thoughts are threaded together, each one emanating from and supporting the other, as opposed to a random sequence of unrelated thoughts. McPeck (1981) called this type of thought voluntary or directed thinking, and Garrison (1991, p.289) noted that *critical* thinking is a “proactive form of thought” which reflects the notion of deliberately seeking grounds for a belief as noted by Dewey (1910, p.2).

This notion of “conscious inquiry into the nature, conditions and bearings of the belief” as characteristic of reflective thought provides a basis for both critical thinking as the application of specific skills and as reflection, the latter indicating the metacognitive element of critical thinking which is discussed in a subsequent section. It is also reflected in Ennis’s definition of critical thinking, which has persisted over time, and which defines critical thinking as

reflective and reasonable thinking that is focused on deciding what to believe or do
(Ennis, 1985, p. 45).

Dewey therefore conceptualised critical thinking by excluding thinking that was neither critical nor deliberate. He excluded non-directed thinking, and he excluded thinking that was not aimed at belief. He defined reflective thought as

active, persistent, and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it, and the further conclusions to which it tends
(Dewey, 1910, p.6).

In order to be critical, thought needed to be directed, deliberate, and aiming to examine the evidence that supported beliefs.

Others, such as Peters (1972) and Siegel (1988) supported the view of critical thinking as being “scientific” in nature by focussing on impartiality and rationality as essential components in critical thinking. Garrison (1991, p.289) noted that such conceptualisations failed to adequately address “the non-rational phenomenon of insight” (which can be seen as reflected in what Dewey referred to as a “note of invention”), and he distinguished a narrow and a broad or comprehensive view of critical thinking (Garrison, 1991, p.290). He considered a conception of critical thinking as consisting of “a set of discrete micro-logical skills” as narrow or weak. In educational settings, it is the strong sense of critical thinking as “a set of integrated macro-logical skills concerned with insight ..., the holistic and Socratic sense of critical thinking” that is relevant (Garrison, 1991, p. 290). This is aligned with Dewey’s view of reflective thought as being the only type of thinking that is “truly educative in value” (Dewey, 1910, p. 2). Garrison further supported the link between critical thinking and reflection or metacognition: “Dewey

used the term reflective thinking in a manner consistent with our discussion of critical thinking. ... In addition, Dewey believed that if a person were not sufficiently critical of his or her ideas then thinking would not be reflective” (Garrison, 1991, p. 290).

Garrison and Anderson (2003) conceptualised critical thinking by associating it with their concept of cognitive presence (one of three elements in their community of inquiry model). They viewed critical thinking as synonymous with inquiry and adopted Dewey’s definition of reflective thought, describing critical thinking as

an inclusive process of higher-order reflection and discourse...[that] both authenticates existing knowledge and generates new knowledge ... [in an] interplay between private and public worlds (p.56)

The “cognitive presence” component of their model has been adopted in conceptualising the critical thinking process within the current study and is covered in detail in the methodology adopted in the explanatory case study in this research (chapters 3 and 4).

Garrison (1991, p. 289) noted that Dewey’s definition of thinking – as “that operation in which present facts suggest other facts (or truths) in such a way as to induce belief in the latter upon the ground or warrant of the former” (Dewey, 1910, pp. 8-9) – was based on the scientific view of knowledge (Garrison, 1991, p. 289). This accounts for Dewey’s exclusion from reflective thought that type of thinking that can be termed “creative”. In their conceptual model of critical thinking, Garrison (1991) and Garrison and Anderson (2003) included creative thinking in the early phases of critical thinking as a divergent, inductive process, and viewed problem solving as a convergent, deductive process that is emphasised in the concluding phases of the critical thinking process (Garrison & Anderson, 2003, p.57).

Brookfield (1987, p.1) saw critical thinking as much broader in scope than the skills of logical analysis, and viewed critical thinking within personal, work and civic contexts. He related critical thinking in particular to “thinking and acting”, as a questioning of the assumptions on which thinking and acting are based as a matter of habit, and then being willing to change both thinking and acting on the basis of critical questioning.

Brookfield conceptualised critical thinking as

a process by which people become aware of the assumptions underlying their habitual actions, ideas and judgments and by which they examine these assumptions for their accuracy and validity ... [a process which] manifests itself differently according to a host of contextual variables (Brookfield, 1990, p.29).

This view of critical thinking as a process, not an outcome, is especially relevant to this study. Brookfield saw the process as continual, never reaching a state of completeness, as that would in itself contradict the critical thinking process. In the same way, critical thinking skills development is never complete (Brookfield, 1987, p.6). Brookfield further noted that critical thinking would manifest in different ways, depending on the context in which it took place, and that indicators of critical thinking would also vary among individuals from an exclusively internal process (that may be discerned only in their writing or speaking) to an overt observable action. He moreover contested the notion that critical thinking was triggered only by negative events (that “cause people to question their previously trusted assumptions”), and contended that positive events could equally prompt critical thinking. He noted that “when we think critically we become aware of the diversity of values, behaviors, social structures, and artistic forms in the world ... we gain an awareness that others in the world have the same sense of certainty we do – but about ideas, values, and actions that are completely contrary to our own” (p.5).

Gabennesch (2006, p. 38) drew attention to the difficulties that continued to surround the conceptual fundamentals of critical thinking and discussed a number of examples from the field of sociology that illustrated his point that many textbooks purported to be supporting the development of critical thinking but in reality taught students what to think rather than how to think. He commented: “No one should pontificate a definition of critical thinking, nor should we expect to achieve unanimity” (Gabennesch, 2006, p.38). He nevertheless presented a definition for consideration:

Critical thinking is the use of rational skills, worldviews, and values to get as close as possible to the truth (Gabennesch, 2006, p.38)

He therefore conceived of three essential dimensions that together make up critical thinking: rational skills, worldview and values. He saw critical thinking *skills* as a range of higher-order cognitive operations which are engaged when processing as opposed to merely absorbing information, and included the skills of analysis, synthesis, interpretation, explanation, evaluation, generalisation, abstraction, illustration, application, comparison and recognition of logical fallacies (Gabennesch, 2006, p. 38). He considered these skills to be necessary, but not sufficient. In his view the skills dimension represented too narrow a focus, a “safe and sanitary” area confined to logical reasoning that could be taught as part of any academic course (2006, p.38-39). Gabennesch regarded the worldview and values components as essential to a fully developed conception of critical thinking. The *worldview* component would provide an epistemological basis for viewing reality, and he proposed that a critical thinker’s

worldview would be distinctive in recognising that the world was not necessarily as it appeared to be, and that a critical thinker would be “disinclined to take things at face value, ... not easily swayed by conventional wisdom” (Gabennesch, 2006, p.39). In other words, critical thinkers held a worldview that saw knowledge, and positions taken, as provisional. He explained the *values* dimension as an ethical commitment to *intellectual* due process, which was aimed at increasing the “likelihood of finding the truth” (p. 40), based on informed and reasoned judgement. Like Dewey (1910), Kuhn (2003), Brookfield (1987), and others, Gabennesch (2006) took a broad view of critical thinking as a social asset that underpins democracy.

Minnich’s (2003) view of *thinking* clearly outlined the distinction between critical thinking as a set of micrological skills and a broader conceptualisation of critical thinking:

I distinguish thinking from calculative and instrumental reasoning – from deductions, by which we relate principles to particulars that come under those principles, and from induction, by which we abstract from particulars to create generalizations that subsume them.

I differentiate it from rational deliberation, in which people following the same basic rules of reasoning try to reach agreement by eliminating unsound arguments. Thinking differs from all these uses of cognitive capacities that follow prescribed rules and conventions which, if used well with others who have assented (or been submitted) to the same rules and/or conventions, can coercively prove a conclusion to be correct.

Thinking is neither coerced nor coercive. It is exploratory, suggestive; it does not prove anything, or finally arrive anywhere. Thus, to say people are thoughtful or thought provoking suggests that they are open-minded, reflective, challenging – that they are more likely to question than to assert, inclined to listen to many sides, capable of making sensitive distinctions that hold differences in play rather than dividing in order to exclude, and desirous of persuading others rather than reducing them to silence by refuting them (Minnich, 2003, pp.19-20).

The persistent presence of the goal of critical thinking skills development within the expressed aims and objectives of higher education institutions and of specific programs of instruction indicates that critical thinking has not been sequestered by specific disciplinary domains, but has become part and parcel of the adult education endeavour across disciplinary areas. Which is not to say that a single conception and definition of critical thinking has evolved over the past two decades. Nor has a single, unified notion of “a critical thinker” emerged. Critical thinking remains a highly contested term in the literature.

The next subsection briefly considers some of the concepts that have been associated with critical thinking in the literature.

2.2.2.2 Critical thinking and related concepts

The meanings of concepts such as critical thinking, creative thinking and problem-solving converge, and critical thinking is often viewed as encompassing both creative thinking and problem solving. Problem-solving in particular is regarded as mainly concerned with logical reasoning and inference, whereas the process of critical thinking also includes a creative process of discovery and an evaluative process of reasoning. Garrison (1991) cautioned that attempts to define the process of critical thinking too narrowly (confining it to logical reasoning skills only) were likely responsible for the confusion surrounding the concept. He emphasised imagination and creative thinking as prerequisites for identifying new perspectives and alternative solutions through a process of critical analysis (1991, p.290-292).

Halx and Reybold (2005), in their review of the literature, commented on the range of definitions and identified a consistent pattern in descriptions of critical thinking as “purposeful, reasoned, and goal-directed thinking” (2005, p.294). Moreover, they explained that “most definitions . . . emphasize a heightened awareness of multiple points of view and context, as well as an evaluation of *one’s own* thought processes before reaching a conclusion” [emphasis added] (2005, pp.294–295), which further supports a view of critical thinking as being more than a series of thinking strategies.

In contrast to the view of critical thinking as an essentially cognitive skill in the application of specific thinking strategies, theories of learning that have been advanced in the field of cognitive science in recent times have addressed the role of the metacognitive system in controlling cognitive processes.

According to Garrison (1991) the view that critical thinking includes being aware of one’s own thinking and reflecting on one’s own thinking and the thinking of others “as an object of cognition” cannot be contested. Being aware of and managing one’s own thinking, or “thinking about thinking” is a core component in defining metacognition, “one way of supporting metacognitive development is to encourage students to reflect on and evaluate their activities” (Garrison, 1991, p.290).

Kuhn and Dean (2004) proposed the construct of metacognition as a “bridge” between researchers in the field of cognitive psychology and “the concerns of educators ... whose work is addressed to the development of skilled thinking” (2004, p.268).

In her Foreword to Moseley et al (2005, p.xvi), Diane Halpern listed emphasis on metacognition among the variables that promoted the development of thinking skills (along with explicit instruction, good teaching, attention to disposition, and opportunities to practise thinking skills in more than one domain and within collaborative learning environments).

In brief outline, the cognitive system comprises four categories of processes: the first two are information storage and retrieval and information processing, which are considered to be process structures or procedural networks that do not involve nonlinguistic or affective components, and two “hybrid processes” (Marzano, 1998, p.54), the input-output communication process and the knowledge-utilisation process. While the decoding and encoding function within the input-output process similarly does not include nonlinguistic or affective components, it does move beyond the purely procedural when combined with the knowledge utilisation process. The four cognitive processes are all under the control of the metacognitive system, which comprises goal specification, process specification, process monitoring and disposition monitoring, which are regarded as meta-components of thought (Sternberg, 1984).

According to Schoenfeld (1987), metacognition involves

knowledge of the cognitive processes and products of oneself and others ... [as well as] the self-monitoring, regulation and evaluation of cognitive activity (Schoenfeld, 1987, p.49)

Schoenfeld saw the role of *awareness* and *belief* systems as important in metacognitive behaviours. He also referred to the classification of stages in acquiring problem-solving expertise proposed by John Anderson and colleagues (Anderson, 1982, in Schoenfeld, 1987) which comprised three stages: the first being “a *declarative* stage where the learner receives instruction that is encoded only as a set of facts *about* the skill” followed by a “*knowledge compilation* stage, when the knowledge is converted into a set of procedures that can be carried out without any interpretive operations” and “a *procedural* stage, when the activity can be carried out autonomously”. This is closely aligned with the notion of knowledge “types”, which would indicate that he considered “knowledge about thinking” as playing a key role in being able to think critically, although in elaborating metacognition, Schoenfeld (1987, pp.189 et seq) did add to the need for knowledge of one’s own thought processes, the ability to control or keep track of one’s own thinking (so that the learner is able to manage their own progress), and awareness of beliefs and intuitions in approaching a cognitive task. The declarative stage in Schoenfeld’s explanation would therefore require some instruction *about* critical thinking.

In providing a definition of metacognition, Livingston et al (2004, p.15) drew upon Moseley et al (2004, p.7), who used metacognition to refer to “one’s knowledge concerning one’s own cognitive processes and products or anything related to them ...”. Moseley et al (2004, p.7) elaborated on the concept of metacognition by identifying two dimensions: “awareness of one’s own cognitive functioning (metacognitive knowledge)” and “the planning, monitoring and evaluation of one’s thinking and learning”. They pointed out that metacognition may be used narrowly as “thinking about thinking” but also in a broader sense which included deliberate self-regulation of one’s thinking and learning. They also made an interesting connection between metacognitive ability and dispositional considerations, and commented that it may be more appropriate “to think in terms of a well-established disposition” in relation to *metaskills* rather than the ability to apply metacognitive thinking skills within a specific context or domain as set out in their definition of thinking skills.

The term **self-regulation** is linked to metacognition in many of the studies and interventions reviewed by Livingston et al (2004), who identified it as a component of what they called the *metacognition or self-regulation model* (p. 22), as well as in the taxonomies reviewed by Moseley et al (2004). Livingston et al (2004, p.23) further related the dispositional component to attempts made in a number of studies to establish a basis for generalisation or transfer.

Considerations relating to transferability will be addressed in section 2.3.3, and section 2.3.4.1 covers the need for transferability.

Moseley et al (2004, p. 9) noted the influential nature of the conceptualisation of critical thinking in the *Delphi Report* (APA, 1990) and identified a number of key elements in the critical thinking approach set out in that Report, namely that it emphasised that the ability to think critically and the disposition to think critically were closely related, and highlighted the important role of self-examination and self-correction in the process of critical thinking (Moseley et al, 2004, p.10; APA, 1990, p.20). (The Delphi Report included self-regulation as one of six critical thinking skills components and is discussed in more detail in section 2.2.3.1.)

Moseley et al (2004, p. 8) noted that much of the research viewed self-regulation as “a systematic process involving the setting of personal goals and the channelling of one’s behaviour towards their achievement”. This also reflects the view of critical thinking as being goal-directed or purposeful which is common to most conceptualisations of critical thinking. Moseley et al (2004) identified four component parts of self-regulation, namely *cognitive*, *motivational*, *affective* and *behavioural*, which they viewed as necessary for individuals to adjust their behaviour (or modify the targeted goals) in order to achieve the results they seek

within changing environments, and noted that metacognition was a prerequisite for such adjustment.

The many perceptions and conceptualisations of critical thinking, some narrow and some broad, show that it is a complex process that may not be conducive to a single, simple definition. Nevertheless, some consensus on what critical thinking is would be necessary, and a number of consensus statements have been proposed in the literature. These are reviewed in the section that follows.

2.2.3 Consensus statements: A convergent conceptualisation

In response to the inclusion of developing in graduates the ability to think critically, communicate effectively, and solve problems as an expressed National Educational Goal in the USA in the 1990s, a number of consensus reports were generated from research into the critical thinking skills required of graduates.

The first of these was sponsored by the American Philosophical Association and aimed to establish consensus – among a panel of 46 experts in the field – on the role of critical thinking in assessment and instruction. It used the Delphi method, a qualitative research method, and came to be known as the Delphi Report (APA, 1990).

Two subsequent reports came from research conducted under the auspices of the US Department of Education’s Office of Educational Research and Improvement. The 1995 report (Jones, Hoffman, Moore, et al, 1995) aimed to identify and reach consensus among academics, employers, and policymakers “on the specific higher order communication and thinking skills that college graduates should achieve to become effective employees in the workplace and citizens in society” (Jones et al, 1995, p.iii). This project also used an iterative Delphi survey method. One of its outcomes was to present a Critical Thinking Abilities Framework. It was followed by a subsequent report in 1997 (Jones, Dougherty, Fantaske & Hoffman, 1997) that focused on the reading and problem-solving skills essential to graduates, and again presented faculty, employer and policymaker perspectives.

This section considers first the Delphi Report, followed by a brief overview of the reports by Jones et al (1995) and Jones et al (1997).

2.2.3.1 The Delphi Report

Moseley et al (2004, p. 9) noted the influential nature of the conceptualisation of critical thinking in the *Delphi Report* (APA, 1990) and identified a number of key elements in the critical thinking approach set out in the report, namely that it emphasised that the ability to

think critically and the disposition to think critically were closely related, and highlighted the important role of self-examination and self-correction in the process of critical thinking (Moseley et al, 2004, p.10;APA, 1990, p.19).

Investigations for the 1990 *Delphi Report* (APA, 1990, p.2) were started in 1988 by convening a panel of experts who participated in several rounds of questions to seek consensus on critical thinking as it related to educational assessment and instruction.

The panel consisted mostly of members of faculty and included experts affiliated with philosophy departments (about half), education, economics, and social and physical sciences, all recognised for their experience and expertise in critical thinking instruction, assessment or theory. Among them were prominent figures in the field of critical thinking: Robert Ennis, Kenneth Howe, Matthew Lipman, Stephen Norris, Richard Parry, Richard Paul, and Carol Tucker, with Peter Facione as Project Director. The research findings and recommendations resulting from this project were published in the *Delphi Report*.

The major focus of the investigation was to articulate a clear and accurate conceptualisation of critical thinking. The report (APA, 1990, p. 6) acknowledged that the conceptualisation in the consensus statement represents an ideal:

It may be that no person is fully adept at all the skills and sub-skills the experts found to be central to CT [critical thinking]. It may be that no person has fully cultivated all the affective dispositions which characterize a good critical thinker. Also humans compartmentalize their lives in ways that CT is more active and evident in some areas than in others. This gives no more reason to abandon the effort to infuse CT into the educational system than that knowing no friendship is perfect gives one reason to despair of having friends (p.6).

The conceptualisations of critical thinking and of a good critical thinker contained in the consensus statement were therefore aspirational and were intended as a goal to guide critical thinking assessment and curriculum development.

The panel arrived at consensus on the following conceptualisation of critical thinking and the ideal critical thinker (APA, 1990, p.3):

We understand critical thinking to be purposeful, self-regulatory judgment which results in interpretation, analysis, evaluation, and inference, as well as explanation of the evidential, conceptual, methodological, criteriological, or contextual considerations upon which that judgment is based. CT is essential as a tool of inquiry. As such, CT is a liberating force in education and a powerful resource in one's personal and civic life.

While not synonymous with good thinking, CT is a pervasive and self-rectifying human phenomenon.

The ideal critical thinker is habitually inquisitive, well-informed, trustful of reason, open-minded, flexible, fairminded in evaluation, honest in facing personal biases, prudent in making judgments, willing to reconsider, clear about issues, orderly in complex matters, diligent in seeking relevant information, reasonable in the selection of criteria, focused in inquiry, and persistent in seeking results which are as precise as the subject and the circumstances of inquiry permit. Thus, educating good critical thinkers means working toward this ideal. It combines developing CT skills with nurturing those dispositions which consistently yield useful insights and which are the basis of a rational and democratic society.

This definition is broad, and encompasses the majority of views that are evident in the conceptualisations of critical thinking reviewed in the preceding sections. It contains both a cognitive skills dimension and a dispositional dimension. The Delphi Report classified the cognitive skills dimension of critical thinking into six component skills and related subskills (APA, 1990, p.6):

- (1) Interpretation: categorisation; decoding significance; clarifying meaning
- (2) Analysis: examining ideas; identifying arguments; analysing arguments
- (3) Evaluation: assessing claims; assessing arguments
- (4) Inference: querying evidence; conjecturing alternatives; drawing conclusions
- (5) Explanation: stating results; justifying procedures; presenting arguments
- (6) Self-regulation: self-examination; self-correction

While many of the studies of critical thinking programs in higher education, some of which have been reviewed in section 2.5, have focused on the cognitive dimension, and also on the specific skills components and subskills identified by the panel, the full report cautioned that “the experts warn that good CT is *not* rote, mechanical, unreflective, disconnected execution of sundry cognitive processes” [emphasis added] (APA, 1990, p.8).

Not all the experts agreed on all aspects of the consensus statement. In the final round, one assessment expert strongly dissented on certain aspects, namely the inclusion of *interpretation* as a critical thinking subskill, which was felt to be part of communication, not critical thinking, and the definition of *analysis* which was felt to overlap with reading and listening. The final report (APA, 1990, p.11) nevertheless supported the view that “many of the skills and sub-skills identified are valuable, if not vital, for other important activities, such as

communicating effectively ...[and can be] applied in concert with other technical or interpersonal skills to any number of specific concerns” (pp.11-12).

Of particular interest to the current study is some of the debate surrounding self-regulation, which is deemed to play a key role in team-based approaches, which relate to the collaborative approach in the program under investigation.

Experts viewed this as an area that may not be amenable to testing (an area “where testing must merge with teaching”) and noted that it “appears to be a skill of different kind or level ... [since] in self-regulation one applies the other CT skills to one’s own CT” (for example, by evaluating one’s own inferences) thereby giving critical thinking a recursive character (APA, 1990, pp.9-10). This view resonates with the view held by others such as Brookfield (1987) and Garrison (1991) who consider critical thinking to be a process rather than the application of discrete skills. It was also noted that “the meta-cognitive aspect of self-regulation makes it extremely difficult using the standard kinds of paper and pencil [ie multiple-choice] instruments”. There was nevertheless strong consensus that interpretation, explanation and self-regulation have a central role in critical thinking.

Self-regulation, when viewed from the perspective of the expert panel, can therefore be considered to be a *metaskill* (a concept that Moseley et al, 2004, link to dispositional aspects of metacognition).

The finding that one might improve one’s own critical thinking by critically examining and evaluating one’s own reasoning processes and learning to think more objectively and logically, and that critical thinking should not be regarded as a body of knowledge to be delivered to students, supports the assumption in this study that engaging in authentic tasks involving ill-structured problems can enhance critical thinking skills, and that by engaging in reflective activity, students can contribute to the development of their own critical thinking skills

The consensus view of critical thinking as “one among a family of closely related forms of higher-order thinking” reflects the variety of conceptualisations to be found in the literature. There are moreover conceptual overlaps among different forms of higher-order thinking and the relationships among them are complex.

The report included explanations as well as examples of the different skills components and subskills (APA, 1990, pp.13-19) but cautioned against seeing the classification of skills adopted by the expert panel as “excluding all others” and recognised that many different classifications could be equally valid. It also noted that while “the execution of some skills or sub-skills may

presuppose others ... the order of the Delphi listing is not intended to imply any ... skill-sequence or skill-hierarchy (APA, 1990, p.11).

In terms of the dispositional dimension of critical thinking, the report identified a particular link between disposition and self-regulation and its subskills of self-examination and self-correction (APA, 1990, p.20).

There was no clear consensus on whether affective dispositions formed part of critical thinking, but the majority of experts agreed that the affective dimension formed part of the disposition to think critically, and the resultant consensus statement included both the cognitive skills dimension and the affective dispositions dimension of critical thinking in describing an ideal, or 'good' critical thinker.

The discussion among experts also included consideration of an ethical or moral dimension (raised in Gabennesch, 2006), although there was no consensus view on the inclusion of a normative dimension in the conceptualisation of critical thinking, and the finding was that the ethical dimension should be regarded as a separate concern. Without being prescriptive in normative elements, the consensus statement nevertheless also contained a value element in its reference to the role of critical thinking as "a resource in one's personal and civic life" and as "the basis of a rational and democratic society" (APA, 1990, p.3).

2.2.3.2 Other consensus statements

Two reviews and surveys of employers and policymakers followed the Delphi Report and its consensus statement. The first was conducted in 1995 by Jones, Hoffman, Moore and collaborators to identify the critical thinking skills (along with writing, speech and listening skills) that graduates should possess, and the second was by Jones, Dougherty, Fantaske, and Hoffman in 1997 to elicit perceptions and conceptualisations of critical thinking.

The 1995 study followed a Delphi survey process and specifically considered "the specific higher-order ... thinking skills that college graduates should achieve to become effective employees in the workplace and citizens in society" (Jones et al, 1995, p.iii). The consensus was that important critical thinking skills included (p.161) the ability of graduates -

- to apply interpretation skills to detect
 - indirect persuasion including the use of leading questions that are biased towards eliciting a preferred response
 - use of misleading language
 - use of slanted definitions or comparisons

- instances where irrelevant topics or considerations are brought into an argument to divert attention from the original issue
- to categorise information by
 - making comparisons
 - formulating frameworks or categories
 - classifying data
 - translating information from one medium to another
- to clarify meaning by
 - making clear the meaning of words, issues, conclusions or beliefs
 - recognising confusing, vague language
 - asking relevant or penetrating questions
 - identifying and seeking additional resources
 - developing analogies or other forms of comparisons
 - providing examples to explain ideas

Jones et al (1995, p.161) noted that these results were “consistent with the outcomes from Facione’s (1990) Delphi study”. The 1997 review by Jones et al provided a definition of critical thinking, based on an in-depth review of the literature and feedback from faculty members, employers and policymakers, that incorporated the following categories: interpretation, analysis, evaluation, inference, presenting arguments, reflection, and dispositions.

The nine Tasks of Critical Thinking incorporated into the Educational Testing Service (ETS) in the USA, made available to assist higher education institutions “in assessing critical thinking for the improvement of instruction and accountability”, are most closely aligned with this definition (Erwin & Sebrell, 2003, p. 50) (although the ETS’s set of tasks are categorised as analysis, inquiry and communication). The abilities included within these categories include (1) formulating hypotheses and strategies, (2) applying techniques, rules and models to solve problems, (3) demonstrating breadth, flexibility, and creativity, (4) evaluating assumptions, evidence, and reasoning, and (5) finding relationships and drawing conclusions (analysis category); (6) planning a search, (7) using various methods of observation and discovery, (8) comprehending and extracting, and (9) sorting and evaluating (inquiry category). The communication category included the tasks of organising a presentation, writing effectively, and communicating quantitative or visual information. It is worth noting that although the ETS tasks in critical thinking cover some of the categories offered by Jones et al (1997), they do not cover reflection or dispositions.

The consensus statements by Jones et al (1995) and Jones et al (1997) therefore supported the comprehensive conceptualisation presented by the Delphi Report.

While critical thinking is most often conceptualised, defined and measured at individual level, the collaborative learning context of this study brings a social dimension to the development of critical thinking skills and necessitates consideration of how critical thinking could or should be conceptualised within a collaborative environment. Collaborative critical thinking is considered in the next section.

2.2.4 Collaborative critical thinking

The employability skills development program (ESDP) that provides the context for this study follows a collaborative teamwork model. This places the learning process in an environment that has not often been addressed in the field of critical thinking in higher education and the literature on collaborative critical thinking remains comparatively scant.

The role of the social setting in cognitive development has nevertheless received substantial attention in theories of learning and more recently in the field of cognitive science. This section reviews the conceptualisation of shared cognition briefly, before looking more closely at a specific conceptualisation of the social dimension of critical thinking or collaborative “higher-order” thinking skills development.

Lauren Resnick (1991) noted that the phenomenon of shared cognition “seems almost a contradiction in terms ... for cognition is, by past consensus and implicit definition, an individual act bounded by the physical facts of brain and body” (p.1). The interest in cognition as a social phenomenon can nevertheless be viewed as a logical outcome of the constructivist paradigm that has prevailed in learning since the late 1970s when the translation of Vygotsky’s (1978) thesis on the enabling role of social interaction in the development of higher-order skills was published.

It is worth noting that although Vygotsky’s frequently referenced work *Mind in society: Development of higher psychological processes* was first published in English in 1978 (as a translation edited by Michael Cole, Vera John-Steiner, Sylvia Scribner and Ellen Souberman), he developed his socio-cultural theory of cognitive development in the ten years before his death in 1934. The literature also refers to the influence of Jean Piaget on Vygotsky’s work. Piaget and Vygotsky were contemporaries, born in the same year (1896), but it is worth noting that Piaget’s work was mostly published after Vygotsky’s death. Both Vygotsky and Piaget laid the theoretical foundations for social cognition, and suffice it to note here that the main distinction between the Vygotskian and Piagetian perspectives of cognitive development is

that Vygotsky saw learning as preceding development (so that what is learned through social interactions is subsequently internalised) while Piaget saw development as preceding learning, so that a learner had to reach a specific stage of development before learning of higher-order thinking skills could be achieved.

The notion of socially shared cognition recognises that the social context forms an integral part of cognitive activity – the context therefore provides more than a mere setting for individual cognitive activity (Resnick, 1991, p.4). This has brought into question the interpretations of the earlier research into cognitive development conducted in laboratory settings (specifically within the Piagetian theoretical framework), which did not distinguish between the social and individual cognitive factors but regarded both as logical operations and largely ignored causal links between the two (Perret-Clermont, Perret & Bell, 1991, p.42). Investigations into cognitive development were frequently conducted in settings that were considered to represent “neutral” social and physical surroundings, disregarding the possibility that participants’ responses would nevertheless be coloured by their own understandings of the investigative events themselves. Perret-Clermont et al (1991) concluded that in addition to the logical features of tasks, the context would affect “the way the subject considers the task, deals with it, and reflects and communicates about it” (p.51). When considering development of critical thinking skills, understanding of the participants’ perceptions of and responses to the collaborative environment can cast light on those aspects that play a role.

The value of the broad view of “thinking as social practice” or shared cognition that has emerged from the field of cognitive science lies largely in identifying the importance of the group context and participants’ understanding of the context.

A number of studies have looked at specific aspects of cognition within group contexts, for example Schoenfeld (1987) focused on *problem-solving* in mathematics education and Moshman and Geil (1998) considered collaborative *reasoning*, while King and Kitchener’s research targeted *argumentation*. Schoenfeld (1987) strongly advocated the use of collaborative approaches in problem-solving and referred to Vygotsky’s point of view regarding the development of metacognitive skills, which was “that all higher order cognitive skills originate in, and develop by the internalization of, individuals’ interactions with others” (Schoenfeld, 1987, p.210). Schoenfeld further noted that “this perspective provides strong justification for the use of small groups in problem-solving contexts ... [since] a large component of effective problem solving consists of advancing multiple perspectives...” (p.210).

One of the few attempts to conceptualise and define the construct of collaborative critical thinking has been presented by Olivares (2005) who explored collaborative critical thinking

within the contexts of cooperative learning, collaborative learning, and critical thinking (Olivares, 2005, p. 87).

Olivares viewed cooperative and collaborative learning as having different epistemological frameworks, characteristics and goals as set out in table 2.1.

Table 2.1: Differences between cooperative and collaborative learning

Characteristic	Cooperative learning	Collaborative learning
Knowledge	foundational	Non-foundational; a social artefact
Epistemological orientation	structured instruction	social construction
Process	achievement-oriented	course of action
Group structure	high / positive interdependence	low / laissez faire / individualistic
Teacher's role	micro manager; hands-on / director	moderator / facilitator / guide
Student's / participant's role	cooperative / agreeable	dissident / independent
Goals	develop social skills and learning for all members	knowledge construction through conversation; concern for problem solving

Source: Olivares, 2005, p.92

Olivares saw collaborative critical thinking as being

concerned with inducing group level critical thinking so that good judgments may be rendered and/or solutions acquired

and further defined collaborative learning as

an unstructured, small group process that cultivates independent thinking, free thinking, and dissent

which aimed to engage team members in thinking about and solving

abstract problems, problems that may have no specific answers, or multiple solutions. ... Collaborative learning is, fundamentally, an intellectual process ... (Olivares, 2005, p.92).

Olivares followed a reductionist approach to conceptualising collaborative critical thinking by drawing a clear distinction between collaborative and cooperative learning, with different epistemological bases, characteristics and goals (p.93), and concluded that unlike cooperative critical thinking, the aim in collaborative critical thinking was not for the group to ensure that all its members developed critical thinking or social skills (p.95). Collaborative critical thinking was characterised by “a *relatively* unstructured social process whereby group members share information as well as engage in critical discussion of data, interpretations of data, plans, and perspectives” (p.96), but Olivares acknowledged that information-sharing and critical

discussion did not happen spontaneously, and that groups had to be structured to facilitate this process. On the other hand he cautioned that “imposing structure may actually undermine, not facilitate, the free flow of ideas and the constructive controversy needed for critical thinking to take place” (pp.96-97). He finally proposed that this quandary may be resolved by finding common ground between the two approaches. He considered cooperative learning to be “a type of collaborative learning”.

Olivares’s distinctions in terms of knowledge, epistemological orientation, and the teacher’s role are not contentious, and are well supported in the literature (eg Bruffee, 1995), and the basic assumption is that collaborative learning is more clearly aligned with critical thinking. For example McWhaw, Schnackenberg, Sclater and Abrami (2003) noted that “cooperative learning is seen as more appropriate for knowledge that is foundational such as learning facts and formulas, while collaborative learning is seen as being better suited for learning non-foundational higher order knowledge, which requires a critical approach to learning” (p.72).

While Olivares’s characterisation of two distinct group structures for cooperative and collaborative learning is supported in some of the literature, it needs to be interpreted with some caution. While groups engaging in collaborative learning may not be prestructured by the teacher, this does not preclude the group itself from establishing a specific interdependent structure, and initial “individualistic” structures can furthermore evolve into more cohesive structures working towards consensus within collaborative groups. In an address to the National Teaching and Learning Forum in 1996, Zelda Gamson noted that “these kinds of approaches don’t happen automatically; in fact, they need to be very carefully designed. It isn’t just a matter of getting people together and having them discuss. ... It seems to me that the active creation of social community is a precondition for the intellectual impacts of these methods. Unless students are encouraged to learn how to work together, some students’ interpersonal difficulties may get in the way, such as issues of dominance in the group, issues that will always come up” (Gamson, cited in Rhem, 1996, p.2). Schoenfeld (1987, p.211) also commented that assigning specific roles to members of groups and facilitating effective operation of group dynamics were not likely to be easy tasks.

While Olivares concluded that collaborative learning was not the same as cooperative learning, it can be argued that the process and goals of collaborative learning may well contain elements of cooperative learning and vice versa, so that a learning event or episode may contain elements of both these views of group work. An exclusionary distinction seems to serve little purpose other than to provide a useful term or label for specific approaches. In conceptualising collaborative critical thinking, it may be more productive to focus on critical thinking in the

context of collaborative learning rather than on the distinction, or perhaps artificial divide, between cooperative and collaborative learning.

Olivares noted two definitions of critical thinking –the definition presented in the Delphi Report (APA, 1990, p.3) comprising the skills (interpretation, analysis, evaluation, inference, explanation, and self-regulation) and affective dispositions set out in section 2.2.3, and that proposed by Watson and Glaser (1994, p.9) who defined critical thinking in three components as

- (1) *attitudes of inquiry that involve an ability to recognise the existence of problems and an acceptance of the general need for evidence in support of what is asserted to be true*
- (2) *knowledge of the nature of valid inferences, abstractions, and generalisations in which the weight or accuracy of different kinds of evidence are logically determined; and*
- (3) *skills in employing and applying the above attitudes and knowledge*

Olivares considered it to be reasonable to base a conceptualisation of collaborative critical thinking on the concept of critical thinking , but acknowledged that this also imposed on collaborative critical thinking the same limitations of malleability and variability that characterises the conceptualisation of critical thinking as such.

Olivares proposed what he referred to as a coarse definition of collaborative critical thinking as

a relatively unstructured social process that results in judgments being made or problems solved through the process of conversation and through the use of evidence, inference, interpretation, logic, and reflection (p.95).

Halx and Reybold (2005, p.294) noted that most definitions of critical thinking emphasise “a heightened awareness of multiple points of view and context, as well as an evaluation of one’s own thought processes before reaching a conclusion”. This awareness of multiple points of view is particularly relevant to critical thinking in collaborative settings.

Schamber and Mahoney (2006) investigated strategies used to improve high-level group thinking skills in collaborative learning. In providing a definition of group critical thinking they adapted the definition of critical thinking that emanated from the Delphi Report (APA, 1990, p. 3) and defined group critical thinking as:

purposeful, collective judgment produced by a task-oriented small group of four to six members that combines interpretation, analysis, evaluation, and inference with the

relevant considerations on which that judgment is based regarding the specific task at hand

Their definition was therefore couched within a specific group task context. They further related the notion of “this type of judgment” more closely to “the context of a group endeavor” and highlighted the involvement of “the dynamics of group interaction, including the contributions that the individual members bring to the group endeavor”. Their focus was on the end product or final outcome of the group task (which in their study is evidenced in a written group report) (Schamber & Mahoney, 2006, p.106).

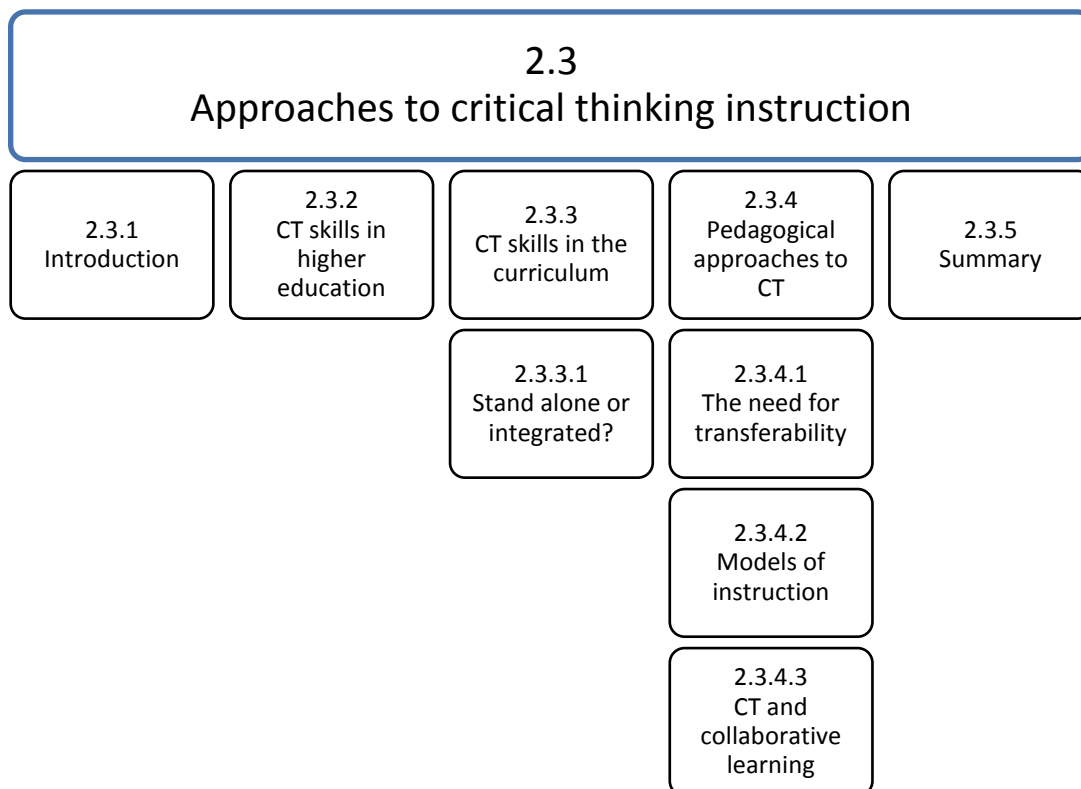
Following the distinction drawn in Olivares’s conceptualisation, Schamber and Mahoney’s emphasis on the final product can be seen to relate the “group” aspect to cooperative rather than collaborative group work, although they did not make this distinction. They then related group critical thinking to collaborative learning, which they based on the view of collaborative learning from a cognitive constructivist perspective as involving the development of “more sophisticated mental representations and problem-solving abilities by using tools, information resources, and input from other individuals” (Windschitl, 2002, p.137, cited in Schamber & Mahoney, 2006, p.106).

2.2.5 Summary

This section has reviewed different conceptualisations and definitions of critical thinking in the context of higher education. It covered conceptualisations of critical thinking from a number of different perspectives and the view of critical thinking as metacognition (section 2.2.2), as well as the consensus statements that attempted to provide inclusive definitions (section 2.2.3). It also explored different views on collaborative critical thinking (section 2.2.4) which are pertinent to the case study in the current research.

Different epistemological views of knowledge creation and conceptualisations of critical thinking will be operationalised in different ways when it comes to developing learners’ critical thinking skills, and the next section reviews the prevalent approaches to critical thinking skills instruction in terms of where in the curriculum critical thinking skills should be taught, and how they should be taught or developed within courses of study.

2.3 Approaches to critical thinking instruction



2.3.1 Introduction

Section 2.2 provided a review of the conceptualisations of critical thinking in the literature. It showed the concept of critical thinking to be malleable, and that there are almost as many definitions as there are definers, but also that many definitions contain similar components, and that critical thinking can be viewed as a framework of interrelated skills and dispositions.

This section starts with a brief consideration of critical thinking skills instruction as imperative in the context of higher education (section 2.3.2). It then reviews the approaches to critical thinking instruction presented in the literature, first from a curricular or structural perspective, in other words *where* in the higher education curriculum critical thinking skills are or should be taught (section 2.3.3), and then the pedagogical aspects, in other words *how* critical thinking skills are taught (section 2.3.4). Section 2.3.5 considers approaches to teaching critical thinking within collaborative contexts.

2.3.2 Critical thinking skills in higher education

At the start of the 20th century, Dewey (1910, p.101) noted that “if our schools turn out their pupils in that attitude of mind which is conducive to good judgment in any department of affairs in which the pupils are placed, they have done more than if they sent out their pupils merely possessed of vast stores of information, or high degrees of skill in specialized branches”. He advocated the “training of thought” as being at the core of education:

While it is not the business of education to prove every statement made, any more than to teach every possible item of information, it is its business to cultivate deep-seated and effective habits of discriminating tested beliefs from mere assertions, guesses, and opinions; to develop a lively, sincere, and open-minded preference for conclusions that are properly grounded, and to ingrain into the individual’s working habits methods of inquiry and reasoning appropriate to the various problems that present themselves. No matter how much an individual knows as a matter of hearsay and information, if he [she] has not attitudes and habits of this sort, he is not intellectually educated. He lacks the rudiments of mental discipline. And since these habits are not a gift of nature (no matter how strong the aptitude for acquiring them); since, moreover, the casual circumstances of the natural and social environment are not enough to compel the acquisition, the main office of education is to supply conditions that make for their cultivation. The formation of these habits is the Training of Mind (Dewey, 1910, pp.27-28).

Some of the original reasons for the gap between recognising the need for developing critical thinking skills and addressing this need within institutions of higher education are made evident in Dewey’s work, *How we think* (1910). Dewey refers to “the vogue of the formal-discipline idea in education” – a “vogue” that has persisted and flourished, to a significant extent, for more than 100 years, along with methods and conditions that focus largely on learners acquiring the knowledge already possessed by experts in specific fields, with little attention paid to teaching students how to think.

Dewey grouped the nature of studies into three categories:

- (1) those that involved acquiring “skill in performance” (which can include basic skills such as reading, writing and numeracy, as well as music)
- (2) those that were mainly concerned with acquiring knowledge – “informational” studies

- (3) those that placed less emphasis on performance skills and information, and that focussed instead largely on reasoning, which Dewey (1910, p.50) called “disciplinary studies”.

Under Dewey’s grouping, business studies may be categorised largely as informational studies, with some aspects of reasoning, although frequently these are confined to what Halpern (1997, pp.12-13) described as instruction that relies on the acquisition of jargon and application of formulas, and which does not include any metacognitive monitoring of thinking processes.

So while “teaching for thinking” has in a sense always been seen as the core of liberal education, an industrial model of education emerged and persisted throughout the first half of the 20th century and beyond. Disciplinary studies became increasingly specialised. Discrete units of study that make up courses or programs in business education are mostly delineated narrowly into subject areas such as accounting, finance, economics, marketing, and management (with some potential opportunities for integrative studies at postgraduate level, but which also remain largely locked into discipline-specific specialisms), and teaching by and large follows an information transmission model.

Nearly 100 years after Dewey, the appeal for *training of the mind* is still resounding in the ranks of both academic researchers and educational practitioners, while at the same time practitioners continue to search for approaches to critical thinking instruction that work (Kuhn & Dean, 2004, p.268).

The need for developing students’ critical thinking or higher-order thinking skills as a primary outcome of higher education came under the spotlight during the 1960s with the work of educational psychologist William Perry, whose scheme of intellectual and ethical development comprised a model of cognitive development that extended Piaget’s (1964) four developmental stages beyond the age of 15 and focussed on college students’ cognitive development (Perry, 1970). Perry’s scheme still provides a basis for both theory building (eg King and Kitchener’s reflective judgement model, 1994) and practice in the field of cognitive development and has received renewed interest within the Personal Development Portfolios initiative that resulted from the Bologna Declaration and the employability skills initiatives in the UK and Europe (set out in Chapter 1).

In the 1980s, increased focus on the need to develop students’ thinking skills saw the emergence of the critical thinking movement, and in the 1990s, developing critical thinking skills became an articulated goal of higher education in the USA. Nevertheless, the “poor state of critical thinking” persisted across international boundaries (Halpern, 2003, p.4). Critical

thinking instruction has often been seen as the domain of philosophy programs in higher education, although developments in the field of cognitive science have brought critical thinking into the spotlight in that field, especially in relation to critical thinking as metacognition. In the USA, where critical thinking instruction is a requirement in many states, it is typically offered as a single unit of study in the undergraduate curriculum. While there is no requirement to include critical thinking instruction in university courses in Australia, here as in the United Kingdom (Moseley et al, 2005, p.370), critical thinking skills are recognised within the graduate skills framework and have been included in the graduate attribute lists of most universities.

Over the past decade, the need for developing critical thinking skills in higher education has been driven by the reality of the post-industrial era. There has been a growing realisation that the industrial model of instruction has become inadequate to prepare graduates for an increasingly complex world – both professionally and socially. Bereiter (2002) highlighted the importance of the mind-shift that is required to change the focus in higher education from the transmission of knowledge towards the development of thinking skills that will equip graduates for the new challenges. Garrison (1991, p.287) noted: “The concept of critical thinking reflects the increased emphasis that educators place upon cognitive processes in knowledge development and problem solving as opposed to simple information acquisition.”

A forward-looking education must be built on the twin foundations of knowing how to learn and knowing how to think clearly about the rapidly proliferating information with which we will all have to contend (Halpern, 1997, p.3).

2.3.3 Critical thinking skills instruction in the curriculum

The ideological outlooks and intellectual orientations that colour different conceptions of critical thinking are also reflected in different views on the curricular responsibility for critical thinking instruction within higher education. The debate surrounding the location of critical thinking skills instruction gained momentum in the last decades of the 20th century, as critical thinking became an overtly expressed goal of higher education and a formal requirement in some educational systems (such as the Californian community colleges and state universities).

While approaching critical thinking from a particular ideological or epistemological perspective is likely to limit its accessibility to educators in general, educators’ own perspectives nevertheless do impact their approaches to and views of critical thinking skills instruction. In practical terms, the way in which their views are implemented in practice, and the approaches that they adopt, are further hampered or enhanced by the institutional contexts and realities

of their teaching circumstances. In other words what happens in programs of instruction is determined by the prevalent view of the role of the institution and by the views of individual practitioners as to their obligations and roles within the institution.

There is no consensus on an optimum approach to critical thinking skills instruction. The main distinction among models of instruction is between stand-alone programs deliberately aimed at “critical thinking instruction” in a formal sense and an embedded approach in which critical thinking skills are overtly taught within the context of discipline subjects.

Halpern (1993), Livingston et al (2004) and others considered a fundamental question in critical thinking research and instruction to be whether stand-alone courses or instruction integrated into other courses should be required.

2.3.3.1 Stand alone or integrated?

The Delphi Report (APA, 1990, p.29), in Recommendation 8, proposed that “direct instruction in CT and assessment of CT should be an explicit parts [sic] of any course granted approval for purposes of satisfying CT requirements, whether that course is a CT course *per se* or a course in a given subject field”. The discussion among participating experts during the course of that project nevertheless cautioned that transforming critical thinking into one subject field, or confining the application of critical thinking to domain-specific subject content would “truncate its utility, misapprehend its nature and diminish its value” (APA, 1990, p.29).

Hatcher (2006) considered the issue of stand-alone versus integrated approaches and noted constraints in both: Stand-alone approaches are constrained by issues of transferability and of uptake by students in different disciplines. The constraints in integrated approaches, also identified in Livingston et al (2004), included the lack of time in view of demands to cover discipline content, the readiness of lecturers in several respects (whether lecturers in subject disciplines are willing, ready and able to integrate critical thinking skills into their curricula), the readiness of students (who have expectations to learn about the concepts and theory of their subjects rather than thinking skills), and the readiness of institutions to promote and support the integration of critical thinking skills instruction across the curriculum.

Hatcher (2006) noted that, based on recent substantial studies “an integrated approach to teaching CT yielded greater pre-to posttest gains on a variety of standardized CT tests than a typical stand-alone CT/informal logic course” and argued for an integrated approach whereby “the higher-order thinking skills required of critical thinkers might well be imparted by faculty from across the disciplines in a variety of departmental courses, *if they only took the time to do so*” [emphasis added] (p.248).

Hatcher further distinguished three possible integrated approaches:

1. teaching selected critical thinking skills by including in a course only those skills that have specific application in the discipline in question (Hatcher, 2006, p.248)
2. integrating generic logical skills (that is, the skills found in informal logic or critical thinking textbooks) in general academic skills courses that have value across the curriculum (for example oral or written communication skills courses)
3. integrated approaches where students are taught generic critical thinking skills (such as circular reasoning, logical fallacies, concepts of validity and soundness) and then shown how they can be applied to improve their performance in other courses (for example to improve a generic skill such as effective communication or in working with specific discipline-related issues) (p.249).

While Peck (1981) has been critical of teaching critical thinking skills as a distinct subject and maintained that there was little sense in regarding critical thinking as a distinct subject (1981, p.5), instead recommending a discipline-specific integrated approach, Hatcher pointed out that, based on Facione (1986) and Harvey Siegel (1988), this view ignored the existence of generic critical thinking skills that are not bound by specific disciplines but which are applicable across all fields of study (Hatcher, 2006, p.249).

The third approach above combines instruction in thinking skills and application of thinking skills in a specific discipline. Hatcher favoured and examined the application of this approach, which is similar to the “infusion approach” described by Angeli and Valanides (2009) below.

Livingston et al (2004, p.24) classified critical thinking skills programs or interventions into three categories:

1. discrete programs for teaching general thinking skills (separate from other components in the curriculum)
2. programs for improving students’ thinking skills within the context of specific subject knowledge
3. programs “designed to incorporate thinking skills throughout the existing curriculum” (p.24).

They found that very few of the interventions in post-compulsory education which they included in their review (which selected programmes for review on the basis of “firm evidence that indicated learning gains were transferred to any situation beyond the programme in which the thinking was practised”) were discrete programs, and noted that “the benefits of

discrete programmes for teaching general thinking skills” separately from existing curriculum components were widely contested in the literature at large. According to Livingston et al (2004), discrete programs that do not form part of the set curriculum serve little purpose unless the outcomes can clearly demonstrate that the skills learned can be transferred to other contexts in the course (p.24).

Where programs or interventions were intended to improve student thinking *with specific subject knowledge*, they found “sound evidence that learners were able to engage in complex tasks” to meet the learning outcomes of their course, but that evidence was weak when it came to transfer outside the specific domain in which the interventions took place (pp.24-25).

In reviewing research on programs that targeted thinking skills throughout the curriculum, they found few studies that provided evidence that the instructional processes were “both useful and translatable across the curriculum”. They found that the evidence did support transfer in terms of application to the contexts of other areas of the curriculum, but there was still a lack of evidence that students would be able to transfer their thinking skills to contexts outside of their curricula (Livingston et al, 2004, p.25). They suggested that “metacognitive approaches have considerable promise in promoting transfer from one domain to another” (p.25).

Angeli and Valanides (2009, pp.323-324) drew clear distinctions among three instructional approaches which they called the general approach, infusion approach, and immersion approach. They highlighted arguments for and against each of these approaches.

- (1) The **general approach** where general critical thinking skills are taught separately from subject matter, also called discrete programs (Livingston et al, 2004; Hatcher 2006), freestanding (Haskell, 2001) or stand-alone (Halpern, 1993; Prawat 1991) programs. In this approach thinking is seen as “a skill of know-how that invokes general-purpose heuristics ... [which are] likely to be effective in a variety of problem situations, along with the meta-knowledge about situations in which specific heuristics are more appropriate” (Angeli & Valanides, 2009, p.323). This notion of the transferability of cognitive operations has evolved from the common elements approach and views thinking skills as translatable mental processes (Livingston et al 2004, p.16&24).
- The argument in favour of this approach was that it did not rely on learners having existing knowledge of subject matter.

- The argument against this approach was that there was no convincing evidence that critical thinking skills taught within a generic context will necessarily be transferred to other contexts or content areas (Resnick, 1987; Haskell, 2001).
- (2) The **infusion approach**, where instruction in general critical thinking skills is embedded within the teaching of subject matter. The shift from the general to an infusion approach took place in the 1990s. This approach assumes that thinking skills taught within one domain can be transferred to another, and is aligned with Livingston et al's general principles model (2004, p.21). This approach is sometimes referred to as the "embedding approach" (Prawat, 1991; Collins, Brown, & Newman, 1989; Ennis, 1989; Perkins & Salomon, 1989) or the "integrated" approach (Hatcher, 2006). Critical thinking skills are expressly integrated in teaching subject-related content, and while some advocate that the skills should be taught first and then applied within the content domain, a different argument has been made that the skills should be taught as the need for their use arises.
- Arguments against this approach concern the competing demands of skills versus subject matter. How much time and effort should be spent on skills instruction and how much on covering subject matter?
 - Arguments in favour of this approach are that transferability can be made possible when critical thinking is taught in authentic contexts, provided instructional approaches use ill-defined problems that do in fact require critical thinking.
- (3) The **immersion approach**, where "the most important resource or tool in promoting thought is the role of ideas – not thinking skills. Concomitantly[sic], critical-thinking skills are not made explicit during teaching ... students are involved in dialogue where they are prompted to consider, analyze, and evaluate different points of view" (Angeli & Valanides (2009, p.324).
- Ennis (1992) argued against the immersion approach on the basis that unless students have a clear conception of general critical thinking skills, transfer to other domains will be impeded because students will not be able to generalise the skills they have acquired.
 - The advantage that the immersion approach offers is that it overcomes the concern of the infusion approach that attention might be diverted away from subject requirements.
 - Tynjälä's (1998) research findings showed that learning in a constructivist environment with an emphasis on examining different perspectives, free

expression of ideas, and analysis from the perspectives of the students' own experiences can enhance critical thinking more easily than a traditional learning environment with an emphasis on grades.

- Additional support for an immersion approach came from the Delphi Report which noted in Recommendation 14 (APA, 1990, p.33) that critical thinking instruction "should bridge the gap between the subject and the student's own experience ... [and] the topics of discussion should not be restricted to factual matters or academic subjects, but should include issues which have normative, moral, ethical or public policy dimensions". The discussion further recommended that students be required to "reflect on, articulate, share and discuss" how they went about different critical thinking tasks, which added a metacognitive element.

So while the literature shows little variation in the types of potential approaches to situating critical thinking skills in the curriculum, this is an area that remains at the centre of the debate. No single approach, supported by strong evidence, that will be more effective than all others has been identified. The immersion approach as described by Angeli and Valanides (2009) nevertheless relates strongly to the theoretical conceptualisation of critical thinking set out in the expert consensus statement of the Delphi Report (APA, 1990).

Moving from the curricular approaches of this section, the next section looks at the specific instructional or pedagogical approaches to teaching critical thinking skills.

2.3.4 Pedagogical approaches to critical thinking skills development

In addition to the curricular location of critical thinking skills instruction, the pedagogical approaches applied in teaching critical thinking skills are likely to have the greatest impact on the effectiveness of such instruction and the transfer of critical thinking skills beyond the learning tasks and beyond the learning context itself.

While curricular approaches to teaching critical thinking skills have been classified in a number of different ways, there is no definitive classification of pedagogical approaches employed in teaching critical thinking, although Livingston et al (2004, pp.18-23) identified four different models based on the transferability of skills.

This section and the next review the approaches to critical thinking skills instruction and assessment advocated in the literature by authors such as Halpern (1993/2001, 1997, 1998), Garrison (1991, 2000), Kuhn and Dean (2004), and approaches that have been highlighted in broader reviews and evaluations, including Moseley, Baumfield, Higgins et al (2004), Moseley, Elliott, Gregson and Higgins (2005) and Livingston, Soden and Kirkwood (2004).

Other studies and research into critical thinking skills instruction are reviewed in section 2.4.

2.3.4.1 The need for transferability

One aspect of critical thinking skills instruction that appears throughout the literature (especially in cognitive science) is the matter of transferability of cognitive, and therefore critical thinking, skills. Different points of view are generally enlisted to justify “where” in the curriculum critical thinking skills instruction should best be located, but also to provide a basis for “how” critical thinking skills should be taught. Related to transferability is the debate about whether thinking skills can be generic or whether critical thinking is necessarily context bound. While transferability is not explored in depth in the context of this study, its centrality in the field of critical thinking warrants some comment.

Perkins and Salomon (1989, p.17) posed the question: “Should we teach entirely for richly developed local knowledge, subject matter by subject matter? Or should we invest a significant portion of educational resources in developing general skills of problem solving, self-management, and so on? Or, indeed, does this dichotomy obscure some important factors?”. They listed a number of conditions that can facilitate transfer, for example instances where learners are made aware of similarities between problems and their underlying goal structures, familiarity with problem domains, strategies where learners formulate rules to accompany examples, and *when learning takes place in a social context* – a condition which they deemed to be very important). Perkins and Salomon (1989) concluded that “when the conditions *are* met, useful transfer from one context to another often occurs” (p.22).

Schoenfeld (1999) put the matter of transferability into perspective:

Transfer is ubiquitous. We couldn't survive if we weren't able to adapt what we know to circumstances that differ, at least in some degree, from the circumstances in which we learned it. Yet transfer is mysteriously absent from the psychological laboratory; it seems to vanish when experimenters try to pin it down. This apparent paradox vanishes when you realize that in the laboratory, researchers are typically looking for pre-determined transfer; the connections they hope their subjects will make have been determined in advance. That may not happen very often. But, people are making connections all the time. This issue is to figure out which ones they make, on what basis – and how and why those connections are sometimes productive (Schoenfeld, 1999, p.10).

Halpern (2001, first published 1993) identified the goal of critical thinking instruction as “to produce students who have become better thinkers in the real-world contexts that extend beyond the usual in-class exam” (2001, p.273). She advocated multiple strategies and

identified a number of pedagogical approaches to facilitate the development of critical thinking skills, including active learner involvement, providing students with a clear rationale for learning critical thinking skills, opportunities for practising thinking skills in a variety of different settings, and using examples that relate to the situations in which learners will be required to use critical thinking skills (Halpern, 2001, p.276). Based on an independent review of programs intended to enhance critical thinking conducted by Chance (1986), Halpern (2001, p.278) suggested that “critical thinking skills do not necessarily develop as a by-product of discipline-specific coursework” (p.278).

Livingston et al (2004, pp.18-23) also raised the important issue of transferability in considering different models of critical thinking skills instruction by relating these to the assumptions of the nature of thinking skills that underlie each model. Underlying assumptions were also highlighted in the research by Angeli and Valanides (2009) and have been set out within the context of their research in section 2.5 (Research and other studies). Livingston et al noted that empirical evidence of transferability in their review was confined to instruction that targeted the development of metacognition and self-regulation of thinking (in studies by Butler, 1998, and Masui & De Corte, 1999), while evidence in other studies was limited to self-reports on student levels of motivation and confidence.

Livingston et al (2004, p.25) identified a number of key features of programs that provided evidence that the thinking skills developed would be applicable in more than one domain. Such programs would promote transfer by –

- encouraging the acquisition of both an extensive knowledge base within the primary domain and a level of knowledge in “subjects outside the primary areas”
- ensuring that students were aware of the need for transfer, what it constituted and how it could be effected
- making the “thinking goals” explicit at the outset and fostering a “spirit of transfer”, creating “cultures of transfer” and providing the necessary support systems
- engaging students in substantial amounts of consciously practising transfer of skills to other domains
- allowing sufficient time on tasks “for the learning to incubate”

It is therefore evident from the literature that transfer would be made attainable by the pedagogical approaches followed in critical thinking skills development, and that transfer is not necessarily determined by where in the curriculum structure critical thinking skills instruction takes place.

2.3.4.2 Models of instruction

A number of pedagogical models or frameworks for critical thinking skills instruction provide detailed information on the characteristics of and types of tasks that such instruction should comprise.

Halpern (1998, p.451) noted that the methods that were usually applied in teaching content knowledge in specific subjects were not suited to teaching critical thinking skills that could be applied across multiple knowledge domains. She proposed a four-stage model that incorporated

- (1) a dispositional/attitudinal component
- (2) instruction in critical thinking skills and opportunities to practise thinking skills
- (3) structure training to facilitate transfer, and
- (4) a metacognitive component that will enable learners to direct and assess their own thinking

In stage (2) of the model, learners would receive instruction to enable them to determine causes, recognise and criticise assumptions, analyse means-goals relationships, support conclusions with good reasons, assess degrees of likelihood and uncertainty, incorporate data into frameworks, and use analogies to solve problems. She proposed that instruction in critical thinking should cover verbal reasoning and argument analysis skills, skills in thinking as hypothesis testing and in applying analyses of likelihood and uncertainty, as well as decision-making and problem-solving skills.

In discussing structure training (the third stage), Halpern (1998, pp.453-455) highlighted the need for students to be able to apply skills effectively in novel situations by recognising external cues that called for specific strategies to be applied, in order for acquired skills to be transferred to new situations. To achieve this, students needed to develop retrieval cues by focussing on the structural rather than content aspects of a problem or argument. Presenting critical thinking skills instruction in authentic contexts could then provide a believable learning environment that approximated the real-life contexts in which thinking takes place. Authentic learning contexts should moreover be rich in information so that students learn to select relevant from irrelevant information – the important aspect of such an exercise being “what the learners are required to do with the information”. Learners would develop critical thinking skills through tasks that required thoughtful analysis and synthesis (p. 454).

During metacognitive monitoring in the fourth stage, students monitored their progress and evaluated how well they were progressing towards the goal/s of the task. Halpern (1998, p.454) proposed the use of guiding questions to ensure that students were aware of the metacognitive monitoring skills that they were employing, including explicitly considering the critical thinking skills that were useful in the exercise. Students should moreover reflect on their learning and identify insights that would be useful in future.

She further elaborated on the dispositional component (Halpern, 1998, p.452) and identified the following characteristics of a critical thinker to be promoted through instruction:

- (a) being willing to engage in and complete complex tasks (since critical thinking is “effortful”)
- (b) making and following plans, therefore avoiding impulsive activity
- (c) being flexible and open-minded
- (d) being willing to self-correct and change strategies that were not productive, and
- (e) being aware that in some social contexts there may be a need to seek consensus and to compromise in order to achieve targeted outcomes.

A comprehensive review of the literature by Livingston, Soden and Kirkwood (2004) showed that thinking skills programs in higher education generally followed constructivist approaches.

Other principles underlying such programs included

- challenging the learners
- employing measures to prepare students for tasks
- helping students to transfer their learning
- developing skills that enabled students to become independent learners (for example concept formation, enquiry and reasoning skills)
- promoting collaborative learning
- encouraging learners to regulate their behaviour
- ensuring tasks have personal meaning for learners
- making students think about thinking

They noted that the literature in their review rarely addressed the motivational and affective dimensions of thinking.

In their evaluation of thinking skills frameworks for post-16 learners, Moseley, Baumfield, Higgins et al (2004) reviewed 35 classifications (including taxonomies, theories and models) and identified key principles that were essential for teaching approaches that aimed to develop thinking skills. They concluded, among other points, that there was substantive evidence that “thinking skills can be developed by means of teaching practices” that

- emphasised learner engagement, “in particular, beliefs and feelings that help determine the motivation to learn” (p.1)

In addition, approaches intended to foster critical thinking should give attention to

- “metacognitive knowledge (knowledge of one’s cognitive functioning, including knowledge developed through reflection)
- the strategic management of thinking and learning through self-regulation (involving planning, conscious direction, monitoring and evaluation)” (p.1).

Moseley et al (2004) saw value in the diversity of frameworks, and suggested that the purpose of the instruction (be it to improve communication skills, to develop problem-solving skills, or to develop reflective judgement on topical issues) should guide the selection of an appropriate framework.

One discrete intervention that provides useful insights for the present study, especially in relation to the use of reflection, has been reported by Butler (1998, p.2), whose study was based on the centrality of self-regulation. She defined self-regulation as the learner’s “flexible, planful, and recursive engagement in a sequence of cognitive activities” and proposed an intervention model of self-regulation in academic domains that she called the Strategic Content Learning (SCL) approach. She distinguished between the ability of even young children to “self-direct” their learning activities and the later development in learners of the “ability to articulate understandings about cognitive processes”, that is, metacognitive abilities, which Flavell (1976, p.232) defined as “one’s knowledge about one’s own cognitive processes and products or anything related to them”.

Students develop mature self-regulated performance when they are assisted to reflect consciously and to deliberately adapt the ways in which they approach tasks. Such conscious reflection should relate both to domain-specific tasks and to the development of generalised, metacognitive knowledge that applies across domains.

Butler (1998, p.4) identified a number of characteristics shared by instructional models that promote reflective self-regulation. Such approaches –

- were generally sustained over a period of time
- integrated the use of learning strategies within academic tasks
- included discussions about learning processes
- were structured and explicit
- incorporated collaboration
- required students to adapt and apply strategies in multiple tasks, and
- helped students to recognise that strategic approaches could be applied to different tasks and across domains.

In contrast to many other instructional models, in which the aim is to promote mature academic problem solving by guiding students to internalise generalised cognitive processing that has been modelled and described (that is, translating “generalized descriptions about cognitive processing into cognitive actions”), the SCL approach assisted students in identifying the problem-solving abilities that they already possessed, to apply these in tasks and then to articulate generalised descriptions “in their own words, linked to contextualized experiences” (p.5).

Livingston et al (2004, section 3, pp.10-11) further reported on a post-school program designed to incorporate thinking skills throughout an existing curriculum which relates strongly to the current research, namely the process workshops model introduced at the State University of New York by Hanson and Wolfskill (2000). They described the process workshops as “a classroom environment where students are actively engaged in learning a discipline and in developing essential skills by working in self-managed teams on activities that involve guided discovery, critical thinking, and problem solving and include reflection on learning and assessment of performance. The essential skills covered in the workshops included, critical thinking, problem solving, teamwork, information processing and communication (Hanson & Wolfskill, 2000, p.210). The emphasis in this approach is on guided discovery and problem solving, although as distinct from the program under investigation here, the process workshop model was interspersed with traditional format lectures or “recitation sessions”. Hanson and Wolfskill’s study (2000) is also discussed in section 2.5.

Moseley et al (2003) concluded that “there is powerful empirical evidence that thinking skill interventions can be very effective at all levels, but ... their effectiveness is likely to be greater if they are used for learner self-regulation rather than coming under the control of teachers” (p.79).

Most pedagogical approaches advocated in the literature are aligned with general teaching strategies that are constructivist rather than instructivist in nature, and that seek to promote active learning rather than applying information transmission models. Much of the literature is increasingly critical of instructivist approaches predicated on a skills-based view of critical thinking (Haskell, 2001), and recognise the multidimensional nature of critical thinking while cautioning that critical thinking should be taught and does not happen as “a byproduct of something else” (Gabennesch, 2006, p. 41).

2.3.4.3 Critical thinking and collaborative learning

While critical thinking as a set of cognitive skills is generally considered as an individual construct, the literature increasingly references collaboration among learners in approaches to critical thinking skills instruction.

In their review, Livingston et al (2004) noted that positive results were reported in nearly all the programs where student tasks required them “to construct, test and justify knowledge through some form of peer interaction”(p.30). They found the evidence that supported the effectiveness of collaborative learning approaches to developing thinking skills to be extensive and convincing, but noted that little was as yet known about the ways in which specific aspects of collaborative learning impacted on critical thinking performance (2004, p.28).

Livingston et al followed Foot and Howe’s (1998) distinction between three forms of what they called “peer-based learning”:

- (1) cooperative learning (where each member of the group pursued a different sub-goal, and contributions were then combined into a composite product, and which also involved the joint gathering, organising and interpretation of information
- (2) peer-tutoring, and
- (3) peer interaction, defined as “a situation in which the learners jointly learn material; for example, jointly constructing concepts or jointly solving a problem in science learning” (p.28).

The reference to *jointly learning material* may appear to be targeting learning of subject or content matter and not to be aimed at critical thinking development, although they elaborate on *peer interaction* as a form of collaboration used in the studies in their review “as a means of enhancing students’ thinking, often along with other measures” (p.28).

Hanson and Wolfskill (2000) combined all three forms of peer-based learning in their process workshops model which targeted the development of aspects of thinking in the domain of

chemistry education. Research by Hanson and Wolfskill is discussed in more detail in section 2.5.

Instructional approaches where learners participated in groups further support the importance of exposing participants to multiple perspectives. In proposing an approach to fostering group critical thinking, Schamber and Mahoney (2006, p.106-107) incorporated principles of collaborative learning, group dynamics – specifically the central role of group goals based on Shaw (1976), Maier (1963) and Slavin (1999) – and the writing process. Like Halx and Reybold (2006), they emphasised the role of multiple perspectives or collective input: “Collaborative learning can facilitate the development of high-level critical thinking and problem-solving abilities of students because of its focus on collective input from members of the group” (p.109).

Moseley et al (2004, p.46) concluded that there was a need for three complementary frameworks to be used within post-secondary education. They viewed Pintrich’s framework of self-regulated learning as most suitable for developing *strategic and reflective thinking* and Halpern’s approach as a useful *productive thinking* framework. They highlighted the need for learners to be placed in situations that afforded opportunities for using strategic and reflective thinking (p.52), and identified the problematic nature of assessing the personal attributes and dispositions of learners, especially in group situations (p.53).

2.3.5 Summary

This section has reviewed the literature on the imperative for teaching critical thinking skills in higher education in order to equip students for the workplace and the demands for lifelong learning in the 21st century. It has shown that thinking skills as the core of the educational endeavour is not new and has been pursued as an ideal for a century or more. Section 2.3.2 identified the competing demands for teaching subject content as one reason why the “training of thought” (Dewey, 1910) has not permeated higher education in a more ubiquitous fashion.

Section 2.3.3 showed that the debate surrounding the curricular “location” of critical thinking skills instruction has not been resolved, and proponents from different disciplines continue to favour either stand-alone or integrated approaches. The general, infusion and immersion approaches were identified as the main classification of curricular approaches.

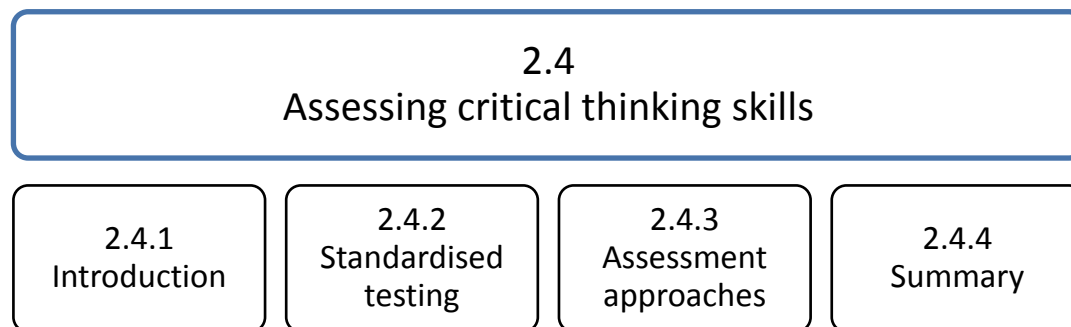
In section 2.3.4 transferability of skills has emerged as a key consideration in selecting appropriate pedagogical approaches. The literature on critical thinking skills instruction presented a number of different models of instruction and framework for thinking skills

development which contain common elements, and yet no single model has emerged as being most effective. Halpern's (1998) four-stage model demonstrated the need for a structured approach and for carefully attending to the dispositional components of critical thinking. The metacognitive element of critical thinking was highlighted in a review of critical thinking research (Livingston et al, 2004), and the central role of self-regulation was emphasised (Butler, 1998; Moseley et al, 2003). Collaboration emerged as a core requirement in enhancing critical thinking skills (Hanson & Wolfskill, 2000; Garrison & Anderson, 2003; Livingston et al, 2004).

Specific approaches to critical thinking skills instruction are considered in greater depth in section 2.5 when examining a number of studies into critical thinking skills development.

The next section looks more closely at the challenges associated with the assessment of critical thinking skills.

2.4 Assessing critical thinking



2.4.1 Introduction

This section provides a broad overview of different approaches to the assessment of critical thinking skills. A more detailed review of specific research studies which assessed the development of critical thinking skills will be provided in section 2.5.

The literature on the assessment of critical thinking shows that standardised testing, in the form of multiple-choice questionnaires, remains prevalent in the field of critical thinking, and that other forms of assessing critical thinking skills reported in the literature remain largely confined to research studies where the focus is often on evaluating a specific intervention. Large-scale assessment initiatives are focused on evaluating the effectiveness of higher education in delivering on targeted outcomes and aim to provide evidence of overall improvement in the critical thinking skills of students by the time they graduate. Such assessments are necessarily summative and frequently discrete from the instructional process.

While vast amounts have been written on the conceptualisation of critical thinking, and ever more is being written on different approaches to the development of critical thinking skills as part of the curriculum, information on non-standardised, formative or classroom-based assessment of critical thinking skills as part of the teaching and learning processes is mostly confined to research reports. In a comprehensive review of thinking skills instruction for post-16 learners, Livingston et al (2004, p.46) noted that “there was little emphasis on the assessment dimension” within such studies, and they could identify only five studies that sufficiently addressed assessment strategies.

This section briefly reviews the assessment of critical thinking skills using tests, and then highlights other considerations in the assessment of critical thinking skills development. . A

more detailed discussion of the ways in which critical thinking skills have been assessed in practice and in research studies follows in section 2.5.

2.4.2 Assessment of critical thinking skills using standardised tests

A large number of standardised test instruments is available commercially for assessing higher-order or critical thinking skills. A detailed review of test instruments falls outside the scope of this study, but the different uses of standardised tests warrants comment, and this section briefly considers large-scale and admissions testing.

The desirability of large-scale testing of critical thinking in higher education has been the subject of much debate, and is often seen as being a politically-driven preoccupation (Moseley et al, 2004). Large-scale extracurricular testing is frequently linked to ranking of institutions and policy-making issues and are intended to ensure transparency and accountability within national education systems.

In Australia, large-scale testing of learner outcomes has thus far been confined to schools (primary and secondary) in the recently introduced National Assessment Program – Literacy and Numeracy (NAPLAN). The Australian Council for Educational Research (ACER) also led the development of the OECD Programme for International Student Assessment (PISA) (<http://www.pisa.oecd.org/>) currently used in the assessment of learners at the end of their compulsory schooling.

In the specific context of higher education, Australia has participated in the OECD's feasibility study for the international assessment of higher education learning outcomes using the Collegiate Learning Assessment (which is used in the US to test student outcomes on critical thinking, writing, and synthesising data). The OECD is set to report on the feasibility study for higher education in July 2011 (*The Australian*, 3 February 2010, "Universities must be made to measure").

In the USA, where critical thinking skills instruction is a compulsory component in many courses, there has been a move towards nationwide testing for critical thinking following a recommendation made by the Commission on the Future of Higher Education in what is generally known as The Spellings Commission Report (2006). In an essay in response to the recommendation, Ennis (2007, "Problems and dangers") cautioned that while such testing could help to promote the development of critical thinking, careful attention should be paid to the conception of critical thinking that provided the basis for the test, situational validity, and reliability. Ennis (2007) defined situational validity as "the extent to which [an educational test] assesses what it is supposed to be assessing in a given situation or type of situation".

Other commonplace use of critical thinking skills testing is for admission purposes, notably the use of the Thinking Skills Assessment (TSA) developed and used by the University of Cambridge since 2001. It comprises 50 multiple choice questions to be completed in 90 minutes, and is intended to test the critical thinking and problem-solving skills of applicants for admission to courses in Computer Science, Economics, Engineering, Land Economy, Natural Sciences (Physical and Biological), Politics, and Psychology and Sociology (PPS).

The Australian Council for Educational Research has developed and makes available a large number of standardised tests (<http://www.acer.edu.au/tests/university>), including the Business Select multiple-choice questionnaire, a selection tool that tests generic skills (including problem solving, critical thinking and interpersonal understanding) of graduates seeking admission to post-graduate Business studies, and the Graduate Skills Assessment (GSA) for testing generic skills. It is intended for use at the start of university studies and immediately prior to graduation. The test includes the areas of critical thinking, problem solving, interpersonal understandings and written communication (and includes two writing tasks). (The Business Select test was considered for use in this study, but the cost attached to using the test was prohibitive.)

Several authors have compiled annotated lists of available standardised tests. Arter and Salmon (1987) provided a “consumer’s guide” of higher-order thinking skills (HOTS) tests to aid practitioners in test selection. They included a wide range of instruments including critical thinking, problem solving and decision making tests, developmental and creativity tests, achievement and ability tests as well as observation scales. Robert Ennis (1999) provided an annotated list of critical thinking tests selected as “covering more than one aspect of critical thinking (and thus comprehensive to some degree)”. The list includes tests in multiple-choice format (the California Critical Thinking Skills Test, California Critical Thinking Dispositions Inventory, the Cornell Critical Thinking Test, and the CAAP Critical Thinking test) as well as tests that contain writing components (eg the Ennis-Weir Critical Thinking Essay Test and the ICAT Critical Thinking Essay Test).

In line with the requirement for evidence of developing students’ critical thinking skills in the USA, the Delphi Report reviewed the critical thinking assessment tools commercially available at that time (APA, 1990, Appendix A, pp.36-39), some of which remain in use albeit in updated versions. Among these were the Academic Profile Test and related instruments of the Education Testing Service in the USA, the Collegiate Assessment of Academic Proficiency (CAAP), the Cornell Critical Thinking Test, the Ennis-Weir Critical Thinking Essay Test, and the Watson-Glaser Critical Thinking Appraisal. The discussion noted that the “challenge of CT

assessment is not to let what is easily measured restrict our sense of the fullness of CT” (APA, 1990, p.30), and that any assessment of critical thinking should encompass both the cognitive skills dimension and the dispositional dimension. The California Critical Thinking Skills Test which has been used in the current study was developed after the release of the Delphi Report and is addressed in detail in Chapter 3, section 3.3.3.3.

2.4.3 Assessing critical thinking: Considerations and approaches

A practitioner’s particular conceptualisation of critical thinking is likely to determine the approach to critical thinking skills instruction that is adopted, as well as the type of assessment that takes place during the course of instruction. Assessment and evaluations of critical thinking instruction are therefore likely to be aligned with specific approaches to critical thinking skills instruction. The review of other studies in section 2.5 incorporates different assessment and evaluation strategies, while this section reviews a selection of general considerations in assessing critical thinking skills.

Participants and contributors in the Delphi Project commented on the following four potential ways of judging whether a person was more or less proficient in a given skill, and the commentary provided some useful insights into expert views of assessing critical thinking (APA, 1990, pp.103-106), including:

- (1) observing the person performing the skill and making a judgement on the degree to which the person possesses the general skill in question
- (2) comparing the outcomes of executing a specific skill against a set of criteria
- (3) questioning the person to establish the procedures and judgements they are using, would use or did use to perform the skill
- (4) comparing the outcomes of some other task against a set of criteria, where performing that other task “has been shown to correlate strongly with performance of the skill of interest”.

In terms of the first option, there was a strong feeling that mental skills cannot be directly observed as they are being used, and there was some opposition in general to all four approaches as being inadequate to address “any effort, visualisation, mental rehearsal, or [use of] ... any inner resources” (p.28).

The third suggestion was criticised as being dependent on the second (a person can only be asked to describe how they performed a skill after it has been established that they possess the skill). It was also argued that critical thinking skills were generally used unconsciously and

that such a procedure would only be suited to the critical thinking operations of experts, who can be expected to be conscious of the mental procedures that they employed. The implication is that it would be challenging to assess metacognitive elements of critical thinking. Difficulties with the reliability of self-reports were also mentioned.

Several contributors expressed a preference for the second option because it was considered more practical, less time-consuming, and “easier to design instruments for”. Others felt that the second option would be acceptable if it also included some assessment of the steps taken to arrive at the desired outcome. Contrary views criticised the second option for not revealing the “understandings and reasoning behind the answers given”, noting that the right answer could be dependent on a person’s understanding of the desired outcome, and conversely that a correct outcome cannot be assumed to necessarily be the result of thinking critically (pp.28-30).

Interestingly, in wrapping up the fifth round of the Delphi project, Facione mentioned his intention to create and pilot test a critical thinking assessment instrument, and commented as follows (APA, 1990, Delphi Research Letters, p.107): “Ironically, a key assumption in our experimental design is that the Philosophy faculty [at Santa Clara University, Fullerton] teaching CT are doing an effective job. The experiment is to find out if the assessment tool is sensitive enough to detect the difference *we assume* our CT instruction is making”.

Halpern (2001, p. 273) presented specific criteria for assessing critical thinking and noted that a quality assessment should not only assess students’ ability to think critically, but also whether they do so in practice “without specific prompting” and noted that many of the indicators of critical thinking were difficult to measure with standard instruments. She also highlighted issues surrounding the validity and reliability of measurements used to evaluate the effectiveness of instruction, and noted that multiple-choice tests may be problematic in terms of validity, that open-ended assessments typically have problems when it comes to reliability, and that techniques such as portfolios, interviews and focus groups often have limitations in terms of both reliability and validity (Halpern, 2001, p.277).

While some of Halpern’s criteria are more relevant to evaluative research to establish the effectiveness of instruction (such as using multiple comparison groups, specific times of testing and identifying specific strategies), she called for the use of “ecologically valid indicators” that would indicate that students were able to use critical thinking skills “in real-world contexts that extend beyond the usual in-class exam” and pointed out that “a good assessment will be based on ‘simulated scenarios’ that are similar to the situations that students will encounter out of the classroom” (2001, p.274). These criteria have been applied in the current research.

Livingston et al (2004, p.42) highlighted the need for thinking skills assessment to follow what is generally known to be good practices in any instructional situation, specifically in relation to greater use of formative assessment or “assessment for learning” (as opposed to summative assessment, or “assessment of learning”). As in any teaching and learning context, formative assessment requires frequent feedback on student performance, and such feedback should be “systematic, timely and specific to the content being learned”. Learners should moreover be aware of the criteria to be used in assessment, and needed to be trained in self-assessment (p.43). Teachers similarly needed expertise in assessing growth in student thinking.

Livingston et al (2004, p.4) identified a number of useful approaches, including authentic, focussed and in-depth assessment tasks in a variety of contexts that involved a range of thinking skills, setting clear criteria to be met, and using formative and peer feedback. They also noted (p. 43) the time demands of devising, administering and scoring open-ended, authentic tasks.

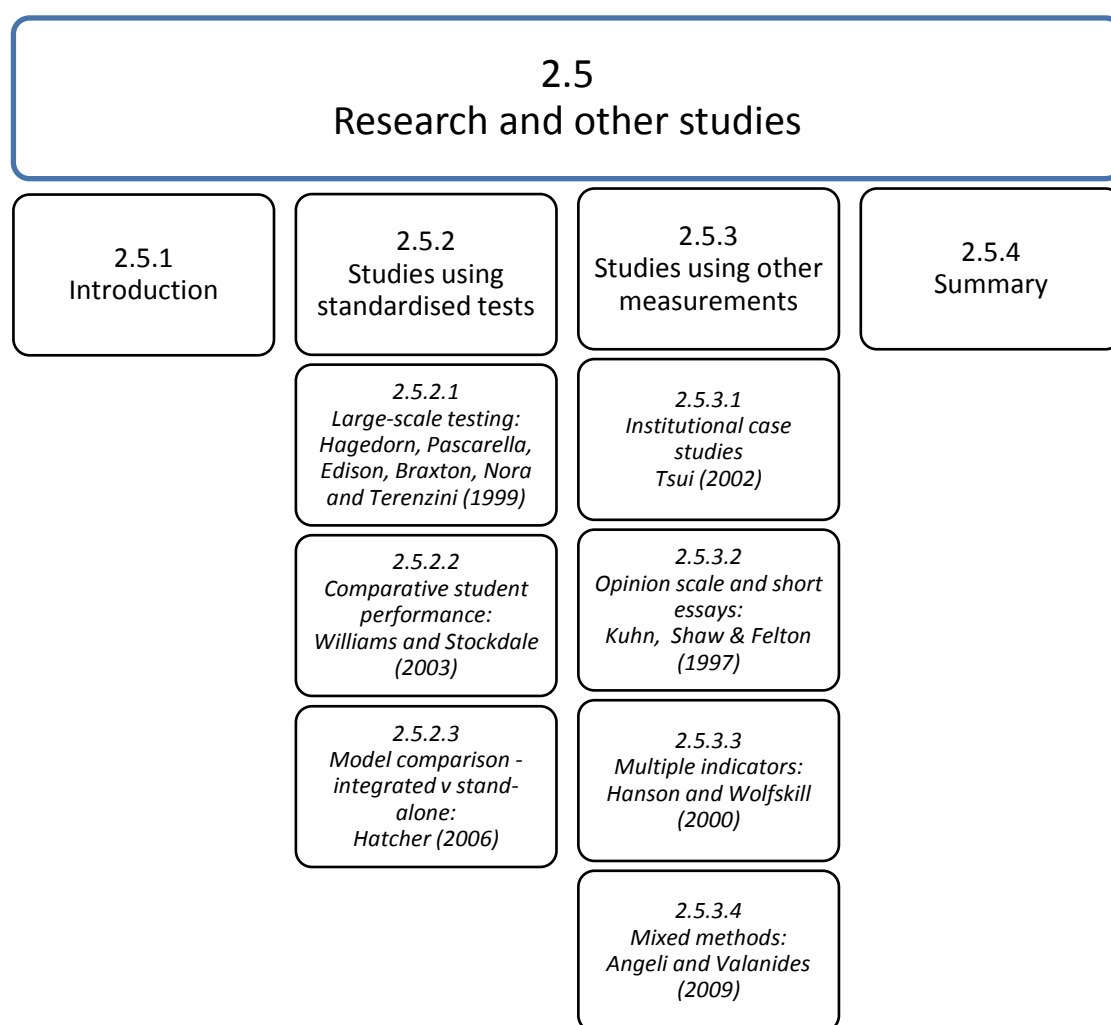
2.4.4 Summary

This section has briefly noted that standardised testing remains prevalent in assessing critical thinking skills, and has highlighted considerations in assessing critical thinking skills development that show the need for assessment approaches other than standardised tests, which may not be sensitive enough to detect changes in critical thinking ability (APA, 1990). Critical thinking skills development should be assessed using ecologically valid indicators within authentic contexts that reflect the real-world situations in which learners will apply critical thinking skills (Halpern, 2001, p.274). Sound approaches to assessing critical thinking skills should consider both the process of employing critical thinking skills and the outcome, measured against clear criteria (APA, 1990) and should be a formative part of the learning process (Livingston et al., 2004). Such assessment can be demanding, but promises to have greater ecological validity (Halpern, 2001).

Additional assessment strategies are covered in the next section (2.5) within the context of specific studies.

2.5 Research and other studies

Previous sections have reviewed the literature on approaches to teaching critical thinking (2.3) and assessing critical thinking (2.4). While effective approaches to instruction have been explored in a growing body of literature, ways of assessing critical thinking within the different contexts of instruction have not received the same level of scrutiny in the literature. Standardised testing remains prevalent in assessing the development of critical thinking skills, and a number of considerations for ensuring relevant and constructive assessment of critical thinking skills have been highlighted. Section 2.5 provides more information on the ways in which the development of critical thinking skills have been measured in a number of studies.



2.5.1 Introduction

The review of other studies in the sections that follow highlights the approaches and features that can be expected to enhance critical thinking. The review of approaches to critical thinking skills development in section 2.3 reflected three distinct approaches (general; infusion;

immersion), and some of the studies on the development of critical thinking incorporate comparisons of more than one approach. The review of other studies has therefore been divided into studies that assessed or evaluated different approaches by employing standardised tests and those in which other measures were employed. The studies in section 2.5 represent a relatively small subset of research into critical thinking development and have been selected on the basis of relevance, either in the use of standardised testing (as in the quantitative component of the case study in this research) or on the basis of the approaches to critical thinking skills instruction, which is the focus of the qualitative component of this study.

Section 2.5.2 covers studies in which standardised testing was used to evaluate the effectiveness of instruction in developing critical thinking skills:

- Hagedorn, Pascarella, Edison et al (1999) conducted institutional-level evaluations using student scores in the critical thinking module of the *Collegiate Assessment of Academic Proficiency (CAAP)*.
- Williams and Stockdale (2003) administered both the *California Critical Thinking Skills Test (CCTST)* and the *Watson-Glaser Critical Thinking Appraisal – Form S* in pre- and posttests in a program that followed an integrated or infusion approach to critical thinking skills instruction.
- Hatcher (2006) reported on results obtained using first the *Ennis-Weir Critical Thinking Essay Test (E-W)* and then the *California Critical Thinking Skills Test (CCTST)* to compare scores of students in a General Education Program (that can be viewed as following an immersion approach) with the scores obtained in stand-alone critical thinking courses.

Section 2.5.3 addresses studies in which other measures were used.

- Tsui's study (2002) presents four institutional case studies and employed an explanation building strategy using national data (institutional scores on the Institutional Growth in Critical Thinking variable included in the data collected through the Cooperative Institutional Research Program), other institutional information as well as data collected through classroom observations and focus group interviews.
- Kuhn, Shaw and Felton (1997) used an opinion scale developed by Kuhn and Lao (1996, in Kuhn et al, 1997, p.289), and short essays to measure indicators of critical thinking skills development.
- Hanson and Wolfskill (2000) evaluated an immersion approach using four years of data on attendance, enrolments, student evaluation, students' ratings of instructors, student results in examinations, and instructor reports on student skills development.

- Angeli and Valanides (2009) followed a mixed-methods approach to compare the effectiveness of three different approaches to critical thinking skills instruction. They administered the California Critical Thinking Skills Test (CCTST) as a pretest to account for entry level critical thinking skills, developed a rubric to analyse the content of written summaries in order to assess critical thinking skills performance and a questionnaire to evaluate students' understanding of critical thinking skills, as well as reviewing participant reflections on their performances and their understanding after the interventions.

2.5.2 Studies using standardised tests

The review of the studies in this section follows a consistent structure (where relevant information has been reported) by presenting first a brief overview or summary of the study and its findings, and noting the definition of critical thinking. Each section then presents more detail on the context and methodology of the particular study and the explanations offered or comments on the findings.

2.5.2.1 Large-scale testing: Hagedorn, Pascarella, Edison, Braxton, Nora and Terenzini, 1999

The first study covered in this section is a 1999 investigation conducted by Hagedorn, Pascarella, Edison et al to establish whether individual students' critical thinking skills development was influenced by the average student body level of critical thinking at an institution. It followed a prior study by Terenzini, Springer, Pascarella and Nora (1995) which measured student scores on the critical thinking module of the Collegiate Assessment of Academic Proficiency (CAAP) and which had found that after controlling for entry-level critical thinking, scores were significantly related only to the number of hours a week that students spent studying. The study therefore relates to institutional-level testing. It does not address specific interventions but looks at critical thinking skills development in cohorts of students at institutional level. It aimed to measure the effects of university studies on critical thinking skills development.

The study found that attending highly prestigious institutions with high average critical thinking scores had an effect on the critical thinking scores of individual students as at the end of the first year, but that by the end of the third year of studies the effect was insignificant.

Hagedorn et al adopted a definition of critical thinking (1999, p.265) as

a constituent set of cognitive skills [involving] some or all of the following: making correct inferences from data, identifying central issues or assumptions in an argument,

deducing conclusions from information or data provided, interpreting whether conclusions are warranted on the basis of data given, and evaluating the validity of an argument (Brabeck & Wood, 1990; Furedy & Furedy, 1985; McMillan, 1987; Pascarella & Terenzini, 1991)

The study involved students at 18 four-year and five two-year colleges and universities in 16 different states that had participated in the National Study of Student Learning, and included some 3,840 students in the original sample, 2,650 in the first follow-up and 1,761 in the second follow-up data collection, after the first and third years of study, respectively. The control variables used in the study included precollege levels of critical thinking, precollege academic motivation, age, ethnicity, gender, family social origins and work responsibilities. The data consisted of student results in the CAAP critical thinking test, a 32-item instrument measuring test takers' ability to analyse, evaluate and extend arguments by answering a set of multiple-choice items on each of four passages representing issues typically encountered in the postsecondary curriculum.

Hagedorn et al (1999) found that the average level of critical thinking in an institution had a modestly positive effect on student critical thinking scores as measured at the end of their first year (institutional context accounting for between 0.6% and 2.1% of the total effect, and between 0.6% and 2.7% of the direct effect), but had no significant effect by the end of the third year (0.1% for both total and direct effects) (Hagedorn et al, 1999, p.275). At institutions where the average critical thinking score of the student body was high, there was a greater increase in the critical thinking scores of individual students during the first year of studies, but no significant difference by the end of the third year of study. Analysis showed that this was not attributable to a ceiling effect.

Some of the possible explanations offered for the diminishing effect of the institutional contexts were that students may be socialising less widely after their first year of studies, thus limiting their exposure to the skills and attitudes of the student body at large, or that students may become less susceptible to peer influence, so that the pressure they may have felt to develop the cognitive skills that would enable them to fit in and participate in discussions during the first year were not sustained through to the third year. These explanations were supported by the view of Rodgers (1980) and Stage (1991) (cited in Hagedorn et al, 1999) that "further growth in critical thinking may require curricular and instructional processes that challenge and support students throughout their college careers" (p.280).

2.5.2.2 Comparative student performance: Williams and Stockdale, 2003

Williams and Stockdale (2003) conducted a study in which they assessed the critical thinking skills of students in an undergraduate Human Development unit of study which served as entry to the Teacher Preparation course. Although changes in critical thinking test scores were minimal, they found the greatest increase in scores among students who had low scores in the pretest and yet achieved high grades in their studies, followed by students with high critical thinking scores at pretest who also achieved high grades in their studies. They also found work habits (and specifically note-taking) to be a significant difference between low critical thinkers who performed poorly in their studies and low critical thinkers who achieved high grades in their studies (Williams & Stockdale, 2003, p.209).

Previous research (Williams, Oliver & Stockdale, 2003) had shown that students who performed poorly in their studies were likely to achieve low critical thinking scores at the start and the end of their course, and that it was less likely for poor performers to improve their scores (Williams, Oliver, Allin, et al., 2003). Williams and Stockdale (2003) postulated that critical thinking scores were both a predictor and outcome of study achievement, and that this was a potentially reciprocal relationship, so that students with high critical thinking scores would be more likely to achieve high scores in their studies and to increase their critical thinking ability. By implication, students who started their studies with low critical thinking scores would be less likely to achieve high grades and also less likely to improve their critical thinking. And yet some students with low critical thinking scores achieved high grades in their studies, which raised the question that they set out to answer: “What differentiates the course practices of high-performing low critical thinkers from those of high-performing high critical thinkers and [from] those of low-performing low critical thinkers” (Williams & Stockdale, 2003, p.201)?

Although they did not provide a specific definition of critical thinking, their conceptualisation of critical thinking saw linkages between conclusions and evidence, between argument construction and evaluation, or the ability to identify and generate supportable conclusions from credible information bases:

Our definition ... of critical thinking targeted student ability to select [ie distinguish] conclusions that were most supportable from [mere] assumptions (Williams & Stockdale, 2003, p.199)

Williams and Stockdale used data collected over six semesters, including pre- and posttest results, grades achieved, the work patterns that students employed, as well as selected ungraded support variables. They administered the *California Critical Thinking Skills Test*

(CCTST) as pretest and the *Watson-Glaser Critical Thinking Appraisal – Form 5* as posttests in order to identify high and low critical thinkers. When correlating scores with student results in the unit, they found that some students with low critical thinking ability achieved high grades in the unit. In an attempt to find explanations for this, they identified several support variables (although data were not collected on all support variables from all samples or in all semesters), including attendance, note-taking (in class and out of class), use of the supporting online course site, grades on practice exams, improvement in critical thinking skill scores, ACT scores and prior grade-point averages, as well as generic vocabulary development (which they saw as a possible indicator of how hard the low critical thinkers-high achievers worked, rather than as a purely cognitive factor).

They identified work habits as one significant difference between low critical thinkers who performed poorly and low critical thinkers who achieved high grades in the unit. The latter group's grades were in fact almost as high as those of the high critical thinker-high performance group. They also identified note-taking as a pivotal work habit, with low critical thinking-high performing students doing better at this support variable than all other groups. They came to the conclusion that low critical thinkers used note-taking to compensate for cognitive limitations, but noted that note-taking habits were significant largely in courses with a substantial content base.

In a pretest-posttest comparison, they found little evidence of improvement in critical thinking scores overall. Only participants classified in the low critical thinking/high-grade group showed an improvement in scores (a mean difference of 2.10) while the mean differences for both the low-critical thinking/low-grade group and the high-critical thinking/high-grade group declined (-1.75 and -2.47, respectively). The effect size of the difference in critical thinking scores between the low-critical thinking/high-grade group and the low-critical thinking/low-grade group was +0.63 (+0.42 to +0.74), and that between the low-critical thinking/high-grade group and the high-critical thinking/high-grade group was +2.27 (+1.17 to +3.78).

The most favourable change in generic critical thinking was therefore found in the low-critical thinking/high performing group who "consistently gained more in critical thinking during the course than either of the other critical thinking/grade groups" (p.218), followed by the high-critical thinking/high performing group of students.

As the unit in this study was highly structured, which may not be the case in all courses, Williams and Stockdale recognised the very limited extent to which this study would be generalisable to the wider population of general education students. They did note that findings were fairly consistent across six semesters, although changes in course requirements

and support variables over this time were confounding factors. They also made several normative adjustments to their performance group classifications over this period.

They further noted that adding qualitative data via interviews and focus groups reflecting student perceptions of their course experience could have provided additional insight into work habits and other support variables, including student reports of time spent on various activities, but conceded that “this kind of data collection would be particularly vulnerable to student exaggeration” (Williams & Stockdale, 2003, p.223).

In spite of the shortcomings and several other changes that could have affected results, they noted that “the differences among the performance groups remained generally consistent” (Williams & Stockdale, 2003, p.224).

They concluded that it was likely that students with high critical thinking skills would achieve high grades in their studies, regardless of course organisation and levels of instructor assistance, while good work habits and levels of assistance provided by instructors could make a substantial difference to the achievement of students who begin their studies with lower critical thinking ability.

2.5.2.3 Model comparison – integrated v stand-alone: Hatcher, 2006

Hatcher (2006) conducted a longitudinal study of the gains in critical thinking abilities from freshman to senior years, comparing stand-alone and integrated approaches to critical thinking skills instruction. In the *integrated approach* (also set out in section 2.3.3 and sometimes referred to as the infusion approach) students were first taught generic critical thinking skills and then shown how to apply these to other contexts or courses in order to improve their performance.

The Hatcher study reported greater pre- to posttest gains in critical thinking test results in an integrated approach than that achieved in typical stand-alone courses in critical thinking.

The following definition of critical thinking was developed and adopted in the study (Hatcher, 2006, p.251):

Critical thinking is thinking that tries to arrive at a judgment only after honestly evaluating alternatives with respect to available evidence and arguments (Hatcher & Spencer, 2004, p.1, cited in Hatcher, 2003, p.251).

The study was based on the development of critical thinking skills in a compulsory General Education Program at Baker University, comprising three custom designed core units, the first two of which targeted critical thinking and effective writing and focused on ideas and

exposition, and integrating instruction in critical thinking. The third unit was a capstone seminar – Science, Technology, and Human Values – in which students were required to write and defend a position on a public policy that related to developments in science and technology. The capstone unit was introduced first, and when it was found that senior students were lacking the skills necessary to write the position paper and were unable to construct or evaluate arguments (Hatcher, 2006, p.250), the first-year units were developed to address these shortcomings through instruction in basic critical thinking skills.

Data from 15 years of testing were included in the study. Initial data were comprised of student test scores (freshmen and seniors) in the *Ennis-Weir Critical Thinking Essay Test* (used from 1990 to 1995), and as from 1996 data comprised scores in the *California Critical Thinking Skills Test* (adopted because its widespread use facilitated comparison with other studies).

The Ennis-Weir Critical Thinking Essay Test (E-W), in which students analysed and evaluated the reasoning in an eight-paragraph letter to the editor, was administered in a pretest conducted at the start of students' first semester and in a posttest as part of the final exam at the end of the first year of study. The test was administered again during the semester in which students took the capstone seminar. Comparison of pre- and posttest scores showed a mean effect size of +0.97 for 1990-1996 ($n=977$, with the highest effect size of +1.11 in 1990/1991 and the lowest +0.51 in 1991/1992) (Hatcher, 2006, p.257, table 3). The difference between freshman and senior's scores between 1995 and 1999 showed a mean effect size of +1.47 ($n=387$) (Hatcher, 2006, p.256, table 1). Mean gain for two comparison groups in a standard logic class and a standard critical thinking class at other institutions were -0.31 ($n=44$) and +0.29 ($n=23$), respectively (Hatcher, 2006, p.257, table 2), and the mean gain obtained in another longitudinal study using a standardised test (reported by Pascarella and Terenzini, 2005, p.158) was +0.25.

The California Critical Thinking Skills Test (CCTST) was applied in the same way as the E-W, from 1996 to 2005, and showed a mean gain in scores (pre- to posttest) of +0.57 ($n=1,617$), and a mean difference of +0.88 between freshmen and seniors' scores ($n=396$) from 2000 to 2004.

Hatcher compared these results with a gain of +0.32 in the CCTST validation study in 1990 ($n=262$), as well as an effect size of +0.88 obtained in a University of Melbourne study in 2000 ($n=50$), +0.49 in a study at McMaster University in 2001 ($n=278$), +0.28 in a Monash University study in 2001 ($n=174$), and +0.73 in another University of Melbourne study in 2002 ($n=117$).

It is worth noting that both the McMaster and Melbourne University units of study used computer-assisted argument mapping software in systematic critical thinking skills instruction

to supplement in-class work. The computer-assisted training consisted of “exercises [that] may resemble more closely what students are asked to do on a standardized test like the CCTST” (Hatcher, 2006, p.263) and these units were electives, which could imply a special interest in critical thinking among students who chose to take them.

The results clearly showed the integrated program to be more effective at improving student scores in standardised critical thinking skills tests than traditional stand-alone classes in logic and critical thinking. Hatcher attributed this to a number of factors (pp.266-267):

- (1) the relatively simple “deductive reconstruction” approach: students “reconstruct the arguments in valid argument patterns and then focus on the reasonableness of the premises” (which can be seen as a similar approach to that used in the Melbourne and McMaster studies – argument mapping – albeit without computer assistance)
- (2) the duration of the program: the two-semester freshman program provided ample opportunity to practice applying logical skills
- (3) thorough preparation of teaching staff: a summer workshop attended by all instructors covered textbook and other critical thinking materials taught in the freshman program

Hatcher (2006) added the proviso that knowing that critical thinking can be developed across the disciplines did not necessarily mean that this was happening.

It may be worth considering that the Baker University program was modelled on “simplicity and repetition ... in the repeated application of critical thinking skills ... in what students read and what they write” (Hatcher, 2006, p.258), concentrating on only one type of paper (the argumentative essay). The large effect sizes obtained could arguably have been the result of an approach that might border on “drill and practice”. Hatcher speculated that traditional critical thinking courses might cover too much material, including relevant theory.

Another point of view could be that traditional stand-alone critical thinking courses teach students about critical thinking rather than teaching them to think critically. Be that as it may, Hatcher’s report clearly shows that the two-semester integrated units produced far more significant effect-size gains than a standard one-semester unit in critical thinking, and that gains continued to grow throughout students’ studies.

2.5.3 Studies using other measurements

2.5.3.1 Institutional case studies: Tsui, 2002

Tsui (2002) used an institutional case studies approach in researching pedagogy that would be effective in fostering critical thinking skills. Using national data that provided institutional

scores on the IGCT (institutional growth in critical thinking), one of the variables in the data collected through the Cooperative Institutional Research Program (CIRP), Tsui selected two institutions with high IGCT scores and two with low IGCT scores, all with a similar student body size. To exclude factors in critical thinking skills development that would be contingent upon the selectivity of an institution, her selection included two highly selective institutions, one with a high IGCT score and one with a low IGCT score, and a similar pair of low selectivity institutions.

This study identified a number of elements that accounted for higher critical thinking skills development:

- (1) significant amounts of writing exercises that require less description and more analysis
- (2) peer review of and peer feedback on written work, as well as rewriting based on peer and tutor feedback
- (3) classroom discussions as part of an active learning approach
- (4) self-evaluation and critical self-reflection

Critical thinking, in this study, was defined as

students' abilities to identify issues and assumptions, recognize important relationships, make correct inferences, evaluate evidence or authority, and deduce conclusions (Tsui, 2002, p.742).

Tsui noted that this definition was “less inclusive than that advanced by some theorists” and that it did not include specific aspects of problem solving. As a result, the study emphasised the relationship between critical thinking and literacy skills, but did not extend to the relationship between critical thinking and numeracy skills.

Data consisted of institutional information as well as data collected through classroom observations and focus group interviews, which were analysed using an explanation building approach (Tsui, 2002, p.746) in order to compile comparative institutional case studies.

The study showed the development of critical thinking to be closely linked to and dependent on specific learning environments. It highlighted constellations of factors that affected cognitive development, with no single factor unaffected by the presence or absence of other conditions in the learning environment.

In the four case studies, Tsui (2002) identified a link between the development of critical thinking and the “amount of writing” (especially writing that required less description and more analysis) that students had to complete. She contrasted writing as a learning or

assessment activity with multiple-choice tests which have become prevalent at many institutions. When referring to “writing”, she was referring to a specific learning process that included peer review of and peer feedback on written work, as well as rewriting based on peer and tutor feedback, in other words a two-step process that was considered more likely to bring critical thinking into play than the traditional one-step writing process that students undertake on their own. Other forms of writing that were identified as conducive to critical thinking development included self-evaluation and critical self-reflection.

The study found that institutions with low IGCT scores showed little evidence of class time devoted to peer exchange and feedback on writing. Instead, multiple-choice exams were commonly used to assess student achievement, and staff reported that students had little time to spend on written assignments.

Other factors that appeared to be related to critical thinking skills development were classroom discussions as part of an active learning approach that encouraged students to articulate their thinking and explore ideas. High IGCT institutions used student presentations and small group work to encourage classroom participation.

At low IGCT institutions, lectures were the predominant mode of instruction in an information-transmission model aimed at “[optimizing] course material coverage” (Tsui, 2002, p.751). The main difference in classroom discussions was that at high IGCT institutions, peers were more likely to respond to questions posed by other students, while students at low IGCT institutions posed fewer questions and would rarely respond to other students’ questions in class.

Tsui noted the absence of a “more objective instrument” for measuring students’ critical thinking abilities as a limitation in her study (p.756), but drew on evidence that self-reports on improvements in critical thinking ability were positively related to actual growth in critical thinking skills (Bowen, 1977; Anaya, 1999; Pike, 1995, 1996).

2.5.3.2 Opinion scale and short essays: Kuhn, Shaw and Felton, 1997

This study has been included in the review because openness to other opinions and questioning one’s own beliefs have been seen as important characteristics of critical thinkers. Kuhn, Shaw and Felton saw it as “almost accepted wisdom” that “the most effective way to improve people’s thinking is to give them frequent opportunities to engage in the practice of thinking (Dewey, 1910)” (Kuhn, Shaw & Felton, 1997, p.287). The study looked specifically at argumentative reasoning and did not present a definition of critical thinking.

Kuhn et al (1997) tested the hypothesis that “engagement in thinking about a topic enhances the quality of reasoning about that topic”, and used a series of dyadic discussions among

participants in two age groups, early adolescents and young adults, on the topic of capital punishment to explore cognitive engagement. The study drew on the general principles of social and individual cognition and the interrelationship between social and internal argumentation. It expanded on both the Vygostkian tradition (with its focus on interactions where a more competent partner provides scaffolding for a less competent partner) and the Piagetian tradition (with its focus on partners of equal competence), both of which concentrated on the process of interaction rather than the cognitive outcomes of dyadic interactions (Kuhn et al, 1997, p.288).

Overall, they found that participants who took part in more than one dyadic interaction engaged in a wider range of arguments when measured pretest to posttest than did participants who engaged in a single-partnership dyadic interaction or who did not engage in a dyadic interaction but relied only on their own opinions and arguments (Kuhn et al, 1997, pp.287 & 314).

The *method and research process* adopted in the study compared the effects of dyadic interactions on “argumentive reasoning” at a topic-specific level among primarily Latino and African-American participants in two separate age groups: early adolescents (seventh and eighth-graders) and young adults (college students), using a pretest-posttest format and experimental and control groups for each age cohort. The test asked participants to identify their positions on capital punishment on a 13-point opinion scale developed by Kuhn and Lao (1996, in Kuhn et al, 1997, p.289), and to write a short essay at both pretest and posttest, setting out their positions and arguments on the topic.

Individuals were randomly assigned to an experimental group within their age cohort where they were paired with five different partners consecutively over a five-week period to engage in a series of discussions of between 10 and 15 minutes’ duration each. Each participant was paired with agreeing and opposing partners on different occasions. Dyads were instructed to “discuss their opinions about [capital punishment] with one another and to try to reach a consensus if possible or, if not, to try to identify the nature of their disagreement” (p.290). Dialogues were recorded and transcribed for subsequent analysis. Participants in the control groups completed the pre- and posttests at the same time as the experimental groups, but did not participate in the intervening dyadic interactions.

The study was repeated, employing the same methods, but limiting the intervention to a single dyadic partnership formed after the pretest, with instructions to discuss their positions and write a joint position statement over a period of five days (but allowing a period of up to seven days), followed by the posttest.

Arguments expressed in essays were analysed and the levels and quality of argumentative reasoning classified according to a comprehensive and fine-grained analytic scheme specific to the topic of capital punishment which the researchers had developed using an iterative, inductive process (Kuhn et al 1997, pp.291-293). The analytic scheme classified arguments broadly into three categories as functional or nonfunctional based on the adequacy of the justification provided for either pro or con positions, or as nonjustificatory arguments (arguments based on unsupported appeals to sentiment, precedent, majority or authority). Each category was further subdivided into qualitative levels of argumentation.

In addition to the analytic scheme, essay content was analysed in terms of argument structure (interrelated arguments and synthesis of different argument elements), evidence to support arguments, and metacognitive statements. Metacognitive statements were classified as either self-referring (indicated by uncertainty or conflict in the participant's own views) or other-referring (acknowledging that others may hold different viewpoints).

Opinion scales and argumentation in essays were compared pre- and posttest to identify both qualitative and quantitative changes. Dialogues were analysed with a view to establishing whether new elements of reasoning that appeared in participants' posttest arguments emerged during the dialogue processes.

Overall, Kuhn et al (1997, pp.287 & 314) found that participants in multiple dyadic interactions engaged in a wider range of arguments pretest to posttest than participants who engaged in a single-partnership dyadic interaction or who did not engage in a dyadic interaction but relied only on their own opinions and arguments.

The forms of reasoning improved among the multiple interactions group in several respects, including "a shift from 1-sided to 2-sided arguments, arguments based within a framework of alternatives, and metacognitive awareness of coexistence of multiple views" (p.287). While the quality of reasoning improved, few participants changed their position for or against capital punishment. The adolescent cohort was more inclined to change position than the adult cohort (p.307) (both pro and con positions nevertheless became less extreme), while adults showed a greater increase in the range of arguments that they offered.

Kuhn et al (1997, p.309) noted that the young adolescents in their sample "showed little proficiency in argumentation in a framework of alternatives and made little progress in this respect as a function of the intervention", but also found that the adolescents who progressed from a one-sided to a two-sided argument also showed advancement in metacognition which was absent in the relevant adult group (pp.309-310).

Kuhn et al (1997, pp. 314) cautioned against interpreting their results as establishing generality in terms of the changes that they observed. The main achievement of the study was that it established “dyadic interaction as a form of cognitive engagement that has [positive] effects on thinking” and that contributed to the understanding of the process of developing argumentive thinking.

In reviewing this study, two aspects may warrant consideration. The first is the absence or presence of extraneous inputs – any interactions in which participants engaged in their daily communications over the duration of the intervention could have impacted on their views of capital punishment. This highlights the difficulty of research in any education context, which has been aptly characterised by Brookfield (1990, p.28) as “the untidy contextuality of the world”.

Although Kuhn et al viewed the intervention as “sustained engagement involving multiple dialogues with different partners over a period of weeks”, it is worth noting that the total duration of dialogues was only 50 and 75 minutes for the two age cohorts respectively (5 dialogues, each with a different partner, lasting on average between 10 and 15 minutes). There is no indication that collaboration or discussion took place between the weekly dialogue events, although the likelihood of such interactions taking place among participants as well as between participants and non-participants cannot be excluded.

It is significant that posttest results from participants who took part in the single-occasion dyads and control groups were “limited to repeated elicitation of the participant’s own opinions and arguments”, but it was not reported whether participants had attempted to find information on or discussed the topic with others either within or outside those groups over the duration of the intervention. It would be useful to know whether participants outside of the experimental multiple-dyad group were more inclined to seek support for or confirmation of their own views, rather than exploring other perspectives on the topic.

The second is the difficulty of attributing changes in opinions to any specific interactions and concomitantly the difficulty of establishing causality given the “inchoate complexity” of critical thinking (Brookfield, 1990, p.30). It is doubtful whether any measure can accurately determine whether an intervention or a particular approach to instructions has caused a shift in opinions or enhanced participants’ ability to provide supporting arguments for their case. Kuhn et al (1997, p.308) noted that they could not “say with certainty that an argument not expressed by the participant at the pretest but expressed by that participant at the posttest was acquired as a function of, or even during the course of, the intervention”.

The analysis scheme used by Kuhn et al is nevertheless fine-grained and specific to the topic of capital punishment. Halpern (1993, p.273) noted that “some of the indicators of improved thinking ability may be subtle, but significant, such as an increase in the willingness to suspend judgment or a more deliberate effort to consider information that would disconfirm a favored conclusion. These are important positive changes that are difficult to ‘pick up’ with most standard instruments.” The analysis scheme here was deemed sensitive enough to pick up such subtle changes.

2.5.3.3 Evaluation using multiple indicators: Hanson and Wolfskill, 2000

This study was situated within the context of general chemistry instruction and relates strongly to the current research in that the approach stemmed from the same demands for greater relevance of the university learning experience to the workplace, as well as the changing nature of the workplace and demands from industry for “quick learners, critical and creative thinkers, problem solvers, communicators, and team players”. It does not focus only on critical thinking skills development, but on developing skills in key learning processes, and the workshop format allowed students to complete tasks “as the active agents in the classroom” (Hanson & Wolfskill, 2000, p.120).

The authors did not provide a specific definition of critical thinking, but described the critical thinking process developed in the workshops as involving the following:

identifying key issues, asking strategic questions, developing answers to those questions, and deciding what action to take (Hanson & Wolfskill, 2000, p.127)

Hanson and Wolfskill described the process workshop as “a classroom environment where students are actively engaged in learning a discipline and in developing essential skills by working in self-managed teams on activities that involve guided discovery, critical thinking, and problem solving, and include reflection on learning and assessment of performance” (2000, p.120). The process workshop model can be regarded as an integrated approach in that it is confined to the teaching of skills considered relevant to general chemistry. The authors reported that the approach had also been applied to other areas in the discipline (quantum chemistry) and that aspects of the model had been incorporated into other chemistry units of study. The goal of the workshops was to develop process skills and to master subject content (p.121). The strategies used in this model are nevertheless closely aligned with those that would be employed in an immersion approach.

In evaluating the success of the process workshop model, Hanson and Wolfskill (2000) collected and analysed figures over four years, based on attendance, enrolments, student

evaluations of the value of the workshops and their effect on their confidence in learning and studying chemistry, students' ratings of the instructors, student results in examinations, and instructor reports on student skills development.

The data reflected an increase in attendance from a low of 10-20% to 80-90%, an increase of 15% in enrolments, and an increase of 199 more students scoring above 50% when compared with the semester prior to introduction of the workshops – a shift of 20%. Between 75% and 90% of students found the workshops worthwhile and valuable, and significant numbers (540 of 1000) reported that the workshops “increased their confidence in studying and learning chemistry” (p.129). Workshop instructors were graded A and A+ by students who participated.

Hanson and Wolfskill (2000) identified a number of strategies that contributed to the success of the process workshop model:

- the use of learning teams, guided discovery and problem-solving exercises
- the use of key (critical thinking) questions to prompt students “to process the information, to verbalize and share their perceptions and understanding with each other, and to make inferences and conclusions (i.e., to construct knowledge)” (p.120)
- self-assessment and reflection-on-learning questions to be included in the team reports
- emphasis on process and not only on product, with marks assigned to process as well as products (p.128)

The process workshop model therefore enhanced active learner engagement in class through teamwork approaches based on the principles of individual accountability, self-management of team processes during class time, information-sharing, progress updates through regular report-backs, articulation of perceptions, and team products (report).

2.5.3.4 Mixed methods: Angeli and Valanides, 2009

The study by Angeli and Valanides (2009) compared the instructional effects of three different approaches to critical thinking skills development in the context of undergraduate instruction. The approaches presented by Angeli and Valanides have been outlined in section 2.3.3.1 and include the general, infusion and immersion approaches. Their paper illustrates the three approaches in practical terms and the interventions are therefore covered in some detail here.

Overall, the study found statistically significant differences in the critical thinking performance of the groups who participated in sessions that followed different types of approaches, and the authors concluded that “students were not automatically disposed to think critically even for

controversial issues that lend themselves naturally to critical examination of different perspectives” (Angeli & Valanides, 2009, p.331).

Angeli and Valanides acknowledged different conceptualisations of critical thinking (that have been addressed in section 2.2) and focused on “the conceptualization and teaching of critical thinking as a set of thinking skills” (Angeli & Valenides, 2009, p.232). They therefore conceptualised critical thinking as a set of more generic skills that were not bound to or bounded by specific subject matter and examined the effects of different instructional approaches on critical thinking skills development. They administered the California Critical Thinking Skills Test (CCTST, Form A) in pretest as a measure of critical thinking skills at the start of the intervention, and designed a rubric to assess student critical thinking skill performance by analysing summaries prepared in response to an ill-defined issue during the intervention . Additionally, they measured the effect of different approaches on students’ conceptual understanding of critical thinking using an evaluation questionnaire that students completed at the conclusion of the intervention (p.327). This was followed by a review of student reflections on their performance and of student understanding at a debriefing conducted one month after the interventions.

A total of 144 undergraduate students (drawn from all years of study and different disciplines), who had not participated in previous critical thinking skills instruction, voluntarily participated in the study. The largest representative participant groups were 54.86% second-year students, 69.44% female students, and 67.36% from the field of education. Participants were randomly paired in dyads and the dyads were then randomly assigned to four groups (three groups each experiencing a different instructional approach and a control group).

The study found that the *critical thinking performance* of students who participated in the infusion and immersion approaches was (statistically) significantly better than those in the general and the control groups. It also found that students in the general, infusion, and immersion groups (the three teaching groups) had a better *understanding of critical thinking*, following the intervention, than the control group. Students in the infusion group reported better understanding of critical thinking than the immersion group, but did not always have a better understanding than those in the general group.

The intervention consisted of three sessions. All students participated in the same first and third sessions, and the second session was conducted according to each of the three approaches for different groups. The control group participated in sessions 1 and 2, but received no instruction during session 2.

In the first session (80 minutes), participants completed the California Critical Thinking Skills Test (CCTST), and read and summarised a paper on an ill-defined issue (a single page of text in which two experts presented opposing views on the question: “Are American values shaped by the mass media?”).

In the second session (total 80 minutes), following a 5 minute introduction, students spent 10 minutes reviewing their own summaries. All students received written instructions on how to approach the task. The remainder of session 2 (65 min) differed according to each of the three approaches and for the control group:

- (1) The *general approach* used a “content-free” strategy (p.236) and consisted of students viewing a 35-minute video of a lecture on general critical-thinking skills. The lecture included a presentation and examples, specifically covering analysis of the problem and generating solutions (at which point students completed an exercise to practise these two skills), followed by developing reasoning for each solution, deciding on the best solution, and using criteria to evaluate their own thinking, concluding with a review of the areas covered. There was no interaction during the lecture and no feedback to students afterwards. Students then discussed the issue in dyads and prepared a joint outline for a paper (30 min).
- (2) In the *infusion approach*, each dyad was allowed 15 minutes to discuss the issue and to start developing a joint outline of their position, and 10 minutes to reflect on their thinking and write down their own “rules for good critical thinking”. This was followed by a 10-minute abbreviated version of the video used in the general approach (covering the same five skills, but with no opportunity to practise and no practice examples). After viewing the video, dyads engaged in a 15-minute critical dialogue with the instructor, comparing their own rules with the skills presented in the video. Each dyad then spent 15 minutes writing a joint outline for a position paper.
- (3) The *immersion approach* differed from the infusion approach in that the 10-minute lecture and 15-minute dialogue were replaced by 25-minutes of Socratic questioning in which participants were “challenged ... to re-think their rules about good critical thinking, and re-evaluate their reasoning and the way they developed their point of view” (p.326). The discussion aimed to guide students in clarifying and evaluating their thinking and to consider alternative points of view. The five distinct critical thinking skills were not made explicit to this group.
- (4) Dyads in the *control group* received the same instructions as in the other approaches, but received no input or feedback during the problem-solving process. They spent the

remaining 65 minutes preparing a joint outline for a paper that reflected the dyad's joint position on the issue.

In the third session (60 min), all students worked together in dyads to discuss a new issue ("Should drugs be legalised?") and prepare a joint outline for a position paper. Participants then completed a questionnaire consisting of two open-ended questions: "What is your understanding of critical thinking after participating in Sessions II and III?" and "What were the difficulties that you encountered?" (p.327).

To measure critical thinking performance, the outlines on the new issue were content analysed using a rubric that had been constructed using the constant comparative method that produced four criteria on which different levels were distinguished: clarity of reasoning within a point of view, discussion of the issue from different perspectives, identification of the strengths and weaknesses of each perspective, and explanation of the preferred perspective supported by reasons and evidence. Results were obtained from a rating scale of 1 (poor performance) to 5 (high performance).

One-way analysis of covariance was conducted using critical thinking performance (as measured above) as dependent variable, instructional approach as independent variable and the average individual CCTST score of each dyad as covariate, and found the covariate to be significant. After accounting for the effect of CCTST scores, results also showed a statistically significant difference among the four groups on the critical thinking performance measure. Post hoc comparisons showed that students assigned to the infusion and immersion approaches outperformed those assigned to the control group (p.328). Difference in performance among other groups was found not to be significant.

Between-group comparisons of critical thinking performance results were conducted by calculating the effect sizes (using differences in mean standard deviations divided by the pooled standard deviation). Results showed that students participating in the infusion approach performed much better than the control group – effect size 1.10; students in the immersion group outperformed students in the control group by an effect size of 0.99, which is similarly very large. Angeli and Valanides noted that effect sizes should be interpreted cautiously given the small size of the samples in this study.

No comparison of pretest and posttest CCTST scores was undertaken as the CCTST was administered only once, at the start of the intervention.

To compare the level of understanding of critical thinking among the four groups, students' written conceptualisations of critical thinking were content analysed in terms of four

categories: two statements indicative of precise understanding (1. “a critical thinker evaluates different perspectives”; 2. “a critical thinker is systematically engaged in the thinking process”) and two statements that would indicate imprecise or erroneous understanding (3. “a critical thinker compromises to reach a decision”; 4. “a critical thinker collaborates and listens to others”) (p.327).

Analysis of the frequencies of statements showed that students in the three intervention groups more often stated that evaluating different perspectives defined a critical thinker than those in the control group, who more often identified compromising to reach a decision as characteristic of critical thinking (pp.328-329). In terms of categories 2 and 4, students in the general and infusion groups mostly saw critical thinking as a systematic thinking process while some students in the immersion and many in the control group identified collaboration and listening to others as a critical thinking skill – which the researchers noted was justified since the view of critical thinking as a systematic thinking process was made explicit only in the lectures that were viewed by the general and infusion groups, and the skills were not explicitly stated in the immersion group’s session.

Student reflections one month after the interventions showed that students in the infusion and immersion groups were more satisfied with their performance and students in the general approach felt they needed more help to critically examine the ill-defined problem, while students in the control group stated that they had been under the impression that the aim of the intervention was for them to collaborate, rather than specifically to apply critical thinking skills.

In their discussion Angeli and Valanides (2009, pp.331-333) suggested that students could become “lost and frustrated” in environments where guidance was inadequate, and that lectures without additional discussion or scaffolding were less effective at developing critical thinking than discussions without lectures. The study showed that the approaches applied in the learning environments in which students participated impacted their development as critical thinkers, and that in this study students best performed as critical thinkers and gained a more accurate understanding of critical thinking when they received both some deliberate instruction on critical thinking skills and engaged in debate about the purpose and application of critical thinking.

2.5.4 Summary

Section 2.5 of the literature review has been focused on existing research in the field of critical thinking skills development in higher education.

It showed that standardised testing is considered to be a practical measurement approach that was often used for large-scale evaluation of the effectiveness of studies in developing critical thinking skills (section 2.5.2). Studies using standardised tests showed that attending institutions with high average scores on such tests increased the scores of new students by the end of the first year but did not bring about significantly greater development of critical thinking (as reflected in test scores) by the end of the third year of studies when compared with institutions with lower average critical thinking scores (Hagedorn, Pascarella, Edison et al, 1999). Another study showed that student scores in standardised critical thinking skills tests were not necessarily aligned with academic achievement in their studies, and that students with low critical thinking scores who adopted effective learning strategies such as note-taking, and who spent significant amounts of time on their studies, could outperform students with similarly low scores who did not adopt effective strategies (Williams & Stockdale 2003). Integrated approaches were shown to be more effective in developing critical thinking skills than stand-alone critical thinking skills instruction (Hatcher, 2006).

Courses that involved significant amounts of writing together with peer input (collaboration) and feedback on performance were shown to be more effective than standard lectures (information-transmission models) in developing critical thinking skills (Tsui, 2002). Interventions that engaged students in collaborative reasoning (even of limited duration) also showed greater improvement in critical thinking abilities than approaches where learners engaged with tasks on their own (Kuhn et al, 1997). An immersion approach where students worked in self-managed teams showed that critical thinking skills could be developed within a guided-discovery context without deliberate critical thinking skills instruction (Hanson & Wolfskill, 2000). Critical thinking skills development was also shown to be more effective in environments where students have a clear conception of critical thinking and understand the purpose of engaging in the critical thinking process (Angeli & Valanides, 2009).

Some studies therefore measured critical thinking skills development as an outcome of participating in higher education, and typically used standardised tests to measure critical thinking ability. Others provided descriptions of specific interventions intended to develop critical thinking skills and understanding of the critical thinking process. The process workshop model described by Hanson and Wolfskill (2000) was the only study that provided information on specific instructional approaches applied as part of the learning and teaching process (and not as an intervention for research purposes).

2.6 Chapter summary

The review of the literature has focused on the conceptualisation (section 2.2), operationalisation or implementation (section 2.3) and evaluation or assessment of critical thinking skills and critical thinking skills development (sections 2.4 and 2.5). Given the extensive scope of the field, and given that critical thinking skills development has been a topic of inquiry in many disciplines within higher education, a selective approach was followed in identifying literature for review, based on relevance to the current study.

Section 2.2 reviewed different **conceptualisations** of critical thinking and showed that there is no single definition of critical thinking that meets the needs in all fields of higher education, and that the complex nature of critical thinking requires more than a singular definition of the concept. Over the course of the past several decades, there has been some tension among theorists and researchers in areas where critical thinking has traditionally occupied a central role, such as philosophy and psychology (Brookfield, 1990). It has nevertheless been shown that critical thinking has been at the core of educational endeavours for a century or more (Dewey, 1910), and that subsequent definitions emanating from specific disciplines may have shifted the focus, reformulated conceptions and made explicit the related concepts such as the self-regulatory aspects of critical thinking, but that the conceptualisation of the process of critical thinking remains in essence unchanged (Garrison, 1991).

The challenge has been to define critical thinking in such a way that it can guide and support critical thinking skills instruction. The consensus statement provided in the Delphi Report (APA, 1990) has shown that a comprehensive and inclusive conceptualisation that is relevant to higher education can be formulated with input from experts in different discipline areas. The Delphi Report provides not only a consensus statement on the nature of critical thinking, but also detailed explanations of how the subskills engaged in each category of critical thinking would be demonstrated in practice. This framework is utilised in the analysis of the case study in the current research (Chapter 4).

One aspect of critical thinking that has emerged in recent times is that it is not a purely individual or internal process, but is best conceptualised from a collaborative constructivist perspective as comprising both an internal process of individual meaning making and an external interactive process of shared cognition (Resnick, 1991) confirming understanding and taking into account multiple perspectives (Garrison & Anderson, 2003; Olivares, 2005).

Section 2.3 focused on the **implementation** of critical thinking skills instruction and considered first the central role of critical thinking in higher education as reflected in the literature. The

literature highlighted the competing demands between teaching content and developing critical thinking skills within the context of higher education, and the resultant contrast between information transmission approaches that remain prevalent in many disciplines and approaches that endeavour to develop the capacity for lifelong learning.

Section 2.3.3 explored different views on where in the curriculum critical thinking skills instruction should take place. As stand-alone units of study in the general approach, critical thinking is deliberately taught as a set of cognitive strategies in a discrete fashion, which raises questions about the extent to which thinking skills can be viewed as generic and whether students will be able to apply the skills acquired in discrete units within their discipline studies (Peck, 1981; APA, 1990; Halpern, 2001; Hatcher, 2006). The literature similarly questioned whether approaches that integrate critical thinking skills into specific subject areas would facilitate transferability to areas outside of the classroom (Perkins & Salomon, 1989; Shoenfeld, 1999; Halpern, 2001) (considered in section 2.3.4), and raised concern over the competing demands from the subject matter that such courses are required to cover. A specific concern that was identified in the use of integrated (or embedded/ infusion) approaches is the need to adopt pedagogical approaches that employ authentic learning contexts (Prawat, 1991, Livingston et al, 2004; and others). A third approach emerged from the literature, namely the immersion approach (Angeli & Valanides, 2009). While the immersion approach avoided many of the constraints identified in the general and infusion approaches, it raised questions about the ability of learners to generalise the skills they have acquired in order to facilitate transfer to other domains (Ennis, 1992).

The question of transfer appears to be argued in the abstract in most instances, and positions in this debate depended on the epistemological assumptions of theorists. A clear alignment was nevertheless identified between the conceptualisation of critical thinking skills in the Delphi Report (APA, 1990) and the immersion approach (Angeli & Valanides, 2009).

Section 2.3.4 reviewed pedagogical approaches to critical thinking skills instruction, and in addition to commonly accepted good practice elements such as authentic learning and relevant tasks sustained over a period of time (Halpern, 1998), the literature highlighted a number of elements that are required in order to ensure that learners develop as critical thinkers both inside and outside the classroom, including: careful attention to the dispositional aspects of critical thinking, the need for self-regulation and metacognitive awareness (Halpern, 1998, Butler, 1998; Moseley et al, 2004), and opportunities for collaborative learning (Hanson & Wolfskill, 2000; Livingston et al, 2004).

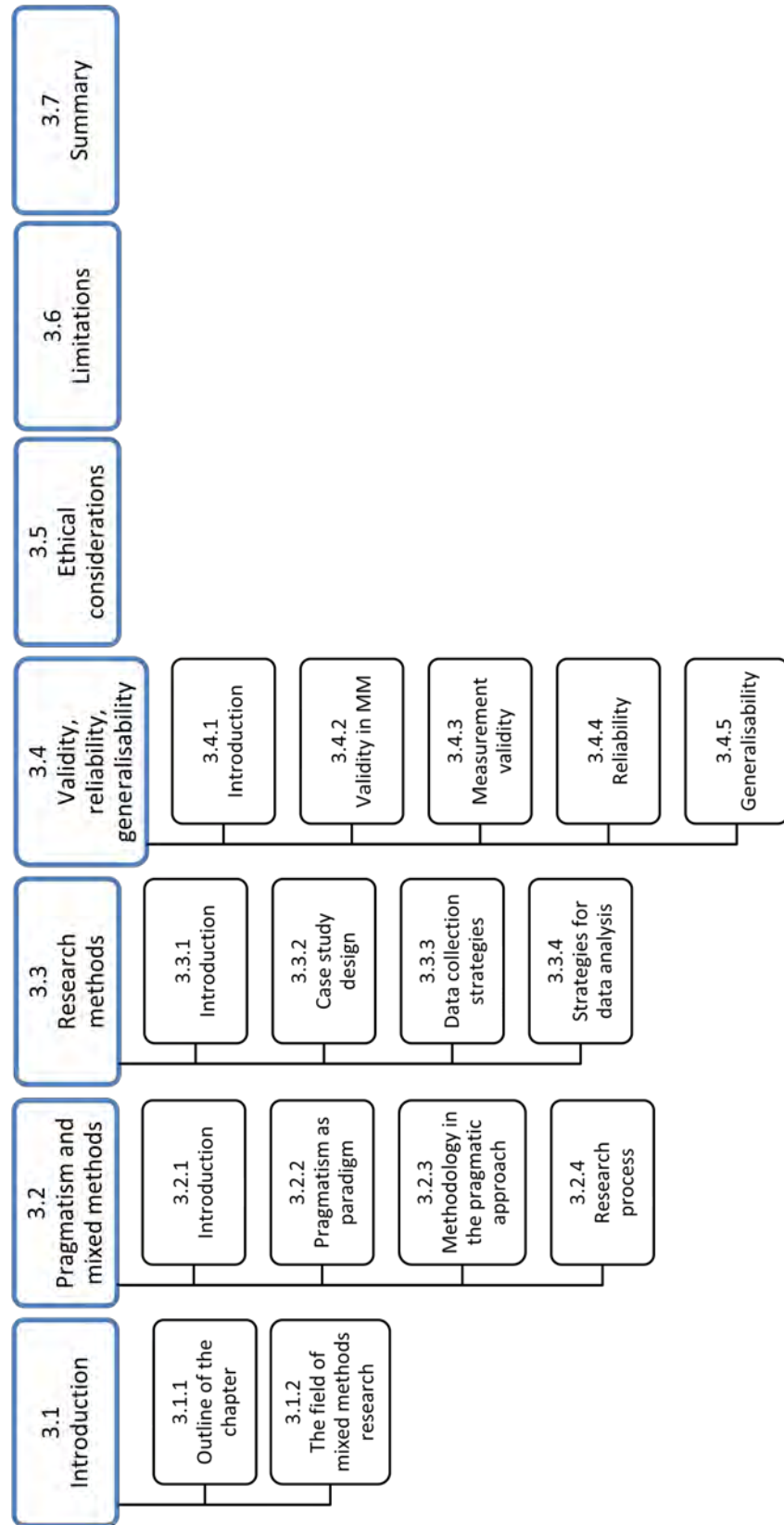
Section 2.4 identified different approaches to critical thinking skills **assessment** in the literature. It showed that standardised tests are used most frequently in large-scale testing for a variety of purposes, including general evaluations of the impact of higher education studies on the development of critical thinking skills (Ennis, 1999; APA, 1990). Other forms of more formative assessment are receiving increasing attention in the literature, although internal thinking processes and metacognitive awareness remain difficult to assess. A clear picture emerged that assessment of critical thinking skills needs to be clearly aligned with the targeted outcomes presented to learners and should reflect the authentic contexts in which such skills will be applied (Halpern, 2001; Livingston et al, 2004), a goal that is encompassed by the need for ecologically valid indicators. Assessment should therefore be appropriate to the pedagogical approach employed in instruction and should form part of the learning process itself.

Whereas section 2.4 provided a broad overview of the literature on critical thinking skills assessment, the review of the literature on **other studies in section 2.5** explored the effectiveness of different approaches to instruction and assessment in greater detail. Studies that evaluated critical thinking skills development at institutional level (the effects of institutional average critical thinking ability in Hagedorn et al, 1999, and the learner strategies that correlate with increased scores in Williams & Stockdale, 2003) used standardised tests in their evaluations, highlighting that such testing is often selected because it is practical to administer. Studies that compared different approaches to critical thinking skills instruction used either standardised tests (stand-alone and integrated approaches in Hatcher, 2006) or multiple indicators (general, infusion and immersion approaches in Angeli & Valanides, 2009). While the process workshop model of Hanson and Wolfskill (2000) was the only study that provided a relatively detailed description of the program, it used a variety of data to measure the effectiveness of the program without directly measuring critical thinking skills development. Studies that included direct measures of critical thinking were conducted as specific interventions rather than sustained programs of instruction (opinion scales and content analysis in Kuhn et al, 1997, and a variety of indicators in Angeli & Valanides, 2009). One study used a comparative case study method (Tsui, 2002), but was confined to utilising institutional data and scores in the IGCT (institutional growth in critical thinking) and did not directly measure critical thinking skills development among participants.

Key differences between the studies reviewed and the current research include the duration of the interventions and the research methods employed. The current research is an explanatory case study that utilises instrumental analysis to measure the extent to which critical thinking skills development is infused into an employability skills program and examines four projects

covering a full year of study. The case study will clearly identify the elements of instruction that can be expected to enhance critical thinking. The current research moreover measures critical thinking skills at individual and group level, and will compare the results of standardised measurement with the ecologically valid indicators identified within the program projects.

Chapter 3: Methodology



3.1 Introduction

Qualitative, quantitative, and mixed research are three current webs of assumptions, beliefs, and practices that are dynamic and flexible across persons and groups that coalesce because they help researchers understand their worlds (Johnson, 2008, p.206).

3.1.1 Outline of the chapter

Chapter 3 presents the research methodology, which follows a pragmatic approach. The research design is an explanatory case study and the study has used a mixed methods research strategy.

Section 3.2 presents the justification for mixed methods research. In order to justify the methodological approach in this study and make explicit its philosophical and epistemological underpinnings, this chapter begins by considering the emergence of pragmatism as alternative paradigm which reconciles the traditional divide between quantitative and qualitative approaches, and their associated epistemological stances, within mixed methods research (section 3.2.2).

Section 3.2.3 presents the methodological approach of this study within the pragmatic paradigm. It links methodological considerations to the epistemological assumptions (section 3.2.3.1) and presents the research process model in terms of the main considerations that have influenced the mixed methods research design (section 3.2.3.2). Section 3.2.4 applies the dimensions of the research process model to the research process in this study.

Section 3.3 sets out the research methods. It includes the rationale for the selection of the explanatory case study design (section 3.3.2) and sets out the data collection strategies (3.3.3) and strategies for data analysis (3.3.4), including the units of analysis and the approaches applied to qualitative and quantitative data analyses.

Section 3.4 comments on considerations of validity, reliability and generalisability from the mixed methods perspective (3.4.2) and addresses measurement validity (3.4.3), reliability (3.4.4) and generalisability (3.4.5).

Section 3.5 outlines the ethical considerations that pertain to this study, and section 3.6 discusses the limitations of the study.

3.1.2 The field of mixed methods research

This study follows a mixed methods research approach and is situated within the pragmatic paradigm. As it does not sit within the traditional positivist paradigm generally associated with quantitative research on the one hand or the purely interpretive/constructivist paradigm associated with qualitative research on the other, the justification for adopting a mixed methods research approach needs to consider the relevance of pragmatism as a third paradigm and the emergence of mixed methods research as a distinct, integrated approach.

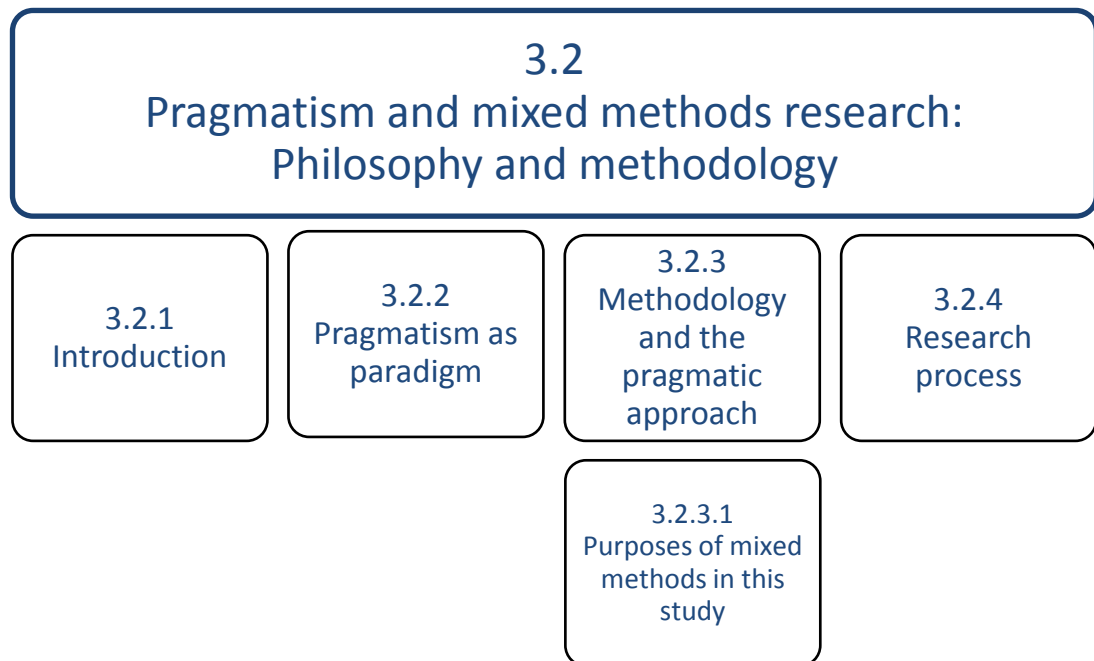
The paradigm within which a researcher operates is important – whether it is defined as a worldview which colours the research or as the shared beliefs of a community of researchers, the paradigm adopted by the researcher can determine the questions selected for investigation, the methodology applied and the methods used in gathering and interpreting the evidence. When viewing quantitative and qualitative research as incommensurable paradigms, “borrowing” methods from an “opposing” paradigm to augment methods within a dominant paradigm (dominant from the researcher’s perspective) can, to some extent, be seen as reflecting a disconnect between the methods and the epistemological and methodological assumptions of the researcher.

In practice, however, researchers have commonly combined qualitative and quantitative methods without questioning the epistemological assumptions dominant in their approach. Employing a quantitative method of data analysis to substantiate or validate findings in an essentially qualitative study, for example, would not be considered as a practice that either demands or signifies a shift in the researcher’s worldview or epistemological stance. Without a clear philosophical foundation for the use of mixed methods, however, the epistemological assumptions that inform and influence the research would be ignored.

Just as the *scientific method* of inquiry within the positivist paradigm was deemed not to meet the needs of research in the social sciences and gave rise to *naturalistic* forms of inquiry, the *pragmatic* approach to research reconciles the needs of researchers by focusing on the research questions, legitimating the use of mixed methods without ignoring the role of the values of the researcher in interpreting results (Tashakkori & Teddlie, 2003, p.713).

In order to justify the methodology adopted in this study, it is necessary to examine the current debate on mixed methods research, the purposes of mixed methods research, and whether this methodology is appropriate for this study, both in terms of epistemological assumptions and method.

3.2 Pragmatism and mixed methods research: Philosophy and methodology



3.2.1 Introduction

The view of mixed methods research as a new research paradigm has emerged in recent years as an alternative stance in the field of social science research. In justifying the approach adopted in this study, it is therefore necessary to start by considering the different uses of the paradigm concept and the need for an alternative paradigm. Section 3.2.2 presents an overview of developments that warrant the claim of a paradigm *shift* and of pragmatism and mixed methods research as a new *paradigm*. It seeks to justify pragmatism as a third paradigm, considering first whether it offers an approach to research that reaches beyond the use of quantitative and qualitative methods in combination. It clarifies the use of the paradigm concept within mixed methods research, and examines the epistemological assumptions that underlie mixed methods research. Section 3.2.3 addresses the methodological considerations within the pragmatic approach, outlining the methodological issues that are the focus of the current mixed methods debate, and justifying its applicability to this study.

In the research literature, especially in the social sciences, the term “paradigm” is variously used to refer to philosophical or metaphysical views on the nature of reality, truth and knowledge. (The term “methodology” is then used in the narrow sense to refer to the

methods or techniques employed within a study, often without explicitly linking the methodology to epistemological considerations.)

In a review of more than 40 research texts to identify treatments of concepts such as paradigm, methodology and method, Mackenzie and Knipe (2006) concluded that “many writers fail to adequately define research terminology and sometimes use terminology in a way that is not compatible in its intent, omitting significant concepts” and that in spite of the pivotal role of a paradigm in the choice of methodology, many texts do not explore the paradigm within which the research is conducted or the role that it plays, perpetuating the dichotomy between qualitative and quantitative research methodologies (p.202) by focusing on method as substitute for paradigm (Mackenzie & Knipe, 2006, p.194).

3.2.2 Pragmatism as paradigm

This section first addresses the concept of paradigm and then sets out the nature of pragmatism as philosophical foundation for this study.

To clarify the paradigm concept as conceived of in this study, it is necessary to distinguish the typical uses of the term in the literature. Not all methodologists draw the same distinctions among different applications of the concept. It is sometimes used to refer to the broader worldview of the researcher that answers the ontological question as to the nature of reality and at other times as referring to the relationship between the researcher and the knowledge to be gained, therefore answering the epistemological question as to the nature of knowledge and how it is constructed (Guba & Lincoln, 1994; Mertens, 1998; Morgan, 2007). At lesser levels of generality, the paradigm concept is also used to refer to the process whereby knowledge can be gained, thus answering more methodological questions (Mertens, 1998, pp.3-4). Paradigm is also used to refer to the shared beliefs among a community of researchers, and more concretely in the notion of “paradigmatic examples” that provide exemplars of typical research within such a community (Morgan, 2007, p.50). In educational context, paradigm is often used to refer to the theoretical basis of research or the research approach that is common to a community of researchers without reference to the philosophical assumptions that distinguish different views of reality.

Depicted as a nested concept, paradigm can encompass worldviews and epistemological stances, and can influence methodological approaches as well as the methods adopted in answering research questions. All four such versions in essence view paradigms as “shared belief systems that influence the kinds of knowledge researchers seek and how they interpret the evidence they collect” (Morgan, 2007, p.50). Different uses of the term “paradigm” are

therefore not mutually exclusive, but apply different levels of generality to the relevant belief system and research approach.

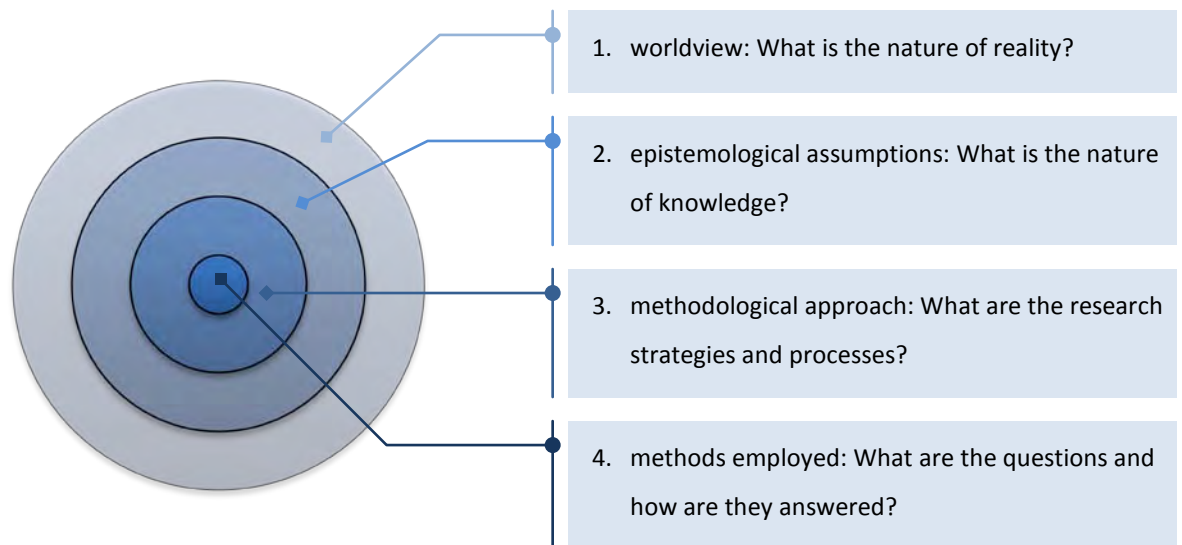


Figure 3.1: Components of the paradigm concept

In the context of the current study which adopts a mixed methods approach, each of these versions has significance:

(1) As *worldviews*, as perspectives on and ways of thinking about the world and reality, the paradigm within which the researcher works recognises the role of personal experience in making meaning of the world. This version of paradigm is sometimes perceived as lacking the specificity to be useful when debating mixed methods research (Morgan, 2007, p.52), but when it is interpreted as a response to the nature of reality, it not only influences the topics the researcher chooses to study or how research is conducted, but reflects the nature of the reality that the researcher anticipates to know.

Pragmatism as a worldview overcomes the perceived incompatibility of quantitative and qualitative research (Morgan, 2007). In the 1980s, the incompatibility thesis advocated for a new constructivist paradigm and prompted the shift from the dominant paradigm of “normal science” based on scientific inquiry to the establishment of naturalistic forms of inquiry. At the time, perceived purists such as Lincoln and Guba (1985) insisted that “the attributes of a paradigm form a ‘synergistic set’ that cannot be meaningfully segmented ... [and that] different paradigms typically embody incompatible assumptions about the nature of the world and what is important to know...” (Greene, Caracelli & Graham, 1989). Paradigmatic assumptions were seen as being paramount in guiding decisions at all levels of the research process, insisting that any research must be consistent in all phases, including the research methods employed.

Not everyone agreed with the purist stance of incompatibility. While not necessarily seeing the two prevailing paradigmatic approaches as fully compatible, methodologists increasingly viewed it as a matter of degree, and adopted different stances (Greene, 2008, p.12) ranging from incompatibility/incommensurability at the one extreme, to the alternative (third) paradigm stance at the other end of the continuum (Morgan, 2007; Johnson & Onwuegbuzie, 2004; Teddlie & Tashakkori, 2009; and others). Pragmatism offers such a third paradigm.

Pragmatism is defined as

a deconstructive paradigm that debunks concepts such as 'truth' and 'reality' and focuses instead on 'what works' as the truth regarding the research questions under investigation. Pragmatism rejects the either/or choices associated with the paradigm wars, advocates for the use of mixed methods in research, and acknowledges that the values of the researcher play a large role in interpretation of results (Tashakkori & Teddlie, 2003, p.713)

As researcher my worldview is aligned with pragmatism in that it differs from the relativistic claim of *multiple realities* that characterises the constructivist ontology in naturalistic or purely qualitative studies. Constructivists believe that such multiple realities are locally co-constructed (Guba & Lincoln, 200, p.195) and exist only as constructs of the human intellect (Teddlie & Tashakkori, 2009, p.92). In contrast, the nature of reality in this study is conceived of as consisting of *multiple perspectives on an external reality*, and of reality as being intersubjective (Johnson & Onwuegbuzie, 2004, p.16), so that the truth about reality cannot be determined absolutely.

In the philosophy of knowledge, metaphysical aspects of ontology are frequently regarded as separate from epistemological and methodological issues. The pragmatic approach recognises that worldviews influence research, and also recognises the relevance of epistemology, but opposes the supremacy of ontological assumptions. In contrast to the naturalistic or metaphysical paradigm's concern with the nature of reality and the impossibility of objective truth, the pragmatic approach takes a broad view of metaphysics more aligned with that of Dewey, with its focus on "the experiences of actions in the world, rather than the existence of either a world outside those experiences or experiences outside such a world" (Morgan, 2007, p.67).

(2) The second version of the paradigm concept corresponds with that of Lincoln and Guba (1985), Mertens (2003), and others, and takes a view of approaches to research that go

beyond matters of method (either quantitative or qualitative techniques) to underlying philosophical assumptions and beliefs about the nature of research and knowledge.

The *epistemological stance* of the researcher, which is the prevailing use of the term “paradigm”, is aligned with the researcher’s ontological views, but is more focused on the epistemology and methodology (as established elements in the philosophy of education) that guide a particular research field. In this context the paradigm presents a broad approach to “knowing” and has a major impact when it comes to combining methods. From a pragmatist perspective, my epistemological stance in this study recognises the existence of multiple forms and valid kinds of knowledge (Johnson, 2008, p.204) and views the process of knowledge generation as intersubjective. (Intersubjectivity is addressed in more detail in section 3.2.3.)

Over a decade ago, Morgan (1998) identified two difficulties in combining quantitative and qualitative methods: the technical difficulties, and difficulties stemming from paradigmatic conflicts in view of differences in “assumptions about both the nature of knowledge and the appropriate means of generating knowledge” – therefore epistemological assumptions (Morgan, 1998, p.363). Morgan distinguished between “choosing methods” and “operating within paradigms”, cautioning that paradigms were important and yet recognising the role of practical considerations and the practicality of approaches. It is interesting to note that pragmatism as consideration in research approaches appeared long before pragmatism was proposed as an “alternative paradigm”. Pragmatism as paradigm, in line with the nested conceptualisation, also guides practical decisions in the research process.

The pragmatic approach places the focus on the area of methodology as the link between abstract epistemological issues and the mechanical issues of technical-analytical methods. Epistemological and technical concerns are regarded as equally important.

- (3) The view of paradigm as *methodology* denotes the shared beliefs within a specific field, typically within a research community made up of practitioners/researchers within a single specialty area (as opposed to a discipline as a whole). In this context the paradigm determines the nature of the questions and how members who share this belief seek to answer such questions. This use of paradigm is encountered frequently in published research, because it enables reconciliation of alternative methods, without necessarily questioning where the approach fits within the broader philosophical orientation. As alternative paradigm, pragmatism recognises that practical decisions in research are guided as much by ontological, epistemological and methodological assumptions as by the context

and theory of an inquiry. Section 3.2.3 focuses on the methodological approach adopted in this study.

(4) While technical matters of method do not fall within the philosophical notion of paradigm, they are subject to the methodological considerations of the research, and pragmatism recognises the technical concerns of researchers. Research designs, as *exemplars of best/typical research*, can exemplify the approach to central issues in a field, which is useful as it is concrete and explicit, but limited in its wider applicability. The use of “paradigmatic examples” of mixed methods research in specific fields is likely to grow as more studies deliberately adopt this approach. This study provides one such example of the use of mixed methods within a pragmatic paradigm.

Researchers should attend to both the connection between epistemology and methodology, and the connection between methodology and methods. Thus methodology becomes the link between epistemology and research design (Morgan, 2007, p.68).

3.2.3 Methodology within the pragmatic approach

This section approaches methodology in three phases. The first is to consider methodology as an overarching approach that makes explicit the epistemological assumptions in this study (section 3.2.3.1). It then considers the research process in terms of the dimensions that influence mixed methods design (section 3.2.3.2) and presents the *research process model* (Table 3.2).

Section 3.2.4 addresses the research process applied in this study. Guidelines for mixed methods research (Creswell, 2009; Johnson & Onwuegbuzie, 2004; Teddlie & Tashakkori, 2009) provide the broader process considerations and research strategies identified in the process *model* presented in Table 3.2. The research strategies adopted in this study are presented in the research process in Figure 3.2 which shows how the different dimensions of mixed methods are operationalised in this study.

(Section 3.3 that follows presents the case study design employed in this research.)

Methodology can be seen as the link between epistemological assumptions and the more technical matters of method. A pragmatic approach provides an alternative to the dichotomous distinctions – between inductive and deductive, subjectivity and objectivity, context and generality – that characterise qualitative and quantitative approaches, respectively.

A number of key distinctions highlight the advantages that the pragmatic approach offers in terms of methodology (Morgan, 2007, p.71). Research conducted within a qualitative methodology follows an inductive-subjective-contextual approach, and research within a quantitative methodology is characterised by a deductive-objective-generalising approach. Rather than seeing these as “absolute, defining characteristics”, the strength of the pragmatic approach lies in “its emphasis on [methodology as] the connection between epistemological concerns about the nature of the knowledge that we produce and technical concerns about the methods that we use to generate that knowledge”, so that an integrated approach can enhance the practical value of combining different methods (Morgan, 2007, p.73).

Table 3.1 summarises the key distinctions between qualitative and quantitative approaches, and the pragmatic approach.

Table 3.1: A pragmatic alternative to the key issues in social science research methodology

Key distinctions	Qualitative approach	Quantitative approach	Pragmatic approach
Connection of theory and data	Induction	Deduction	Abduction
Relationship to research process	Subjectivity	Objectivity	Intersubjectivity
Inference from data	Context	Generality	Transferability

Source: Morgan, 2007, p.71

The characteristics of the pragmatic approach can therefore be defined in terms of the connection between theory and data, the researcher’s relationship with the research process, and the nature of inferences drawn from findings.

(1) Abduction: Connection of theory and data

In contrast to the customary separation of induction and deduction as being exclusive to either a qualitative or quantitative approach, respectively, the pragmatic approach recognises that in reality research is not purely inductive or deductive, and the connection of theory with data and of data with theory is not one-directional. In practice the design, collection, and analysis of data are not exclusively theory-driven or exclusively data-driven processes.

The pragmatic approach relies on *abductive reasoning*, moving “back and forth between induction and deduction – first converting observations into theories and then assessing those theories through action” (Morgan, 2007, p.71). (Morgan notes that his “version” of abduction differs from the conventional use of theories to account for observations, which is more akin to inductive inferences.)

The abductive process is frequently used where researchers combine qualitative and quantitative methods sequentially, using the inductive results of a qualitative component as input for the deductive process in the quantitative component.

In this study, the qualitative component of the case study is explanatory and the case analysis will be instrumental, therefore based on theoretical assumptions or propositions, in an essentially deductive process, but the case analysis will also generate propositions inductively, to be tested in the quantitative component. Hence the deductive process of the quantitative component is intended to determine whether the development of critical thinking skills in the employability skills program as tested support the theoretical propositions generated in the case analysis. As explanatory case study using an explanation building strategy, the qualitative component is in itself abductive. In interpreting results, the researcher will seek to apply the findings inductively to add clarity and build on the theoretical base of the framework used in analysing the case study. This study therefore follows an abductive process, applying a conceptual framework in analysing the case and using evidence to build explanations and generate propositions to be tested in the quantitative analysis of test results, and building on existing theory. The findings of both qualitative and quantitative components are then integrated in reaching conclusions.

(2) Intersubjectivity: Relationship to the research process

The pragmatic approach similarly sees the separation of subjectivity and objectivity as a “forced dichotomy” and “an artificial summary of the relationship between the researcher and the research process” (Morgan, 2007, p.71), since the reality is that complete objectivity and complete subjectivity are equally unattainable. It recognises that “research is not helped by making it appear value free” (Stake, 1995, p.95). The pragmatic approach recognises that the relationship between researcher and research is characterised by intersubjectivity, and that intersubjectivity is an integral part of social life and therefore characterises research in practice.

The intersubjective nature of research can be set out in seven points (Johnson & Onwuegbuzie, 2004, p.16):

1. The “light of reason” is subject to relativity (different people would have different judgements of what appears reasonable).
2. Facts and perceptions are coloured by theory (“theory-laden perception of facts”) – our existing knowledge, experiences and theories influence what we see and how we perceive it.

3. Evidence (a set of empirical data) may determine more than one theory (“underdetermination of theory by evidence”).
4. It is not possible to fully test an hypothesis in isolation – each test depends on a number of assumptions, the hypothesis itself is situated within a “holistic network of beliefs”, and alternative explanations will always exist (“Duhem-Quine thesis or idea of auxiliary assumptions”).
5. Any evidence we obtain in empirical research is probabilistic – it is not possible to obtain “final proof” (“the problem of induction” – “the future may not resemble the past”).
6. Research is a social process (the researcher is part of a community and can be influenced by and can influence attitudes, values and beliefs).
7. All inquiry is value laden (“values affect what we choose to investigate, what we see [notice/observe] and how we interpret what we see” [the meaning we make of what we see] (p.16).

Smeyers (2008) supports this view within the context of education research: “Clearly, it is generally accepted that one is part of an intersubjective reality that may be characterised in various ways (what is considered to be a fact, what we value, how we situate ourselves as human beings)” (p.698).

The intersubjective nature of knowledge is most pertinent in the current research. In my role as curriculum developer, I have had a close involvement in the program under investigation, and this undoubtedly influenced me in selecting the program as object of investigation. Although the conceptual framework used in analysing the case was selected after the program was implemented, my existing knowledge of collaborative constructivist learning theory prompted many of my research decisions. Being mindful of the intersubjective nature of knowledge, my research seeks to avoid a purely subjective interpretation by using conceptual frameworks and documentation in an instrumental analysis rather than relying on observations and self-reports. The role of the researcher is also addressed in section 3.2.4, and the data used in the study are described in more detail in section 3.3.3.

(3) Transferability: Inference from data

The third duality between qualitative and quantitative approaches that the pragmatic approach addresses concerns the view inherent in essentially qualitative approaches that knowledge is specific and context-dependent, and the contrary view from the quantitative

perspective that knowledge is necessarily based on universal principles and relies on generalisability.

The pragmatic approach does not demand a choice between the extremes of specificity and universality. Morgan (2007) writes: “ I do not believe it is possible for research results to be either so unique that they have no implications whatsoever for other actors in other settings or so generalized that they apply in every possible historical and cultural setting” (p.72). What is important in the pragmatic approach is to identify whether the knowledge gained from results obtained by one method in one context can be appropriately used in other settings. Rather than assume that, because of the method/s we use, our results are confined to a specific context or should necessarily be generalisable to all other contexts, it is more important to identify those factors that will impact the transferability of new insights or knowledge to other contexts.

The design of the current study reflects the use of mixed methods to establish transferability. The qualitative case study makes no claim to generalisability as defined in the scientific paradigm, but limits claims of transferability to analytic generalisation. It presents an approach to explanatory case analysis that is transferable to other contexts, and an approach to critical thinking skills instruction that may be applicable in other situations.

The next section outlines the purposes for which mixed methods are employed in the current study.

3.2.3.1 The purposes of mixed methods in this study

Johnson and Onwuegbuzie (2004, p.16) point out that from a pragmatic perspective, it is often necessary for research to adopt a certain “value stance”, but that “research is more than simply one researcher’s highly idiosyncratic opinions written into a report”. So far from sanctioning “whatever works” for the individual researcher, the pragmatic approach requires that the use of mixed methods serve some clear purpose.

The use of mixed methods in this study serves a number of purposes.

- (1) It provides the means for triangulation to corroborate findings and uncover contradictions.

Early uses of mixed methods were largely for validation purposes through “multiple operationalism” (a term first used by Campbell and Fiske in 1959, although the process was first advocated by Boring in 1953) to validate constructs, the reasoning being that a new construct with a single operational definition remained a mere construct, and that it would require additional alternative operational definitions in order to be validated. Using multiple

measures was therefore a measurement and construct validation technique rather than a comprehensive research methodology. The notion of multiple operationalisation was expanded by Webb, Campbell, Schwartz and Sechrest in 1966 who argued for a triangulation of measurement processes (now referred to as between- or across-method triangulation) to look for convergence of findings to validate results (Johnson, Onwuegbuzie & Turner, 2007, pp.113-114).

Triangulation in mixed methods research generally looks for convergence and corroboration of results in studying the same phenomenon, but importantly it seeks to blend the research methodology at any or several stages in the research process, either simultaneously or sequentially. As part of the research process, triangulation can allow greater confidence in results, and can create opportunities for richer, thicker data, and it can support integration or testing of competing theories and uncover contradictions (Jick 1979, in Johnson et al, 2007, p.115).

When working with purely quantitative data, triangulation is often confined to corroboration of results. Using mixed methods in the current study does serve a triangulation purpose, but not purely to corroborate results. Its purpose is also one of complementarity (Johnson & Onwuegbuzie, 2004). In assessing student performance in a standardised test, the researcher seeks not merely to confirm or disconfirm the conclusions reached in the qualitative analysis, but also to evaluate the use of test results as indicator of critical thinking skills development, and therefore to uncover contradictions if they exist.

- (2) It serves a complementary purpose by allowing for a qualitative component in the case study that builds an explanation as to the infusion of critical thinking skills within a program that does not provide direct critical thinking skills instruction, and a quantitative component in which the propositions generated within the qualitative approach can be tested.

In the current study, the mixed methods approach is therefore used primarily for purposes of complementarity. The qualitative component of the case study examines the infusion of critical thinking skills within the matrix of skills in the program in order to generate further propositions to be tested in the results of the quantitative component. The qualitative component provides greater understanding of the context in which learning took place, specifically in terms of the conceptual framework of the model of inquiry that supports the development of critical thinking skills.

(3) It allows the researcher to answer the research questions.

The fundamental principle of mixed methods research is to select methods based on the research question/s – the methods adopted should follow the question/s and should serve a specific purpose within the study. “A tenet of mixed methods research is that researchers should mindfully create designs that effectively answer their research questions” (Johnson & Onwuegbuzie, 2004, p.20) – the research question/s therefore determine whether a mixed methods strategy is appropriate, and the purpose for which such a strategy is employed will determine the research design.

The use of a mixed methods design in this study is dictated by the nature of the research questions, which demand answers that can be provided only by two different methods:

- *How does the immersion approach followed in the program provide opportunities for developing critical thinking skills; and*
- *How effectively does participation in an employability skills program develop students’ critical thinking skills as measured in a standardised test?*

In addition to serving a variety of purposes, mixed methods research is not confined to one particular research strategy. The next section first considers some of the research processes and research design typologies (process models) in mixed methods research, and then outlines the rationale for the mixed methods strategy in the current study.

3.2.4 The mixed methods research process

Strategies for research using mixed methods have been variously referred to as multi-method, integrated or combined designs (Creswell, 2009, p.14). As a number of recent authors have used different **terminology** in presenting typologies for mixed method design, this is worth clarifying very briefly.

Johnson and Onwuegbuzie (2004) propose a mixed methods typology that defines a mixed-*method* design as including a quantitative phase (or phases) and a qualitative phase (or phases) which can take place either sequentially or concurrently. These phases are conducted separately and data collection, analysis and interpretation remain completely separate. They distinguish this from a mixed *model* design where quantitative and qualitative approaches are mixed within or across the three stages in the research process – therefore as part of the process of stating the research objective, in the data collection stage, and when analysing or interpreting the data. Teddlie and Tashakkori (2009) use the term “quasi-mixed methods study” for instances where a mix of methods is used in a single study, but without integration at any stage of the research process, while using *mixed methods design* to indicate an

approach where integration takes place at some stage of the study. Greene (2008) similarly uses the term *mixed methods design*, and this has become fairly well established in the literature on mixed methodology.

Mixed methods research seeks to legitimate using more than one approach to answer research questions. It offers researchers a choice of methods. Johnson and Onwuegbuzie (2004) see this as “an expansive and creative form of research” and advocate an “eclectic approach to method selection ...” (p. 17). There is furthermore general agreement that “methodology follows from inquiry purpose and questions” (Greene, 2008, p.13), which is aligned with the pragmatic approach, and that “research methods should follow research questions in a way that offers the best chance to obtain useful answers” (Johnson & Onwuegbuzie, 2004, p.18).

The literature contains a number of different **typologies** of mixed methods designs and different stages in the research design process that need to address method integration or connection, as well as the dimensions in which different designs would emerge. Creswell (2009, p.206) proposes four dimensions or aspects that will influence a mixed methods design: timing, weighting, mixing and theorising. Greene (2008, p.14) proposes three primary dimensions: independence/interaction, status (parity/dominance) and timing, as well as four secondary dimensions: transformative intent, study (within or between studies), strands/phases, and methods characteristics (the extent to which mixing methods offsets differences in bias, perspective, stance). Johnson and Onwuegbuzie (2004, p.19-20) also mention paradigm emphasis as well as time ordering of phases and degree of mixture, stage of mixing (in stating the research objective, methods of data collection, research methods, data analysis and/or data interpretation). It is generally accepted that the proposed typologies are not exhaustive.

The difficulty of “matching” the design of this study with any of the existing typologies lies in the nature of typologies in general, which depict typical designs in broad categories. Classifying the study as either concurrent or sequential, for example, would not take into account that at some stages of the research process, data may be collected and processes applied concurrently and at other stages sequentially. Similarly, the purpose of mixing methods in some stages may be complementary and at others it may serve a triangulation purpose.

A number of considerations moreover impact the research process in terms of design and strategies in data analysis, including the following (Teddlie & Tashakkori, 2009, pp.264-266):

- (1) the purpose of mixed methods in the study: The main purpose of using mixed methods in this study is complementarity, in that the quantitative component “yields

complementary results regarding the same phenomenon” (p.265). As such, the study has adopted a parallel mixed design and analysis strategy.

- (2) orientation of the study (variable-oriented or case-oriented): The study is strongly case-oriented, as it examines the infusion of critical thinking skills within the context of the employability skills development program. As a case-oriented study, and since the variables used in the quantitative component are predetermined by the use of a standardised instrument, analyses will not attempt to identify additional variables within the quantitative component.
- (3) exploratory or confirmatory purpose: The quantitative component in this study serves a confirmatory purpose. Qualitative and quantitative strands (data and analyses) contribute to building an explanation in the case study. Data are retained in either qualitative or quantitative format during analysis, and integration takes place during interpretation of results.
- (4) parallel or sequential strategies: Data collection takes place concurrently and in parallel. Data analysis is conducted in parallel. Although the quantitative analysis follows the qualitative analyses, it is not dependent on the results or findings of the qualitative analyses. The study therefore employs a parallel mixed data analysis strategy.

Table 3.2 below summarises the key aspects of the design of this study within the research process model. The mixed methods design here takes into account four aspects of the strategy employed in the study: timing, weighting, mixing and theorising (Creswell, 2009, p.206), and the table below identifies these four aspects in the context of the current study. Relative weighting is indicated by the use of capital letters (QUAL/QUAN) where a component is more heavily weighted (QUAL indicating the qualitative component and QUAN indicating the quantitative component), and lower case (qual/quan) where a component carries a lesser weighting.

Table 3.2: Research process model

Stage	Timing	Weighting	Mixing	Theorising
strategy	concurrent	QUAL-QUAN	complementarity/embedded explanation building (QUAL) testing (QUAN)	abductive instrumental use of existing theory (conceptual framework)
data collection	concurrent/parallel	QUAL-QUAN	textual (documentary) and numeric data are collected within the same timeframe	(deductive) → generating propositions from analysis
sampling	parallel	QUAL-QUAN	purposive (QUAL) and convenience (QUAN)	(inductive) → testing propositions
analysis	parallel	QUAL-QUAN	instrumental analysis (QUAL) descriptive and inferential (effect sizes) (QUAN)	(deductive) → interpretation and explanation (abductive)
interpretation	parallel/sequential	QUAL-quant (based on the lesser explanatory potential of quan in the case study)	embedded, iterative	
legitimation	iterative	QUAL-quant	complementary	analytic generalisation
conclusions	concurrent	QUAL-quant	Integrated	plausible explanations; probabilistic

The study therefore follows a combined concurrent/parallel data collection strategy and parallel sampling approach, parallel data analysis and sequential interpretation strategies. Legitimation is approached as iterative, as the use of the quantitative results can corroborate the results in the qualitative explanatory component of the case study (or alternatively identify contradictions). Results are interpreted in parallel first, then integrated in drawing conclusions about the infusion of critical thinking skills into the program of study and the performance of students in a standardised critical thinking skills test.

Figure 3.2 outlines the mixed methods research process in this study.

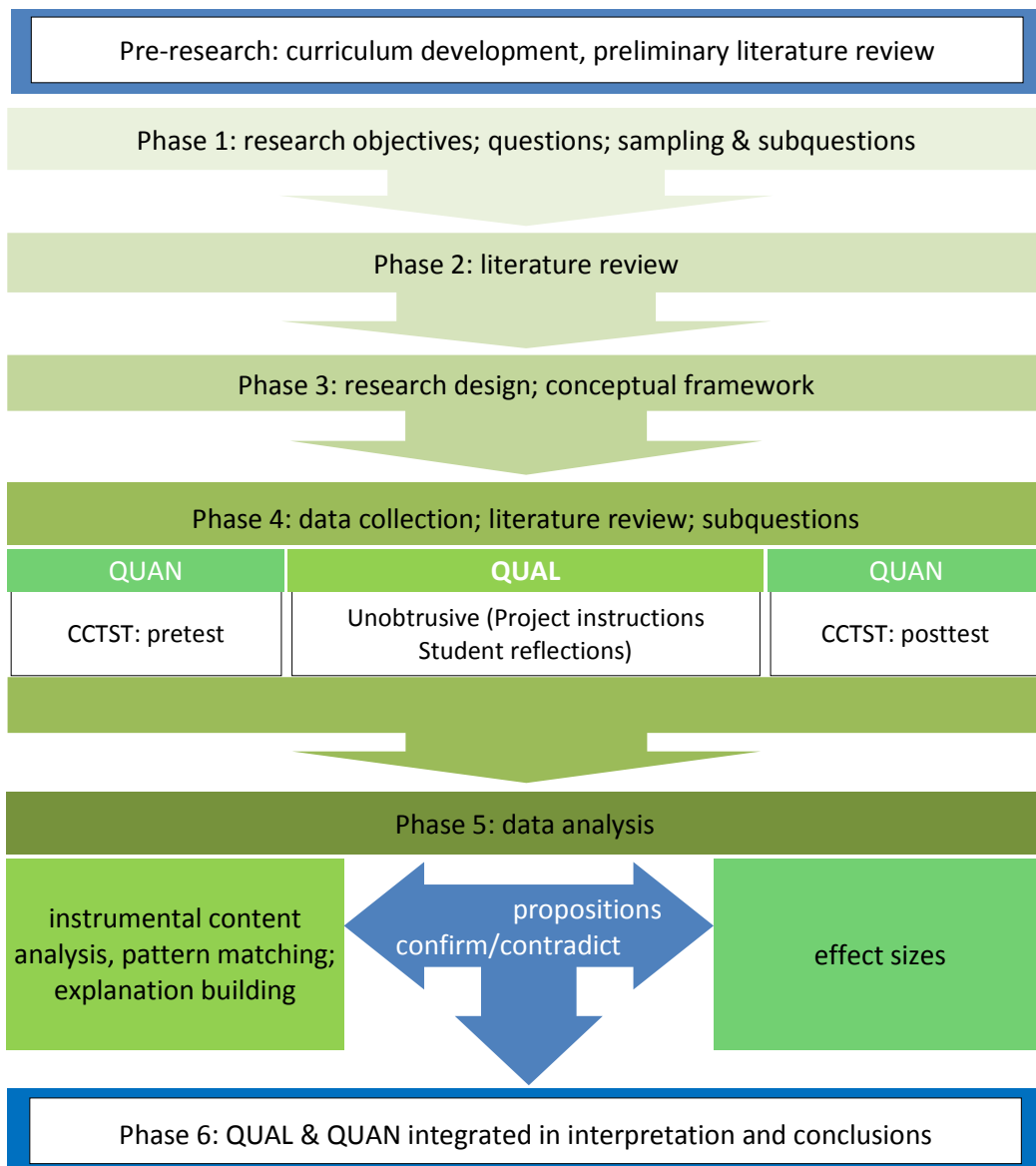


Figure 3.2: Research process: Mixed methods

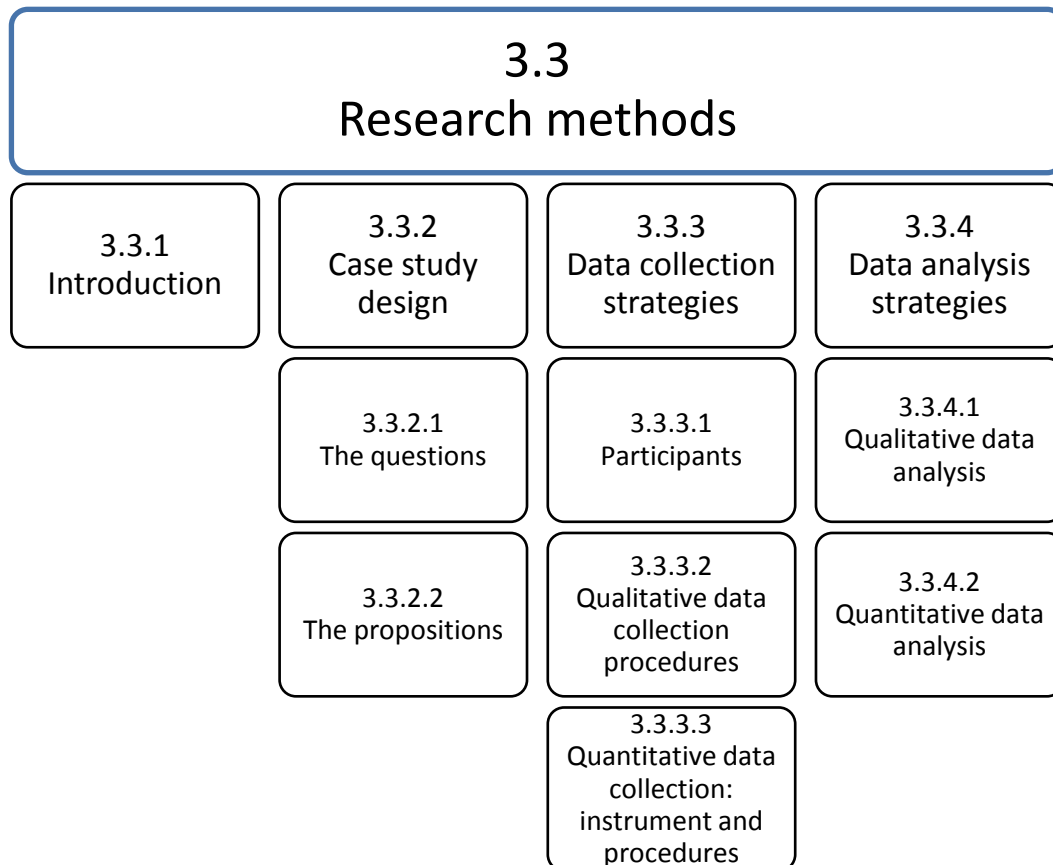
The **pre-research phase** acknowledges *the role of the researcher* in the development of the curriculum for the program under investigation. The researcher also taught online classes in the first year of the program (units 1 and 2). This involvement has provided the necessary insight into the nature of the program and access to data. Familiarity with the program allowed the researcher to apply a degree of educational connoisseurship (Gall, Gall & Borg, 2005, pp.463-464). Although the approach in this study is not strictly one of educational connoisseurship and criticism as a specific approach to educational evaluation (Eisner, 1994), the researcher’s role in the development of the program and experience of teaching in the program have allowed the researcher to be “sensitive to both the strengths and weaknesses of the program” (Gall et al, 2005, p.464). The researcher has been able to rely on her experience

in the program when selecting data sources that are representative of the learning process in the program. Expert knowledge of the approach followed in the program has moreover added significant value in the process of content analysing the documentary evidence.

The researcher's active involvement in the development and teaching of the program also makes the study vulnerable to pitfalls of bias and subjectivity. Several strategies have been employed to minimise threats to validity in the study: adopting a mixed methods approach to allow for triangulation (among other purposes, set out in section 3.2.3.1), the use of unobtrusive measures in data collection to avoid demand characteristics (section 3.3.3.2), relying on theoretical propositions and clear conceptual frameworks identified in the preliminary literature review to guide case analysis and examining rival explanations in drawing conclusions (section 3.3.4.1). Threats to validity are also discussed in more detail in section 3.4.2.

The elements of the case study design (phase 3), including approaches to data collection and analysis, are discussed in the methods section (3.3) that follows.

3.3 Research methods



3.3.1 Introduction

The research design is an explanatory case study. Case study designs are not prescribed to the same extent as experimental and quasi-experimental designs, and in qualitative research, case studies are often used as method to provide thick descriptions of phenomena in order to recreate situations and contexts to aid understanding, or to explain phenomena by looking for themes and patterns to build theory (Gall et al, 2005, pp.306-307). Although case studies have been used largely in the qualitative/interpretive tradition, and are often wrongly equated to ethnographical studies with their associated methods of fieldwork or participant observation, case studies can go “beyond being a type of qualitative research” and “need not always include the direct and detailed observational evidence marked by other forms of ‘qualitative research’” (Yin, 2009, pp.17 & 19). Case studies may also be used in evaluation studies, but a case study is not necessarily an evaluation study. In this study, the intent is not to evaluate the merit or worth of the employability skills development program (ESDP), but to examine the development of critical thinking within the context of the program. The researcher nevertheless makes interpretations that are “evaluative in nature” by using specific sets of

criteria in interpreting the extent to which critical thinking skills development takes place (Stake, 1995, p.96).

Case study research is used to study a particular instance or instances of a phenomenon in its natural context in depth. Phenomena of interest may include individuals, events, activities, programs or processes, focusing on a specific aspect or aspects of the phenomenon (Gall et al, 2005, p.308; Creswell, 2009, p.13)). Yin (2009) provides a two-part definition for a case study as

an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident (2009, p.18).

In other words, the contextual conditions are important in the attempt to understand the phenomenon of interest. The case study approach is therefore appropriate here, because the objective of the research is to investigate a contemporary phenomenon, the critical thinking skills development process, in its natural context – the employability skills development program (ESDP).

The second part of Yin's definition addresses the technical characteristics of case study inquiries, and highlights the fact that the context of the case will offer many more variables than those being investigated or about which data are collected, and that the case study researcher uses more than one source of evidence so that data need "to converge in a triangulating fashion". The final characteristic in Yin's definition is particularly pertinent because it strengthens the legitimacy of the instrumental approach to analysing the qualitative data in this study, namely that case study inquiry "benefits from the prior development of theoretical propositions to guide data collection and analysis" (Yin, 2009, p.18).

Case studies are a comprehensive research method, and as such are not confined to specific types of data or to particular techniques for data collection and approaches to data analysis (Yin, 2009, p.18). Case study designs should therefore cover five important components (Yin, 2009, p.27): (1) the research questions, which both justify and impact the research design in line with the pragmatic approach; (2) the propositions that guide the study and (3) the units of analysis, which are addressed in detail in section 3.3.2; (4) the logic that links the data to the stated propositions and (5) the criteria for interpreting the findings, which are set out in sections 3.3.4 and 3.3.5, respectively.

The design of the case study has been influenced by the guidelines that Halpern (2001) proposed for assessing critical thinking skills development:

- (1) the need to identify outcome variables – based on an operational definition of critical thinking, tied to the goals of the program

The case study design accommodates this requirement by investigating the extent to which the tasks that students undertake in the program of instruction are aligned with the tasks identified as building or representing critical thinking in the Delphi Report (APA, 1990).

- (2) the need to identify classroom strategies that engender critical thinking

The second qualitative component investigates the extent to which participants engage in a process of critical thinking (Garrison, 1991) within the assigned projects.

- (3) the need to apply measures that can detect subtle changes in student critical thinking skills ability

There are many ways to gather evidence of the effectiveness of critical thinking skills instruction, including student self-reports, gains in standardised intelligence tests, Piagetian measures of cognitive development (Fox, Marsh & Crandall, 1983), expert-like mental representations (Glaser, 1992), and measures of spontaneous transfer (Lehman & Nisbett, 1990), as well as testing by applying standardised instruments (Halpern , 2001, p.280). The case study method includes the administration of the California Critical Thinking Skills Test (CCTST) in a pre-posttest design to measure gains in student test performance.

In summary, there is no catalogue of research designs for case studies and no “common” research designs have emerged – case study research designs have therefore not been codified (Yin, 2009, p.25). The design for the case study in this research is set out in the next section. The structure of the case study has been determined by the research questions and the data to be analysed. The format for reporting the case study as such is driven by the need to logically link the data to the propositions in interpreting the findings, and is set out in section 3.3.2.4. Sections 3.3.4 and 3.3.5 look more closely at the data collection and analysis strategies in the research design.

3.3.2 Case study design

The design of the research is a mixed methods explanatory case study that makes use of both qualitative and quantitative data. The case study seeks to explain how critical thinking skills were infused into the program of instruction that provided the context for the case. The study uses a single case, a real-life phenomenon, that represents an immersion approach to critical thinking skills instruction, which meets the requirement that cases cannot be abstractions (Yin, 2009, p.32).

The context for the study is a three-year program consisting of four units of study intended to develop employability skills in an undergraduate degree in the business discipline. In defining a case, it is necessary to delineate the “spatial, temporal and other concrete boundaries” of the case (Yin, 2009, p.32). In this study the scope of the case study is bounded by the first year of study, comprising two units in the program. The design further incorporates a number of embedded units of analysis (Figure 3.3).

3.3.2.1 The questions

The overarching question for the research is twofold:

RQ1 How does the immersion approach followed in the program provide opportunities for developing critical thinking skills; and

RQ2 How effectively does participation in an employability skills program develop students’ critical thinking skills as measured in a standardised test?

The program is intended to develop employability skills, and does not target critical thinking skills development explicitly or directly. The case intends to provide insight into how critical thinking skills may be infused into the tasks that students undertake during the projects in the first year of the program. The case study is therefore explanatory and will be presented in three parts. Part 1 will explain the context of the case study. Part 2 seeks to answer the specific subquestions. Part 2A will answer the subquestion:

RQ1A How is critical thinking skills development infused into learning activities during the first-year of the ESDP (employability skills development program)?

Answering this question will meet the requirement (1) to investigate the program in terms of tasks based on an operational definition of critical thinking.

The case study (Part 2B) will then examine how students engage in a process of critical thinking during the projects. The main analytical focus of the case study will be on the learning processes by evaluating each of four projects, as embedded units of analysis, on the basis of a model of critical inquiry (detailed in section 3.3.4), in order to answer the subquestion:

RQ1B How do students engage in a critical thinking process during the learning activities undertaken in the first year of the ESDP (employability skills development program)?

In answering this question, the case study will address requirement (2) above, by identifying classroom strategies and approaches to designing learning tasks that engender critical thinking skills development.

In Part 2C of the case study, evidence of effectiveness is sought by analysing student performance in a standardised critical thinking skills test (the California Critical Thinking Skills Test: CCTST) to determine the standardised mean difference between pre- and posttest scores (effect sizes), thus meeting the need (requirement 3) to apply measures that can detect subtle changes in student critical thinking skills ability, and answering the subquestions relating to the second research question in four contrasts:

- RQ2A Do testtakers perform better in the CCTST after participating in the first year of the program than at the start of the program?*
- RQ2B Do testtakers who have participated in the first year of the program perform better in the CCTST than students who entered the program in the second year?*
- RQ2C Do testtakers from an English-speaking background perform better in the CCTST than students from non-English-speaking backgrounds?*
- RQ2D Do students from an English-speaking background show greater improvement in CCTST performance after participating in the first year of the program than students from non-English-speaking backgrounds?*

The contrasts of interest are set out in detail in section 3.3.4.2.

3.3.2.2 The propositions

Developing some theory about the case before collecting any data differentiates case studies from other methods in qualitative research such as ethnography (Lincoln & Guba, 1985; Van Maanen, 1988) and grounded theory (Corbin & Strauss, 2008) that deliberately avoid any preconceived theoretical propositions (Yin, 2009, p.35).

The fundamental position that guides this research is that methods of instruction that engage students in authentic tasks and encourage them to think have the potential to enhance critical thinking. This is aligned with the immersion approach and contrasts with the general approach that holds that critical thinking should be taught deliberately and explicitly as well as the integrated (infusion) approach that requires critical thinking skills to be developed together with subject-specific knowledge. Questions surrounding the transferability of thinking skills tend to complicate this distinction, and can best be clarified by attending to the conceptualisation of critical thinking – either as a distinct set of cognitive strategies or as a process taught in tasks that encourage the development of a critical thinking disposition. The assumption in this study is that skills learned in context are transferable, provided they are

developed in a context that is not limited to subject-specific strategies. (Examining transferability is outside the scope of this study.)

Perhaps one of the greatest of all pedagogical fallacies is the notion that a person learns only the particular thing he[/she] is studying at the time (Dewey, 1938, p.48).

The case study will show how critical thinking skills are infused into the projects that students undertake during the first two units of study in the program, both conceptually by identifying the critical thinking skills components and subskills underlying the learning tasks, and operationally by examining the learning process in which students engage during the projects. The case study will also evaluate the development of critical thinking skills by analysing student test scores in a standardised critical thinking skills test.

The propositions are therefore that development of other skills in the program is dependent on the development of critical thinking skills – in other words, that achieving the learning outcomes targeted in the ESDP requires development of critical thinking skills, and that critical thinking skills can be developed through the learning tasks included in the projects that students complete in the program

If the learning tasks in the program are aligned with examples of tasks that develop critical thinking as defined in a comprehensive conceptualisation of critical thinking, and if the learning events in which students participate indicate that they engage in a process of critical inquiry, this will generate a new proposition, namely that critical thinking skills development will be evident in testing.

The theoretical propositions in the study naturally remain to be tested in analysing the case.

3.3.2.3 Unit of analysis

The unit of analysis (the case) is the first year of the employability skills program. The design includes several embedded units of analysis: four projects over two semesters, as well as the pretest and posttest scores achieved in the CCTST. Figure 3.3 depicts the unit of analysis (the case) within the context of the three-year program, and the embedded units of analysis within the first year.

The program includes one further unit of study in the second year and one in the third year. These are excluded from the unit of analysis. The four projects are deemed to be representative of the types of activities that students undertake in the program. Pre- and posttest scores are quantitative units of analysis that measure gains in critical thinking performance over the same period of time (the first year of study). The specific methods for analysing the test scores are set out in section 3.3.5.2.

Other studies have shown (Hagedorn et al, 1999; Hatcher, 2006) that the greatest improvement in critical thinking skills ability takes place in the first year of higher education, so selecting the first year as unit of analysis is not only a practical consideration but also presents the best opportunity for detecting improvements. A limitation of an investigation covering only one year are that other factors may impact new student performance (which may not be present in subsequent years as students become more settled in their studies), and such factors will be difficult to detect or measure.

Halpern (2001, p.275) proposes measuring gains in critical thinking beyond the semester (in which students complete the critical thinking skills instruction which is mandatory in many universities in the United States) to determine whether gains are maintained over time, and notes that “a quality assessment of critical thinking will examine the way critical-thinking skills are maintained over one’s lifetime” (p.275). While such a longitudinal study may be desirable, it is not feasible in the context of this research, and may be difficult to conduct under any circumstances.

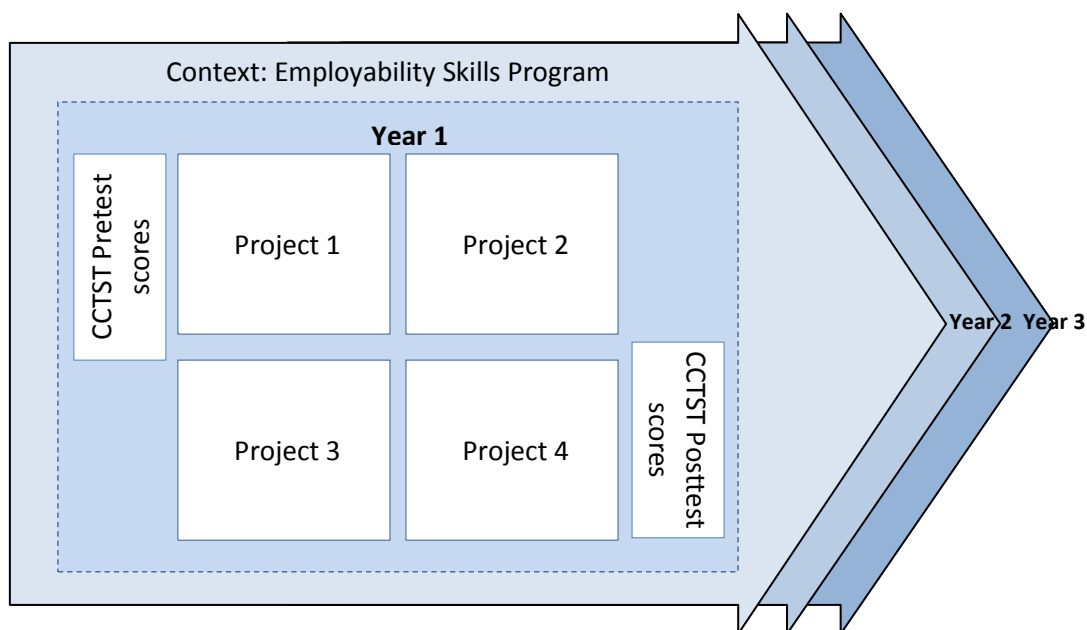


Figure 3.3 Units of analysis

The next section explains the data collection strategies for the study. Section 3.3.3.2 considers the qualitative procedures, followed by the quantitative procedures in section 3.3.3.3.

3.3.3 Data collection strategies

The study uses a between-strategies mixed method data collection approach (Teddlie & Tashakkori, 2009, p.218). The strategies for collecting qualitative data are unobtrusive, using

two different sources of documented data, and the quantitative component consists of test scores collected through a pretest-posttest strategy.

Data collected by unobtrusive measures are sometimes referred to as secondary data in the literature (Johnson & Turner, 2003). The use of unobtrusive measures was first advocated by Webb and colleagues in the sixties (Webb, Campbell, Schwartz & Sechrest, 1966) in response to what they saw as an over-reliance on data collection techniques such as interviews and questionnaires. Unobtrusive measures include the use of data from non-participant observations and documentary sources and allow the researcher to move beyond the confines of data elicited directly from research participants, which can be affected by respondents' perception of the expectations of the researcher as well as the characteristics of the researcher or interviewers themselves.

One criticism that may be levelled at the use of documentary data collected unobtrusively may be that it is opportunistic. Lee (2000) points out that "data obtained opportunistically should not be seen as inherently inferior to data designed for a particular purpose" (p.9). Using a number of different data collection strategies and data sources moreover allows the researcher to compensate for shortcomings that are inherent in any data collection process.

Both qualitative and quantitative data has been collected using two different strategies and four different data types, as set out in table 3.3 below:

Table 3.3: Mixed methods data collection strategies

data strategy	data type / source	data format
UNOB-QUAL	program documents: program overview	text
	program documents: project instructions	text
	unit products: participant reflections	text
TEST-QUAN	California Critical Thinking Test scores and demographic data	numeric

The unobtrusive nature of the strategies used in this study allow the researcher to avoid reactive and investigator effects (Teddlie & Tashakkori, 2009, p.239).

Qualitative (documentary) data in the study have been obtained from two sources:

- (1) program documents: project instruction sheets prepared by teaching staff and presented to students.
- (2) unit products: reflective journal entries written by students and presented to staff.

The use of program documents (archived data) ensures an accurate description of the instructions that students received and the tasks they were assigned. Documentary data

allows the researcher to conduct an instrumental content analysis using conceptual frameworks (analytical constructs) to identify where and how critical thinking skills development has been infused into the program (presenting the etic perspective) (Gall et al, 2005, pp.309-310; Krippendorff, 2004, pp.34-36).

Unit products in the form of student reflections provide participant input (the emic perspective) into the interpretation of the learning process within the program and has enabled the researcher to identify whether students engaged in the critical thinking cycle as set out in the conceptual framework of inquiry (described in approaches to data analysis, section 3.3.4). The student reflections serve a similar function to self-reports, but students write the reflections as part of their own learning processes, and not in response to a specific question relating to the critical thinking cycle (it is therefore a “nonreactive method” (Brewer & Hunter, 2006, p.60)), which makes it possible to avoid demand characteristics that can be weakness in self-reports. Although self-reports have been shown to be reasonably accurate in reflecting actual growth in critical thinking skills development (Tsui, 2002, p.756), data from self-reports can be vulnerable to the presence of demand characteristics, as shown in the study by Kuhn et al (1997, p.305) (discussed in section 2.5.3.2) who found self-reports (on opinion change) to be generally inconsistent with directly assessed changes from pretest to posttest.

Quantitative data have been collected in the form of student test scores in the California Critical Thinking Skills Test. The procedures for data collection are set out in sections 3.3.3.2 and 3.3.3.3 below.

3.3.3.1 Participants

The target population in the study comprised students in a three-year undergraduate business course enrolled in the Employability Skills Development Program as part of their studies.

Participation by way of completing the California Critical Thinking Skills Test (CCTST) was voluntary, and the study therefore made use of convenience samples. Student test scores from consenting participants collected at the start of 2007 and again at the beginning of the second year of studies in 2008 have been used in this study.

Demographic data on students which are collected as part of the CCTST will be used to assign test-takers to the groups necessitated by the research design and set out in the quantitative data analysis strategy (section 3.3.4.2).

3.3.3.2 Qualitative data collection procedures

In many case studies, particularly those that follow an inductive theory-building approach and that rely on data collected in the field through observation or interviews, procedures for data collection can be fraught with difficulty and procedural uncertainty (Yin, 2009, p.66). This study relies on documentary evidence, and therefore does not present the same uncertainty and demand for flexibility that are found in the collection of field data, but it nevertheless requires careful sampling strategies and places an increased demand on the researcher in ensuring construct validity and reliability, since unlike interviews and observations, the data are not generated for the purposes of the case study or purposively for answering the research questions.

The sampling strategy in relation to the qualitative data for this study concerns two tiers: the case as primary unit of analysis and the embedded units of analysis. Case selection was based on two considerations (Gall et al, 2005, p.311):

- representing a key characteristic: the case represents key characteristics of an immersion approach to instruction in that it is distinct from units of study in which the main purpose is to build subject-specific knowledge
- a conceptual rationale: the embedded units of analysis manifest an instructional approach in which students participate actively in collaborative learning tasks (therefore manifesting a specific theoretical construct that is deemed to develop critical thinking skills)

In addition to the above, the case and the embedded units of analysis have been selected on the basis of accessibility that makes it possible to select documentary evidence that can meet the needs of the research, rather than being restricted to documentation that is generally available. Access to a wide array of documentation ensured that data could be collected from more than one source and that data sources were varied and did not represent only one perspective on the learning events.

Documentary evidence was moreover selected for use in the study because it provides certain strengths in addition to being unobtrusive (especially compared with observations) in that the information could be reviewed on several occasions. Documentary evidence nevertheless needed to be viewed with circumspection, taking into account the specific purpose for which the documents were generated (Yin, 2009, p.105).

A wide range of documents were generated in program development and implementation, including project plans, staff training resources, curriculum frameworks, lesson plans,

information booklets for offshore partner institutions, unit plans and student handouts. The documents to be used in the case study have been selected to meet the purpose of the investigation and to address the research questions.

Sampling of documents has therefore been based on relevance to the research questions. The program overview provides information on the overall goals of the program that provide the broader context for the case. Documents containing project instructions were selected because they provide the most direct evidence of what students were required to do in pursuit of the learning outcomes. Documents containing instructions for developing technical proficiency and targeting other learning outcomes were excluded as not being directly relevant to the research questions. Project instructions for all four projects undertaken in the first two units of study (the first year) in the program have been included in the study and selection has therefore been fully inclusive (the texts are not representing a population of texts but constitute the population of texts, bounded by the parameters and context of the case) (Krippendorff, 2004, p.118-120).

Table 3.4 sets out the documents that have been selected and the means of collection:

Table 3.4: Documentary data collection

Document	Description	Source
Program overview	The document sets out the principles adopted in the employability skills development program. The data provide the context of the case and make explicit the goals of the program. The information is descriptive.	Program director
Project instructions	These documents set out the learning outcomes targeted in each of the projects and the tasks that students are instructed to complete. They provide the data to be analysed to explain how critical thinking skills were infused into the program and to examine the learning process in terms of the critical thinking process.	Learning Management System. This ensures authenticity in that the online system contains the documents that are presented to students.
Student reflections	Evidence is collected from an online journal where students made weekly entries to reflect on their learning experience. Reflections were guided by prompting questions that did not necessarily target the same information as the case study. It was therefore necessary to collect journal entries over the course of semester for analysis.	Online journal.

Considerations relating to validity and reliability in data collection are addressed in section 3.5.

3.3.3.3 Quantitative data collection: instrument and procedures

Performance data in the case study are collected by way of a standardised critical thinking skills test. Standardised critical thinking skills tests are widely used in higher education, especially in the United States but also in Australia (mainly in research) to measure the development of critical thinking skills (NPEC, 2000; Williams & Stockdale, 2003; Hagedorn, Pascarella, Edison, et al, 1999). While there are some concerns over whether indirect assessment using multiple-choice measures can adequately represent the construct of critical thinking (addressed in more detail in section 3.4.3), such tests often have high reliability estimates, provide ease of scoring, and are seen as a relatively objective measure that has been subjected to extensive development processes (NPEC, 2000).

Students in the employability skills development program (ESDP) completed the California Critical Thinking Skills Test, Form 2000 (CCTST) for purposes of this study. The test simultaneously served as one of several self-assessments incorporated into the program to increase self-awareness as learners. The pretest has therefore not only provided data for this study, but also served to familiarise students with this form of testing, since employment agencies are increasingly using some form of psychometric testing in the recruitment process. The format of the CCTST is also similar to the multiple choice component of the Graduate Skills Assessment (GSA) and the Business Select Assessment provided by the Australian Council for Educational Research, so it helps build proficiency in undertaking such tests. The same instrument has been used as posttest after completion of the first year of the program to test for gains in critical thinking skills.

The California Critical Thinking Skills Test

The CCTST Form 2000 has been selected to evaluate student performance in critical thinking for a number of reasons: it is practical to administer as student can take the test online, it does not assume an existing knowledge base in a specific subject area and questions assume only general knowledge – it is “discipline-neutral” (Facione, Facione, Blohm & Giancarlo, 2002, p.15), and it is aligned with the conceptualisation of critical thinking in the expert consensus statement of the Delphi Report (APA, 1990) that has been used as working definition in this study and to analyse the tasks that students undertook in the first year of the ESDP.

The Delphi project identified six cognitive skills as central to the construct of critical thinking: interpretation, analysis, evaluation, explanation and inference, as well as self-regulation. The last-mentioned skill is often referred to as metacognition and includes self-examination and self-correction as subskills. The CCTST covers the first five cognitive skills.

The CCTST is a multiple choice test consisting of 34 items selected from a bank of 200 previously piloted items. Item selection took into account clarity, level of difficulty and discrimination. The test was administered to 480 pretest subjects and 465 posttest subjects before final selection of the items. The test was subjected to experimental validation and content validity testing. Items 1-5 in the test target interpretation, items 6-9 focus on analysis, items 10-13 cover evaluation, 14-24 inference, and 25-34 target explanation.

Form 2000 contains questions that have been adapted from Forms A and B to include statements that reflect the kinds of information that students are more likely to encounter in current contexts, including graphic presentations of data in some questions. Questions range from items that require students to analyse a sentence in order to establish its meaning, to identifying the correct inference from a number of assumptions or to evaluate an inference or objections to stated inferences. The questions are written in standard English and do not contain technical or CT-specific terminology.

Results in the test provide subscores (or subscales) in analysis (which includes interpretation as a closely related construct, thereby combining a subscore for items 1-9), evaluation (which includes the related skill of explanation, thereby combining a subscore for items 10-13 and 25-34) and inference (items 14-24). The subscores are not exact indicators of individual ability in specific critical thinking subskills and cannot be isolated as independent factors because they operate interdependently in the overall conceptualisation of critical thinking (APA, 1990).

Results offer two further subscores in which responses have been reclassified as deductive or inductive reasoning, which are the traditional distinctions in reasoning skills. Deduction subscores are derived from items 1, 2, 5, 6, 11-19, 22, 23 and 29. Induction subscores are derived from items 10, 11, 20, 21, 24-29, and 30-34.

Instrument validity is addressed in section 3.4.3.

Test administration procedure

The California Critical Thinking Skills Test was taken online through Insight Assessment in California. Access is restricted to subscribing institutions and all access is password protected. Students were invited to take the test at the start of their studies in the program (pretest), and again after completion of the first year (two units) of study (posttest).

Demographic data obtained for each test-taker indicate

- ethnicity, gender and age (standard in the test format)
- English-speaking or non-English-speaking background
- current enrolment in program (unit)

- completion of another university qualification
- number of years in fulltime employment
- number of units of study completed in current degree

Testtakers were self-selected (by invitation) and participation was voluntary – the quantitative component has therefore made use of convenience samples.

The test was incorporated into the unit curricula, but students were not obliged to take the test. Participation was voluntary and signed consent forms were obtained from all testtakers. Students were invited to complete the test online in class under test conditions. Students were allowed 45 minutes to complete the test.

Students were handed an information letter advising them that test results would be used for research purposes, and were asked to give written/signed consent. Respondents were identifiable in order to match pre- and posttest pairs. All data were de-identified prior to analysis. As respondents were identified when taking the test, it would be possible to incorporate other data such as unit results in any follow-up studies.

The invitation to participate and the collection of consent forms took place in the third week of the first and third semesters of the program (allowing for a period of 12 months between pretest and posttest). The date and time of each test was recorded in order to ensure testtakers were placed in the appropriate group for purposes of analysis.

Copies of the participant information letter and consent form have been provided in Appendix3.1.

3.3.4 Data analysis strategies

Both qualitative and quantitative data are analysed in the case study. Strategies for analysing qualitative data are described in section 3.3.4.1 and strategies for analysing quantitative data are detailed in section 3.3.4.2.

In order to answer the research questions, the data analysis strategies are aligned with the need to explain

(1) how critical thinking skills are infused into the learning tasks in the ESDP (employability skills development program)

To explain the infusion of critical thinking skills development in a program that addresses critical thinking as one component within a matrix of employability skills and which does not contain direct instruction in critical thinking, textual data consisting of project instructions are

content analysed using the operational definition of critical thinking presented in the Delphi Report (APA, 1990). This component of the analysis is referred to as the **task analysis**.

Data have been further analysed to explain

- (2) *the process whereby critical thinking skills are developed as part of the learning activities that students undertake in the ESDP (employability skills development program)*

To examine how students in the program engage in a process of critical thinking, the activities undertaken in the projects as well as student reflections are analysed in terms of the model of inquiry proposed by Garrison (1991). This component of the analysis is referred to as the **process analysis**.

A third purpose of data analysis is to examine

- (3) *the effectiveness of the immersion approach as reflected in student gains in a standardised critical thinking skills test after the first year of study*

Student scores on the CCTST are analysed to determine gains over the first year of study. This analysis involves multiple comparisons, both within groups and between groups in a pretest-posttest design, and reports the effect sizes of gains in scores. Details of quantitative analyses are set out in section 3.3.4.2. This component of analysis is referred to as the **performance analysis**.

Three “instruments” are therefore used in analysing the data:

- (1) The task analysis uses a framework derived from the critical thinking categories, subskills and examples of activities in the Delphi Report (APA, 1990).
- (2) The process analysis is based on a conceptual framework derived from the model of critical inquiry proposed by Garrison (1991).
- (3) The California Critical Thinking skills test is used for the performance analysis.

3.3.4.1 Qualitative data analysis

The techniques applied in analysing the qualitative data in this study are content analysis and pattern-matching. Content analysis has been defined as “a research technique for making replicable and valid inferences from texts (or other meaningful matter) to the contexts of their use” (Krippendorff, 2004, p.18), and approaches to content analysis may be classified as either instrumental or representational (Popping, 1997, pp.214-216; Shapiro, 1997, pp.225-238). The approach followed here is largely instrumental in that it proceeds from the researcher’s perspective and employs a priori conceptual and theoretical frameworks (Shapiro, 1997,

p.228) and applies a pattern-matching technique. Content analysis does not rely exclusively on the manifest content of the texts, but takes into account latent meaning in the tasks described in the texts as representing certain cognitive processes that are relevant within the context of the projects (at conceptual level) and in which students engage in order to complete assigned tasks (at operational level). As such, textual content is seen as “symptomatic of the phenomenon of interest” (Popping, 2000, p.70).

Instrumental approaches to content analysis can be criticised for not taking into account the intended meanings of the authors of texts, or for relying exclusively on manifest content of texts, thereby ignoring the latent potential meanings of text. Such shortcomings are of specific concern when using computer software to analyse texts. The textual data in this study will be analysed manually. There is no attempt to quantify the results (code and count) in order to draw *statistical* inferences.

The aim of content analysis here is to identify

- (1) the extent to which the tasks that students undertake relate to a **conceptual** framework of critical thinking components and subskills; therefore the analysis aims to make explicit the coverage of critical thinking skills and subskills in the projects, and
- (2) the extent to which students engage in a process of critical thinking, thereby examining the extent to which critical thinking is **operationalised** within the projects.

Using instrumental content analysis in the qualitative component of the case study therefore differs from the inductive process usually associated with qualitative analysis techniques such as thematic analysis in grounded theory approaches. The aim of content analysis following an instrumental approach is to generate categories and elements that will allow for pattern-matching techniques to be applied in drawing inferences about the infusion of critical thinking skills by matching or relating theoretical patterns to observed patterns (Trochim, 2006, “The theory of pattern matching”). The process is abductive, in that it applies theoretical or conceptual propositions (using a priori themes) to the units of analysis in a relatively deductive fashion and then inductively generates a proposition to be tested deductively in the quantitative analysis.

Content analysis of qualitative data in the case study further employs two different strategies in explaining the infusion of critical thinking in the task analysis and student engagement in critical thinking in the process analysis (Teddlie & Tashakkori, 2009, p.253):

- (1) categorical strategies (deconstructing narrative data and then arranging such data into categories based on identified similarities), and

(2) contextualising strategies (focusing on complex interrelated elements in context).

The categorical data analysis strategy consists of deconstructing the learning outcomes and task instructions in each of four projects and arranging the data in accordance with the components and subskills of critical thinking provided in the Delphi Report (set out in figures 3.5 and 3.6). The purpose of this analysis is to examine how and to what extent the projects cover the elements of critical thinking. Results of the analysis will answer the proposition that critical thinking skills development has been infused into the projects.

A contextualising strategy is then followed in analysing the process of critical inquiry in which students engage during the project tasks by applying a conceptual framework or model of inquiry (Garrison, 1991) presented in figure 3.7. In this component of the case study, project instructions are deconstructed and fitted to the model, and student reflections are analysed and relevant reflections are selected to illustrate student engagement in the process of inquiry and to identify instances where students experienced obstacles in the process. The contextualising strategy therefore presents both the etic and emic perspectives.

Figure 3.7 provides a diagram of how the theory of pattern matching (Trochim, 2006) is applied through the data analysis strategies and procedures employed in the case analysis.

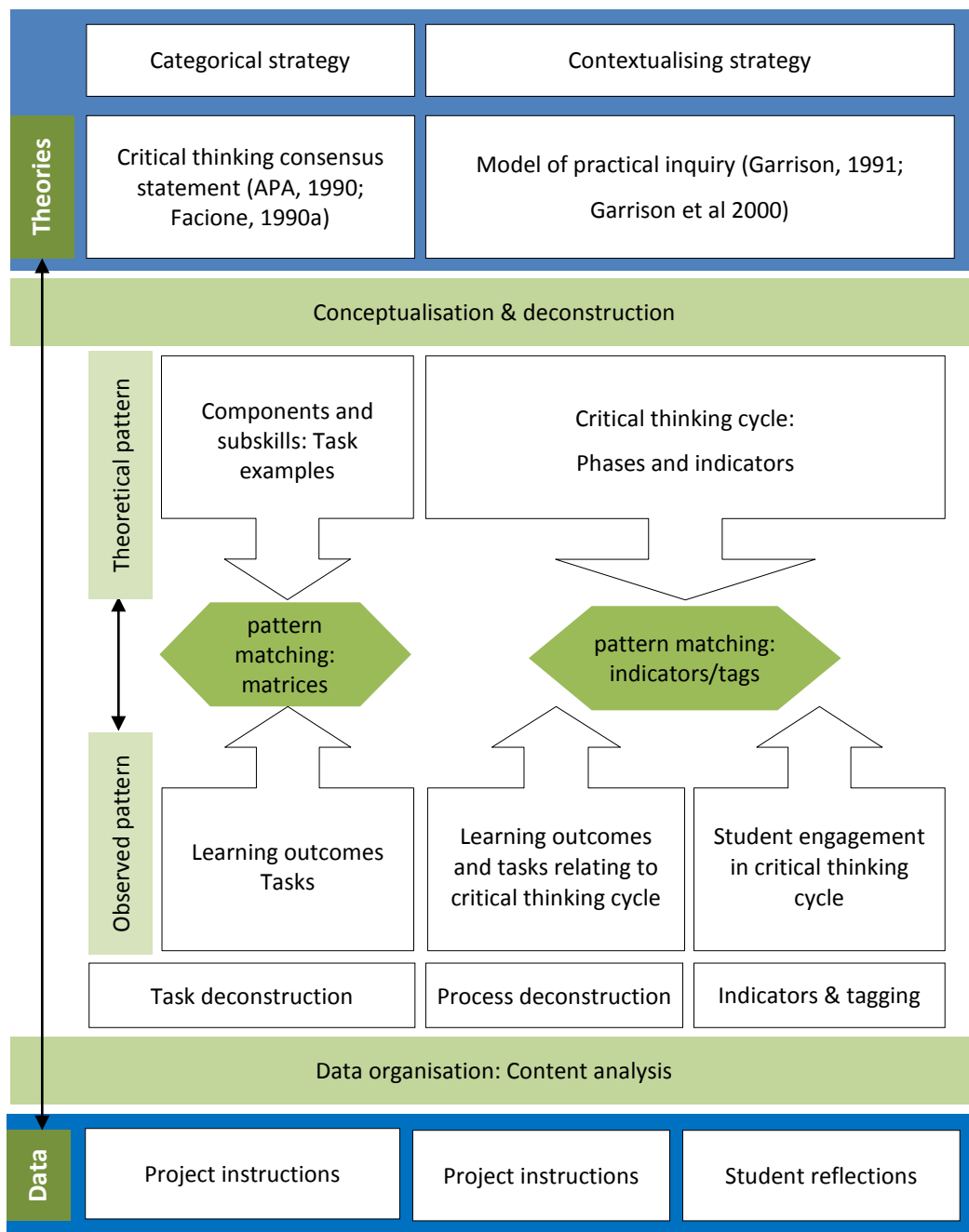


Figure 3.4: Qualitative analysis framework

Qualitative data analysis is typically viewed as three “concurrent flows of activity” (Miles & Huberman, 1994, p.10): data reduction, data displays, and conclusion drawing.

Data reduction takes place not only during the analysis phase of the study, but “anticipatory data reduction” occurs as the researcher decides which data or cases to collect and subsequently which data to include in the study. The strategy for data selection has been outlined in section 3.3.3.

Both the categorical and contextualising strategies (Teddlie & Tashakkori, 2009, p.253) form part of data reduction during analysis and are discussed in sections (a) and (b) below. Strategies for data displays and conclusion-drawing are discussed in section (c) that follows.

(a) Categorical strategies in analysing critical thinking skills: Infusion analysis

To examine the proposition that the targeted learning outcomes and project tasks in the ESDP are appropriate to advance the development of critical thinking skills, it is necessary to analyse the content of the project instructions and to deconstruct the texts, thereby applying data reduction in order to examine the extent to which individual tasks/actions are aligned with the examples of actions that develop critical thinking as set out in the Executive Summary of the Delphi Report (Facione, 1990a).

On the basis of the Delphi Report (APA, 1990) critical thinking can be deconstructed into six core skills and related subskills. Core skills components are not hierarchical, nor are they discrete. There is considerable overlap between different critical thinking subskills and some subskills rely upon the execution of other subskills.

Figure 3.5 sets out the core skills and subskills identified in the Delphi Report that will provide the framework for analysing the tasks targeted in the four projects. Each component core skill and its subskills are coded to facilitate analysis of the texts. A comprehensive framework that includes the examples of applying each subskill is provided in Appendix 4.1.

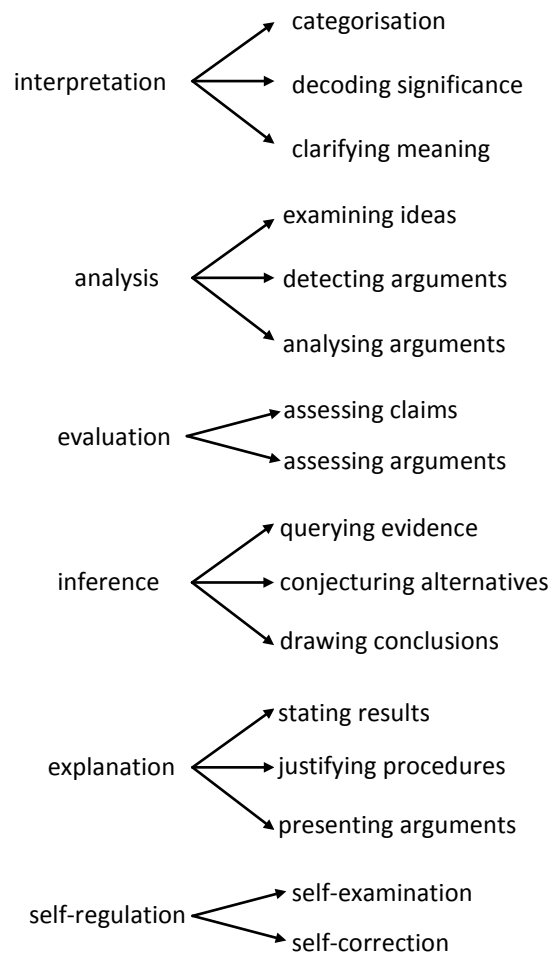


Figure 3.5: Critical thinking components and subskills

Figure 3.6 sets out the framework for deconstructing each project into its main tasks and activities. A comprehensive deconstruction of each project into its constituent tasks and activities is provided in Appendix 4.3.

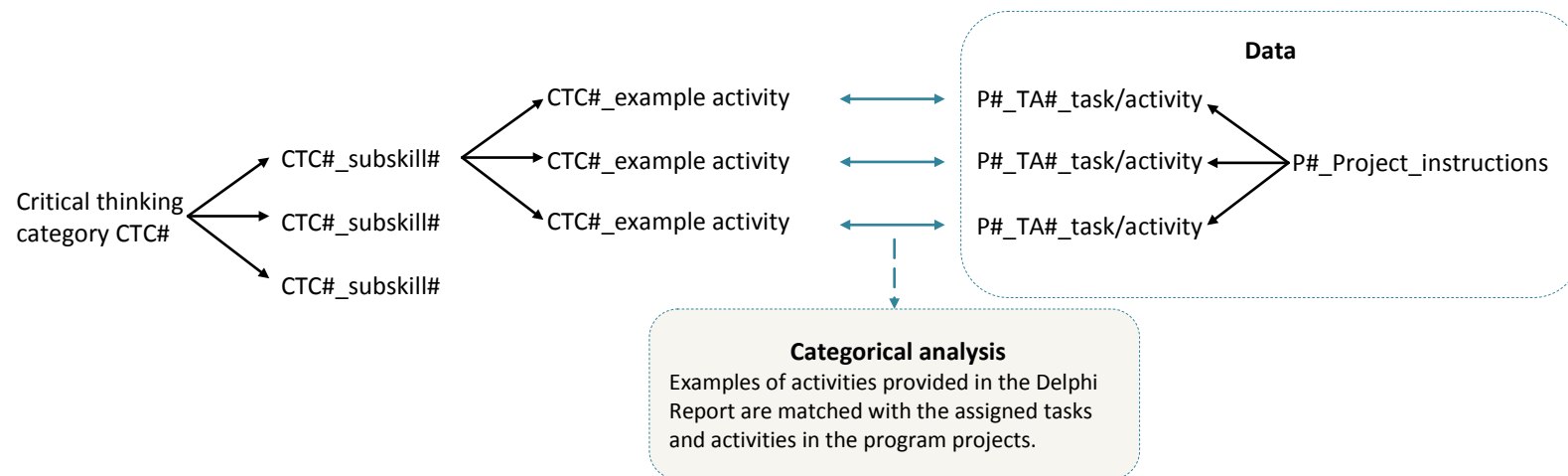


Figure 3.6: Framework for analysis: the infusion of critical thinking skills

Aligning project outcomes and tasks with the critical thinking skills components and subskills will show the extent to which the project tasks cover the subskills in the Delphi Report using a pattern-matching analytic technique (Yin, 2009, pp.136-141). Determining whether and the extent to which critical thinking skills have been infused into the program tasks will not be sufficient, however, to determine whether students engaged in a process of critical thinking during the projects. Subsequent contextual analysis will examine how students engaged in critical thinking processes as part of the projects in the program.

(b) Contextualising strategies in analysing the critical thinking process

The framework for contextual analysis of the critical thinking process is based on a general model of critical thinking (Garrison, 1991), subsequently developed as a model of practical inquiry (Garrison, Anderson & Archer, 2000^{*}). The model is depicted in figure 3.7.

The general model (Garrison, 1991, p.293) described five phases in the critical thinking cycle: problem identification, problem definition, exploration, applicability and integration. This model was later structured along two axes or dimensions (Garrison et al, 2000) with four quadrants representing progressive phases in the critical thinking cycle.

The two dimensions of experience contained in the model are depicted as continua between deliberation (applicability) and action (practice) along the vertical plane, and between perception (analysis) and confirmation/conception (ideas) on the horizontal plane. The latter provides a link or transition between the private, reflective dimension and the more concrete practical dimension. The significance of the two dimensions is that critical thinking is seen as both a private, reflective process and a more public, collaborative process.

The four quadrants represent four phases of critical thinking. It is a “logical or idealized sequence of practical inquiry (i.e., critical thinking)” (Garrison et al, 2000, p.98) – therefore a model or conceptual framework of critical thinking.

The conceptual framework was developed as a generalised model of critical thinking that reflected cognitive presence within online learning contexts. The connected nature of the learning space (explained in Part 1 of the case study, section 4.2.2) and the student-centred, experiential approach adopted in the ESDP remove some of the constraints typical in stand-and-deliver lecture contexts or instances where all resources are preselected and presented to the students. The learning environment here therefore provides many of the same affordances

^{*} Sometimes dated 2001 in the literature. The copyright date is 2000 Elsevier Science Inc.

for student interaction and access to resources that are most often associated with online learning environments.

Garrison et al (2000) view critical thinking or inquiry as a “holistic multi-phased process” which integrates deliberation and action. Each quadrant reflects a phase in the logical or ideal sequence of critical inquiry. The phases can be equally aligned with the cognitive processes of understanding-applying, analysing, evaluating and creating.

The practical inquiry model therefore frames a process of critical thinking progressing through four phases: a triggering event, an exploratory phase, an integration phase, and a resolution phase. Each phase is described in detail in the project analyses in Part 2B of the case study (section 4.3.3). It is worth noting here that “these phases are not immutable ... [t]hey may be ‘telescoped’ or reversed as insight and understanding is either achieved or blocked” (Garrison & Anderson, 2003).

A number of other studies have used the conceptual framework for analysing online interactions. Newman, Webb and Cochrane (1995) developed a method for content analysing asynchronous online discussions to measure critical thinking in group learning, and Schellens, Van Keer, de Wever and Valcke (2008) further developed the content analysis method by tagging “thinking types” in online discussions. Newman et al’s (1995) content analysis framework has not been applied in analysing the student reflections here, as the reflections are individual and private expressions of the learning experience and therefore differ from the interactive discussions examined in the aforementioned studies. Newman et al (1995) and Schellens et al (2008) did not divide discussions into the phases of critical thinking, since individual participants could be anticipated to be engaged in different stages of the cycle during discussions, but did relate indicators to specific stages to provide “an indirect indication of the critical thinking processes going on in each stage” (Schellens et al, 2008, p.13).

In the ESDP case study, student activity associated with each phase of the critical thinking cycle will be analysed by applying the phases in the conceptual framework (critical thinking cycle or process) and by identifying relevant indicators. The tasks undertaken in each of the four projects in the first year of the ESDP will be described in terms of the critical thinking cycle to provide an explanation of how students engage in the *process* of critical thinking. As the instructions are in themselves no warranty that students do engage in the critical thinking process, student reflections generated during the projects will be selected to illustrate how students experience the process and to identify the extent to which they engage in a process of critical thinking in executing learning tasks within the projects. Content of reflections will be tagged using a set of indicators relevant to each phase.

The presence of indicators can be used to judge and assess the quality of critical reflection and inquiry (Garrison & Anderson, 2003, p.60).

To accommodate the distinction between the content of asynchronous discussions and the content of individual reflections, the lists of indicators provided by Garrison and Anderson (2003, p.61) will be modified during analysis on the basis of the specific project tasks to include indicators that are required in order to relate comments in reflections to the associated activities or experiences of students. The revised list of indicators will add to the analytical frameworks for content analysis currently in use.

Garrison and Anderson (2003, p.61) identified specific indicators for each phase that they deemed useful in content analysing e-learning transcripts, as shown in Table 3.5.

Table 3.5: Practical inquiry descriptors and indicators

Phase	Descriptor	Indicator
Triggering event	Evocative (inductive)	Recognize problem Puzzlement
Exploration	Inquisitive (divergent)	Divergence Information exchange Suggestions Brainstorming Intuitive leaps
Integration	Tentative (convergent)	Convergence Synthesis Solutions
Resolution	Committed (deductive)	Apply Test Defend

Source: Garrison and Anderson, 2003, p.61

Figure 3.7 depicts the framework used in the contextual analysis of the critical thinking process.

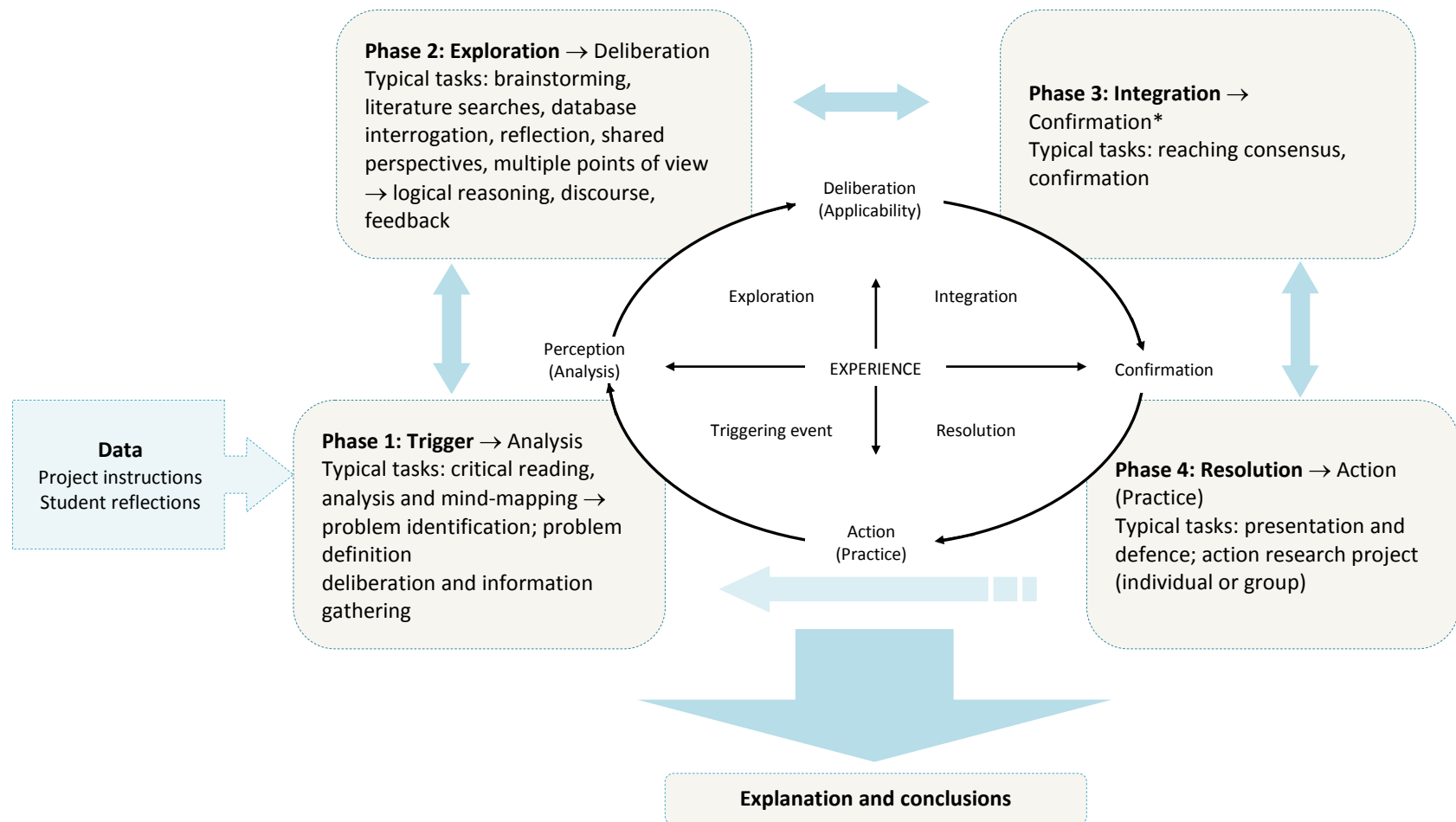


Figure 3.7: Contextual analysis of critical thinking process

* Subsequently, Garrison et al (2000) replaced confirmation with a Conception (Ideas) step, followed by Resolution and Action. Here the original Confirmation stage has been retained to allow more deliberately for the collaborative environment and project outcomes, where consensus plays an important role.

(c) *Conclusion drawing and verification: Data displays and the case study format*

The final stage in the explanatory case study comprises conclusion drawing and verification. Miles and Huberman's (1994) inclusion of conclusion drawing as a concurrent activity highlight that in reality conclusions in some form, however vague and for the time being ungrounded, are often "prefigured from the beginning, even when a researcher claims to have been proceeding 'inductively'" (Miles & Huberman, 1994, p.11). Verification then follows as part of an intersubjective process whereby the "meanings emerging from the data ... [are] tested for their plausibility, ... their 'confirmability' – that is, their *validity*" (Miles & Huberman, 1994, p.11).

The case study is reported in a format that reflects an analytic progression in building an explanation to answer the research questions. It therefore departs from the exclusively narrative descriptions that characterise purely inductive case studies based on a grounded theory approach. The background and broader context of the case have been outlined in Chapter 1, and a more detailed description of the context is presented in Part 1 of the case study. The case format therefore contains some descriptive elements, including demographic data obtained during the quantitative data collection process, since a satisfactory explanation depends on an understanding of the phenomenon being explained. This can be considered to be "a natural progression ... from telling first a 'story' about a specified situation ... to constructing a 'map' (formalizing the elements of the story ...)" (Miles & Huberman, 1994, p.91).

Content analyses of data (the content of project documents) are presented as part of the case study in Chapter 4, using matrices and graphs to organise information in order to facilitate interpretation (Miles & Huberman, 1994, p.11). As shown in figure 3.6, data elements in the content analysis are coded for purposes of analysis in order to determine the extent to which the data match the conceptualising analysis. Codes are displayed to indicate the extent to which pattern match, that is "coverage" or representativeness of critical thinking tasks in the projects, but codes are not counted for purposes of statistical analysis. Data displays are presented in a format that makes it easier to reflect the extent to which critical thinking skills have been infused into the projects.

The contextual analysis of the critical thinking process is integrated into the explanatory framework provided by the general model of critical thinking as set out in figure 3.7. In this sense, data are "transformed, condensed, clustered, sorted, and linked over time" (Gherardi & Turner, 1987, in Miles & Huberman, 1994, p.91). The explanation of the critical thinking process within the projects is supported by reflective journal entries relevant to each phase in

the process, which serve “as exemplars of concepts and theories or as exemplars of exceptions to ... theories” (Bernard, 2006, p.503). Accordingly, reflective journal entries have been selected based on relevance to the critical thinking process.

Results of the quantitative analyses in Part 2C of the case study are integrated into the case study as an integral part of explanation building and in drawing meta-inferences.

Section 3.3.4.2 sets out the quantitative data analysis strategies. Section 3.5 addresses considerations relating to validity, reliability and generalisability.

3.3.4.2 Quantitative data analysis strategies

The quantitative and qualitative components of the study have been depicted as part of the research process in figure 3.2 (section 3.2.4). Quantitative data collection strategies, the procedures used and instrument validity have been discussed in section 3.3.3.3.

The quantitative data in this study provides the **performance analysis** component in the research design. It is intended to examine *the effectiveness of the immersion approach as reflected in student gains in a standardised critical thinking skills test after the first year of study*, thereby answering the question:

RQ2 *How effectively does participation in an employability skills program develop students' critical thinking skills as measured in a standardised test?*

Student scores on the California Critical Thinking Skills Test (CCTST) are analysed to determine gains over the first year of study. This analysis involves multiple comparisons, both within groups and between groups in a pretest-posttest design, and reports the effect sizes of gains in scores. Results from the quantitative analysis are incorporated into the case study to complement the qualitative analysis of skills infusion and the process of critical thinking in the program. Analyses answer four subquestions, the first two relating to pretest-posttest differences and comparisons with students who did not participate in the first year of the ESDP:

RQ2A Do testtakers perform better in the CCTST after participating in the first year of the program than at the start of the program?

RQ2B Do testtakers who have participated in the first year of the program perform better in the CCTST than students who entered the program in the second year?

Figure 3.8 provides a diagram of the group design, showing how data obtained in pretests and posttests have been grouped for purposes of comparison.

Figure 3.9 depicts the series of comparisons that will be conducted. **Contrasts 1, 2 and 3** are intended to answer the above subquestions.

The nature of the population, being made up of students who come from English-speaking backgrounds as well as students who come from non-English speaking backgrounds necessitates consideration of language as a factor in student test performance. This was deemed important since in validation studies of the California Critical Thinking Skills Test (CCTST) (Facione et al 2002, p.22) “no gains were found among non-native English speakers”, as compared to a gain of +0.74 in a cross-sectional comparison (pretest mean = 16.09, n=480; posttest mean 16.83, n=465).

This raises the next two subquestions:

RQ2C Do testtakers from English-speaking backgrounds perform better in the CCTST than students from non-English-speaking backgrounds?

RQ2D Do students from English-speaking backgrounds show greater improvement in CCTST performance after participating in the first year of the program than students from non-English-speaking backgrounds?

Contrast 4 in figure 3.9 shows the comparisons that are intended to provide insight into and explicate potential mean differences associated with language ability as individual-difference variable between the groups.

(a) Group design

Group A comprises testtakers who completed both the pretest at the start of the first year of studies in the program (A_1) and the posttest after completing the first year of the program (A_2). Contrast 1 compares the results for the same group of individuals in pretest and posttest.

Group B comprises testtakers who entered the program after completing their first year of studies without participating in any of the units in the program, and who therefore completed only the posttest. Contrast 3 compares the results of program participants and non-participants at posttest.

Group C comprises students who had completed the first year of the program, but who had not taken the pretest at the start of their studies. This group is combined with group A_2 to provide a composite group of students (**Group A_2C**) who had completed the first year of the program and who took the posttest.

Group D comprises students who had taken the pretest at the start of their studies but did not take the posttest. This group is combined with group A_1 to provide a composite group of students (**Group A_1D**) who completed the pretest at the start of the program.

Contrast 2 compares the results of Group A_1D (pretest) and Group A_2C (posttest). This contrast can alleviate any test effects that may be present in the repeated measures contrast of group A.

Data for comparison of students from English-speaking backgrounds and non-English-speaking backgrounds will be drawn from the groups used in contrast 2.

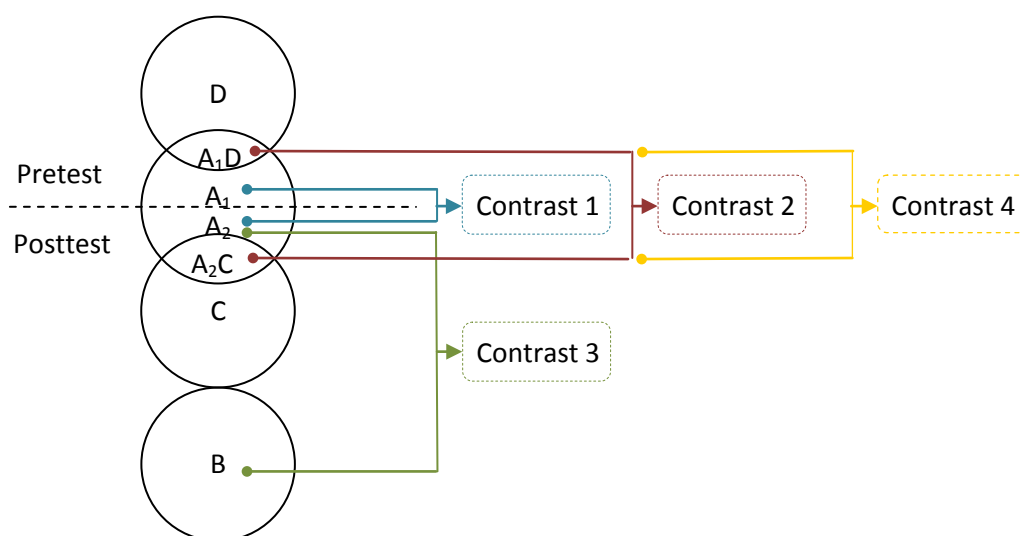


Figure 3.8: Group design

(b) Group comparisons

The term “comparison group” will be used when comparing means between groups generally. Wilkinson and the TFSI (Wilkinson & the TFSI, 1999, p.595), caution against the use of “control group” in instances where it is not possible to implement randomisation nor to control almost totally all variables that can potentially modify effects. They recommend the term “contrast group”, but since this is considered to have a more distinctive “separate group” connotation, and since this design also comprises a within-groups component, the term “comparison group” provides a meaningful alternative.

Group comparisons as set out in figure 3.9 comprises both within groups and between groups comparisons or contrasts. The within-subjects component comprises a non-intrinsically repeated-measures design (**contrast 1**). Between-groups comparisons consist of two contrasts, the first being a between-subjects comparison of all students who had completed the first year of the program and from whom data were obtained at pretest and/or posttest (**contrast 2**),

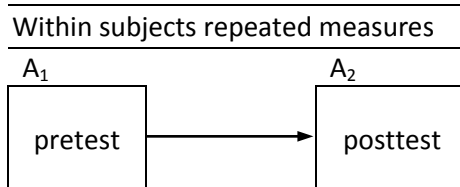
and the second between two groups of testtakers, one of whom who had participated in the program (the treatment) and the other group consisting of testtakers who had not participated in the program (**contrast 3**).

Both within-group and between-groups comparisons are ex post facto or passive, since the research made use of convenience samples and there was no manipulation of independent variables (such as participation in the program, or language – that is, English-speaking background or non-English-speaking background of participants), and no random assignment. The dependent outcome variable is student scores in the California Critical Thinking Skills Test.

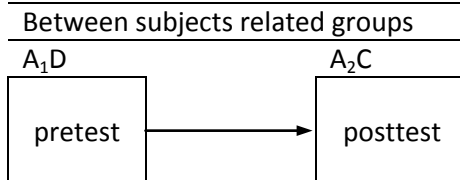
The related samples or within-subjects component potentially offers the advantage of avoiding the influence of at least some extraneous factors since testtakers essentially serve as their own controls, thereby reducing error variance and increasing statistical power. A repeated-measures design may be subject to order or regression effects, but not including the repeated measures component in the design can propagate confounded data (Ellis, 1999, p.553). The independent-samples or between-groups component offers an opportunity to contrast test results for students who had completed the first year of the program with those of students who had not participated in the first year of the program.

For purposes of **contrast 4**, given that groupings of testtakers from English-speaking and non-English-speaking backgrounds are unlikely to be equal in size, the pretest and posttest mean score contrasts between groups will be calculated between subjects as in contrast 2.

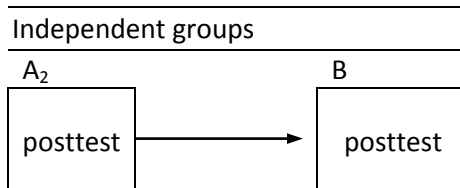
Contrast 1



Contrast 2



Contrast 3



		Contrast 4	
		Independent groups	
		English-speaking background (ESB)	non-English-speaking background (nESB)
Pretest		A ₁ D_ESB	A ₁ D_nESB
Posttest		A ₂ C_ESB	A ₂ C_nESB

Figure 3.9: Group comparisons

(c) Reporting effect sizes

The option to calculate the statistical significance of any increase in students' scores on the California Critical Thinking Skills Test was considered and rejected. This section therefore looks briefly at the recommendations for reporting outcomes of studies and associated pitfalls against the background of existing practices of null hypothesis testing, and outlines the strategy that will be followed in this study.

The contemporary method of null hypothesis significance testing (NHST) was derived from the Fisher model of the 1920s, in which a null hypothesis is presented followed by an estimation of the conditional probability (ρ values) of the data under the hypothesis by means of statistical tests, and the Neyman-Pearson approach of the 1930s which extended the Fisher model by adding the use of alternative hypotheses, and introduced one- or two-tailed regions of rejection (that is, determining a direction for the alternative hypothesis) as well as fixed levels of alpha (α) for all studies. The levels of statistical significance commonly used today (.05 and .01) are attributed to Fisher, although there is some question as to whether he intended for these levels to be applied in all studies (Kline, 2004, p.7). The Neyman-Pearson model also introduced the consideration of power and associated Type I and Type II decision errors. Between 1935 and 1950 these two approaches were integrated by statisticians and became the contemporary NHST approach. Kline (2004, p.7) comments that "many authors have noted that (a) the hybrid logic that underlies modern NHST would have been rejected by Fisher, Neyman, and E.S. Pearson, although for different reasons and (b) its composite nature may be a source of confusion about what results from statistical tests really mean".

While a few authors did criticise the NHST in the period from 1940 to 1960, publications that question the usefulness of statistical tests have increased exponentially since the 1970s, with around 200 such works being published in psychology and related disciplines in the 1990s (Kline, 2004, p.9).

In his address to the American Educational Research Association in 1998, Bruce Thompson outlined a number of common methodology mistakes in educational research (republished with additions in 1999) (Thompson 1999).

Thompson questioned the “ecological validity” of many educational studies, and referred to a report by Elliot Eisner in 1983, in which he examined two volumes of the *American Educational Research Journal* and found that the median treatment time for nearly half the experimental studies was 1 hour 15 minutes. Fetterman’s study of major qualitative projects in 1982 similarly showed very limited observation times on site in ethnographic studies. Thompson considered the methodological flaws as gratuitous, stemming from instruction in research methods as “series of rote-followed routines, as against thoughtful elements of a reflective enterprise ... and, in some cases, from an unfortunate *atavistic impulse* to somehow escape responsibility for analytic decisions by justifying choices, sans rationale, solely on the basis that the choices are common or traditional (Thompson 1998a, p.4)” (Thompson, 1999, p.6-7). Thompson listed seven methodological *faux pas*, two of which are directly relevant to selecting a strategy for analysis here (Thompson, 1999, p.9):

- “failure to recognise that *reliability* is a characteristic of scores, and not of tests”, and
- “incorrect interpretation of *statistical significance* and the related failure to report and interpret the *effect sizes* present in all quantitative analyses”

Two further comments from Thompson are highlighted here. The first is that we need to realise “that our measures are only indicators of our psychological constructs, and that what we really care about in educational research are not the observed scores on our measurement tools *per se*, but instead is the underlying construct.” (Thompson, 1999, p.16). So although this study examines student scores on a critical thinking skills test, the primary interest is in students’ ability to think critically within the context of the program.

Thompson (1999, p.18) further commented: “We must use analytic methods that honor the complexities of the reality that we purportedly wish to study – a reality in which variables can interact in all sorts of complex and counterintuitive ways (Thompson, 1992b, pp.13-14)”. The analyses in the ESDP case study have been selected in view of such complexities.

Like Thompson and others, Kline (2004) advocates new approaches to analysis in research, and questions the usefulness of established practices of significance testing within the *hybrid logic of scientific inference* which he refers to as the “Intro Stats” model, after P. Dixon and O’Reilly (1999, in Kline, 2004). Some of the misconceptions are addressed in the section below. It is important to consider the counter-NHST view here, since it supports the rationale for the analysis, reporting and interpretation in this study which adopts the recommended alternatives to the established NHST practices, namely estimation and reporting of effect sizes and confidence intervals.

Arguments against the use of null hypothesis significance testing highlight a number of fallacies that result in misinterpretation of research results. The abstract to Jacob Cohen’s article, *The earth is round ($p < .05$)* (1994, p.997) provides an unequivocal summary of the argument:

After 4 decades of severe criticism, the ritual of null hypothesis significance testing—mechanical dichotomous decisions around a sacred .05 criterion—still persists. ... the problems with this practice... [include] its near-universal misinterpretation of p as the probability that H_0 is false, the misinterpretation that its complement is the probability of successful replication, and the mistaken assumption that if one rejects H_0 one thereby affirms the theory that led to the test.

Amid the growing controversy surrounding statistical tests, the American Psychological Association convened a Task Force on Statistical Inference (TFSI), charged with elucidating relevant issues, which included significance testing as well as “issues beyond null hypothesis significance testing” (Wilkinson & TFSI, 1999, p.594). Wilkinson and the TFSI published an article that offered guidelines and explanations in the *American Psychologist* prior to the fifth revision of the APA Publication Manual. The article acknowledged that “some had hoped that this task force would vote to recommend an outright ban on the use of significance tests in psychology journals” but the committee felt the need for forbearance on the issue. The TFSI nevertheless made a number of recommendations for data analysis that are relevant in this study, among them:

- (1) selecting a minimally sufficient analysis, advising researchers not to “choose an analytic method to impress your readers or to deflect criticism. If the assumptions and strength of a simpler method are reasonable for your data and research problem, use it. ... don’t cling to obsolete methods ... out of fear of learning the new” (Wilkinson & TFSI, 1999, p.598).

In response to this recommendation, analysis in this study will be minimally sufficient, by focusing on the three contrasts of interest, and the impact of language as a factor.

- (2) always presenting effect sizes for primary outcomes (which may be unstandardised, eg mean difference or regression coefficient, if units of measurement have an ordinary, practical meaning, such as IQ scores, or height, or weight)
- (3) estimating confidence intervals for effect sizes of principal outcomes

The data analysis strategy will follow recommendations (2) and (3) above by reporting the effect sizes and confidence intervals for each contrast.

- (4) applying graphical analysis of assumptions to identify threats to data integrity, for the simple reason that “graphics broadcast; statistics narrowcast”

Graphical displays will be examined to confirm distributional assumptions. Detailed analyses are presented in Appendices 4.5 and 4.6.

Before analysing the data in this study, it is appropriate to consider not only the answers that the questions are intended to provide, but the conclusions that the answers to the questions are intended to inform. The findings of this study should provide some indication of whether the program has been effective, and also whether critical thinking skills tests such as the California Critical Thinking Skills test are in practice an appropriate measure to determine critical thinking skills development in authentic learning contexts as distinct from formal critical thinking skills instruction. The CCTST is considered here to be but one measure or indicator of critical thinking skills development in this study.

While it is important to recognise that the question of whether the program is effective in developing students’ critical thinking skills may not be fully answered in this study, it is equally necessary to accept that employing a scattergun approach in search of patterns among test scores is not likely to provide useful or meaningful answers to questions (that have not been asked).

There are a number of different ways to estimate effect sizes, and experts do not always agree on the appropriate measure of effect size for different kinds of data. The appropriate measure depends on the purpose and design of the research, the characteristics of the population, the sampling method(s), and the nature of the relevant variables (categorical, ordinal or continuous). Some estimates of effect size are prone to positive bias and can overestimate the size of an effect or produce conflicting results. It may also be necessary to consider alternative measures when data obtained do not satisfy the assumptions of traditional measures (for example distributional assumptions).

As appropriate within the pragmatic paradigm and the principles of mixed methods research, the research questions have determined the approach followed in analysing the data in this study. The interest is in whether there will be an increase in the mean critical thinking test scores of the groups in the study, the intention is to select the appropriate effect size index in comparing standardised mean differences, bearing in mind that it is possible that the treatment has had an effect on the tails or variability of results, and if warranted additional contrasts will be analysed to explore such potential effects.

Effect size indices for studies with continuous outcomes can be divided into two broad “families”: standardised mean differences (also called the *d* family or the *group difference index*) and measures of association (also called the *r* family or *relationship index*) (Kline, 2004, p.97). Olejnik and Algina (2000, p.260) refer to the latter as proportion of variance effect sizes, in that they provide a measure of “the proportion of variation in an outcome measure that is explained by (shared with) the grouping variable”. The former is calculated as the standardised difference between two means, and the latter as the correlation between the independent variable and scores on the dependent variable, so that the difference is calculated between either the pretest and posttest means or between the posttest means of an experimental/treatment and a control group. Standardised mean difference effect sizes are more commonly used to measure the size of contrasts.

Typically, in a between-groups design (independent samples), the standardised mean difference between two groups quantifies the size of the difference between two groups and expresses the difference in standard deviation units in order to standardise the contrast. The standardised mean difference is then calculated as follows:

$$\text{Effect size} = \frac{[\text{Mean of experimental group}] - [\text{Mean of control group}]}{\text{Standard deviation}}$$

The *d* family comprises three different approaches to calculating standardised mean differences. These approaches differ in terms of the statistic used as the standardiser in the calculation, which is determined by the nature of the data. A detailed visual examination of distributional aspects of the data is presented in Appendix 4.5 and the results obtained are provided in Appendix 4.6.

The procedure to be followed in analysing quantitative data in this study and the process for examining the data is shown in figure 3.10 (and reported in section 4.5).

SPSS can be used to calculate relational effect sizes within the GLM (general linear model) which are reported as partial η^2 . For purposes of calculating standardised mean differences, a number of online tools are available, among them an effect size calculator made available by

the Cognitive Flexibility Lab at York University, headed by Nicholas J. Cepeda, at <http://www.cognitiveflexibility.org/effectsize/> and a calculator made available by Lee Becker of the University of Colorado at Colorado Springs at <http://web.uccs.edu/lbecker/Psy590/escalc3.htm>. Another calculator is provided by Robert Coe at <http://www.cemcentre.org/renderpage.asp?linkid=30325016>

Effect sizes in this study were estimated using the Effect Size Generator (version 2.3) software made available by Grant Devilly (2004) at the Centre for Neuropsychology, Swinburne University (http://www.clintools.com/products/esg/effect_size_generator.html).

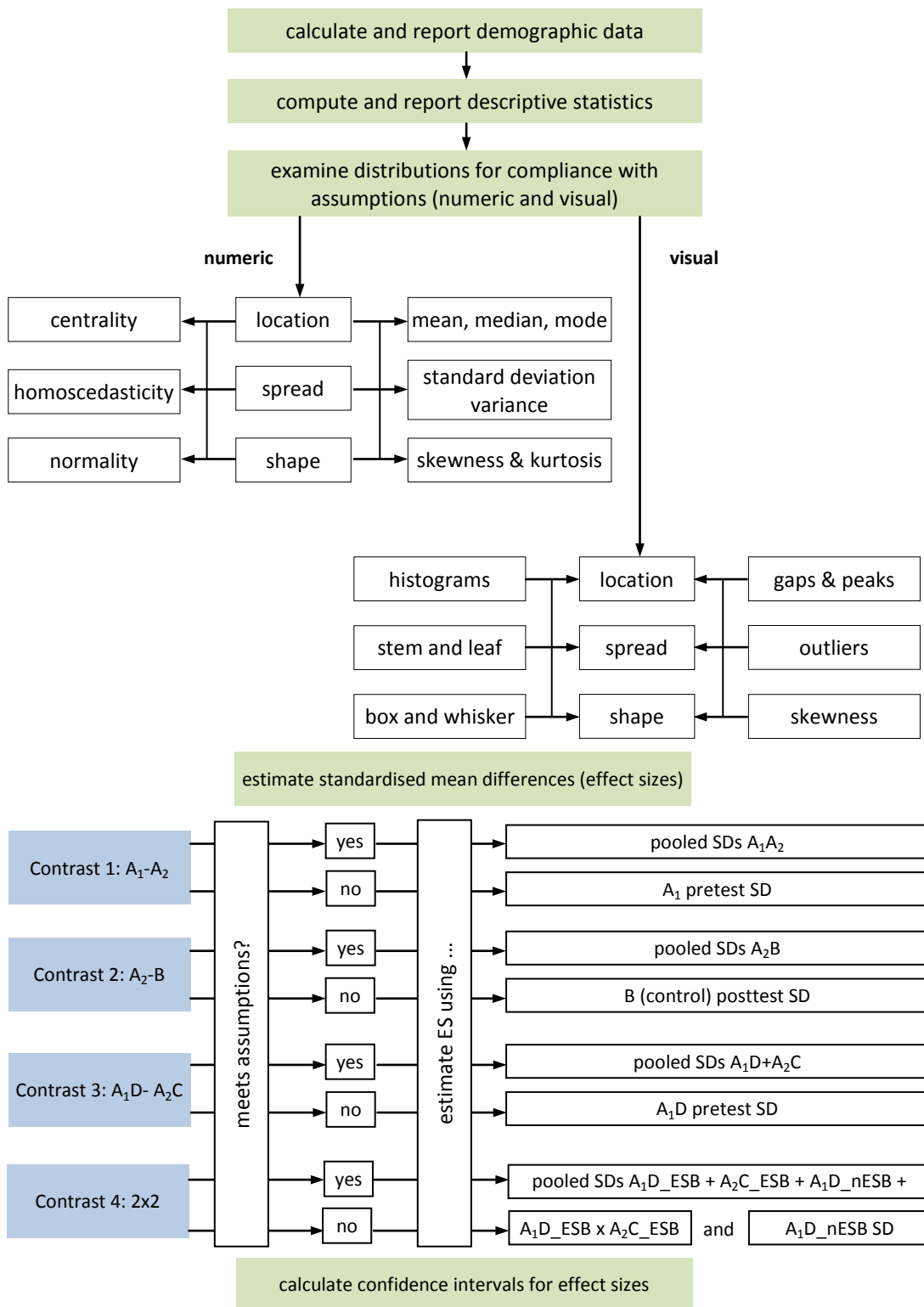
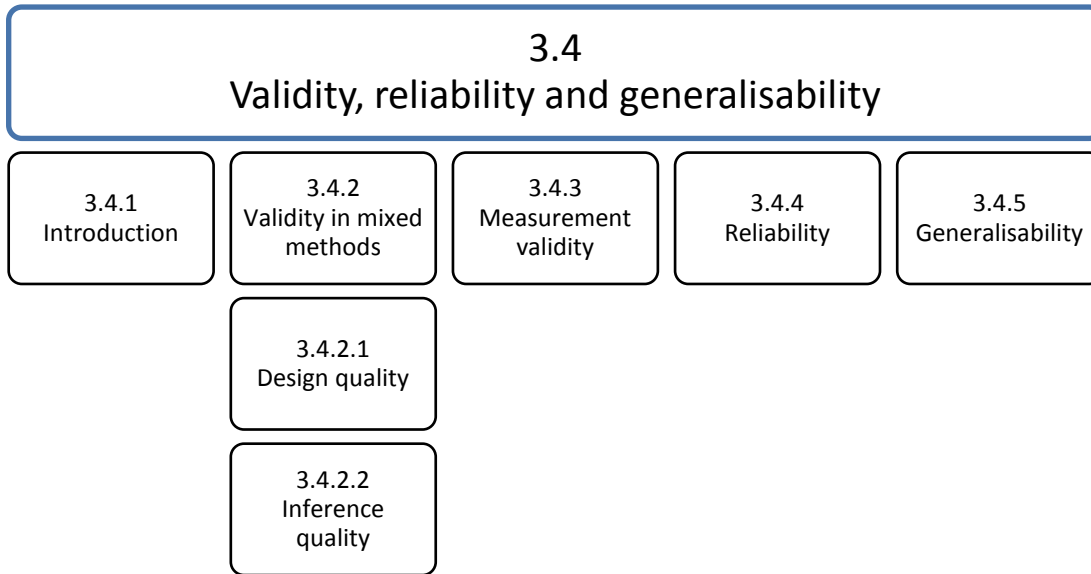


Figure 3.10: Quantitative analysis framework

Further challenges arise when interpreting the effect size obtained and this will be addressed in the discussion of the findings in Part 3 of the case study and in the conclusions in Chapter 5.

"I have learned that there is no royal road to statistical induction, that the informed judgment of the investigator is the crucial element in the interpretation of data ..." (Cohen, 1990, p.1304).

3.4 Validity, reliability and generalisability



3.4.1 Introduction

This section addresses considerations relating to validity, reliability and generalisability in this study. Validation is here considered as relating to the quality of the design as well as to the quality of inferences, while reliability is considered in relation to the quality of the data or evidence used in the study. The validation framework considers first the design quality and then the interpretive rigour, but it is necessary to bear in mind that the quality of the design impacts the quality of data, and that both design quality and data quality influence the quality of inferences as shown in figure 3.11. Generalisability is then considered within the context of the case study format adopted in the study.

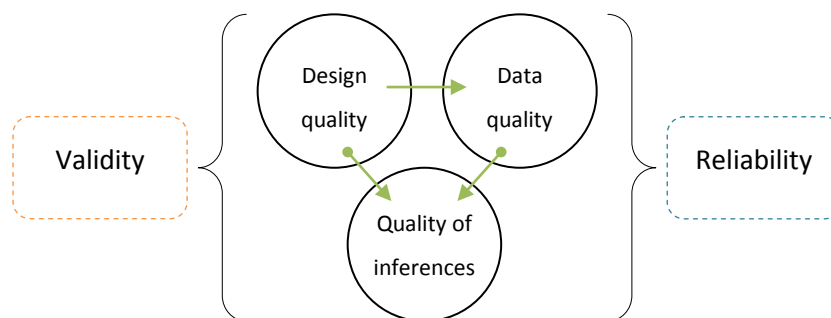


Figure 3.11: Components of validity and reliability

The terminology adopted and the language used in considering validity in mixed methods research differ from that commonly encountered in purely quantitative studies, such as internal, external and construct validity and associated threats (eg Creswell, 2009, pp.162-

164), and the terminology in use in purely qualitative studies, such as trustworthiness, authenticity and credibility (Creswell & Miller, 2000, in Creswell, 2009, p.191), as well as confirmability and data dependability (US Government Accountability Office, 1990, in Yin, 2009, p.40). Which is not to say that the considerations in mixed methods research (such as design quality and interpretive rigour) differ in intent from those in single-method studies or the logic tests applied in case study research in general. Mixed method designs may also require the researcher to apply distinctively quantitative and qualitative validation procedures, depending on the purpose of mixed methods (Hesse-Biber, 2010, p.91-92). There is as yet no single established integrated framework that encompasses both mixed methods approaches and case study designs. In addition, different standards and criteria are proposed when dealing with mixed methods research (eg Teddlie & Tashakkori, 2009; and Onwuegbuzie & Johnson, 2006), with case study research (eg Yin, 2009), and with quantitative methods (eg Cronbach & Meehl, 1955 and Crocker & Algina, 1986, in Dellinger & Leech, 2007, p.310).

This section addresses the criteria for validity in mixed methods studies (in section 3.4.2) with specific reference to validity in case study research and separately addresses validity in the quantitative component by way of measurement (instrument) validity in section 3.4.3.

Addressing issues of validity and reliability in a mixed methods case study can be seen as a layered and continuous process. Maxwell (1992, p.284, in Hesse-Biber, 2010, p.90) notes that validity should not be considered to be a property of a particular method “but pertains to the data, accounts or conclusions reached by using that method in a particular context for a particular purpose”.

The “validity” of research needs to be addressed in all stages of the research process, and is not as clearly delineated as in establishing validity in either a purely quantitative or a purely qualitative approach. Different approaches to establishing validity are moreover aligned with different paradigmatic perspectives. The positivist view sees knowledge as a reflection of a single external reality and places a premium on objectivity, validity and reliability in generating new knowledge. In contrast, interpretivist qualitative studies see reality as being socially constructed and interpret validity as being determined by “examining the sources of invalidity” and the ability of propositions to withstand attempts at falsification (Kvale, 1996, p.241) as well as the trustworthiness of data. Positivist studies are largely associated with scientific measures, but regardless of whether the research deals with quantitative or qualitative methods, researchers who adopt a positivist perspective view validity as being determined by the extent to which the instrument being used measures the constructs it is intended to measure – therefore focusing on measurement validity comprising content, criterion and

construct validity, although construct validity has come to represent an “overarching idea of validity” (Dellinger & Leech, 2007, p.310).

Case study research addresses construct validity as “identifying correct operational measures for the concepts being studied” (Yin, 2009, p.40) (therefore a narrower view than suggested by Dellinger and Leech, 2007), views internal validity as relevant only in explanatory or causal studies that seek to identify causal relationships, and explains external validity or generalisability as identifying the “domain to which a study’s findings can be generalized” (p.40). From a case study perspective, reliability requires that if the procedures in the study (including data collection) were repeated, the same results would be obtained. Addressing these “logic tests” has been interwoven with the integrated validation framework in section 3.4.2.

A number of different frameworks have been proposed for establishing validity and reliability in mixed methods studies. Dellinger and Leech (2007) see construct validation as appropriate in mixed methods research and view construct validation as a pragmatic process, “an open, continuous system in which construct meaning is the product of convergent and divergent evidence, results, consequences, and arguments ... whether qualitative or quantitative”, and as a process that requires mindfulness (p.321). They propose a validation framework that includes five components: (1) a foundational component that focuses on preconceptions and the quality of the review of the literature, (2) a construct validation component that contains the elements of design quality, legitimation (including sample integration and weakness minimisation) and interpretive rigour, and (3) inferential consistency (linking theory, literature, purpose, design, measurement and analysis) (p.322). They include two further elements that can only be determined by subsequent use and acceptance of research, being (4) the utilisation/historical element, and (5) a consequential element.

A more comprehensive integrated framework is proposed by Teddlie and Tashakkori (2009, pp.300-303), which has been used in this study. The next section addresses issues of validity from three perspectives: section 3.4.2 relates validity to the use of mixed methods within a pragmatic approach with specific reference to validity within the context of case study research; and section 3.4.3 addresses validity of the standardised test used in the quantitative component.

3.4.2 Validity in a mixed methods case study from a pragmatic perspective

In mixed methods research, the issue of validity has not been clearly delineated (Dellinger & Leech, 2007, p.315). Tashakkori and Teddlie (2003, p.37) propose using the term “inference quality” instead of validity in mixed methods research. Inference quality then combines the quality of the design and the interpretive rigour of the study. Onwuegbuzie and Johnson (2006) use the term “legitimation” rather than validity and see legitimation as being determined by the quality of the integration of aspects of design and inference in a study.

Issues of validity in mixed methods research therefore centre in part on the methods and design – whether the study provides a clear rationale for adopting mixed methods and explicitly addresses data collection and analysis strategies (Hesse-Biber, 2010, p.86) – and also on the alignment between the problem and the method, which is especially relevant in a pragmatic approach where the questions determine the method. (Validity could then ultimately be determined by whether the findings answer the questions.) The key considerations relating to validity can be viewed as the quality of design and methods (the appropriateness of a mixed methods design, and explicit data collection and analysis strategies) and inference quality.

Teddlie and Tashakkori (2009, pp.300-303) have presented the characteristics of “good inferences” in mixed methods research as an integrative framework that incorporates **design quality** (with four associated criteria) and **interpretive rigour/quality** (with six associated criteria). The next section addresses each of the criteria in the framework.

3.4.2.1 Design quality

The quality of a mixed methods research design can be judged on four criteria, each of which is addressed below.

(1) *Suitability or appropriateness of the design*

Design suitability relates to the selection of appropriate strategies for answering the research question/s, whether the research design matches the purpose of the study, and whether the strands of mixed methods address closely related aspects of the research questions.

The rationale for adopting a mixed methods approach has been set out in section 3.2.3.1. Each of the purposes for adopting mixed methods contributes to the validity of the study. Using more than one type of data as well as more than one method of data collection and data analysis allows for triangulation, which in this study serves a corroborative purpose and is

aimed at either confirming propositions or uncovering contradictions, which enhances the interpretive rigour of this study.

Mixed methods in this study are further aimed at complementarity that makes it possible to identify and address threats to validity by allowing for analyses at different levels (Greene, Caracelli & Graham, 1989 , pp.256-257):

- At conceptual level, the extent to which the tasks in the projects are aligned with the conceptualisation of critical thinking in the consensus statement of the Delphi Report (APA, 1990) strengthens **construct validity** in the study in two ways: it clarifies the operational measures in an explicit and overt way, and it establishes alignment with the performance measure, as the California Critical Thinking Skills Test is based on the Delphi expert consensus definition of critical thinking (Facione, Facione, Blohm, et al, 2002) that has been applied in the categorical data analysis strategy applied in the infusion analysis (set out in section 3.3.4.1(a)).
- At operational level (the extent to which students engage in the critical thinking process) the contextualising analysis set out in section 3.3.4.1(b) not only makes use of different data sources and types of data but incorporates both the etic and emic dimensions, which contributes to the **internal validity** of the study. Internal validity is further addressed in considering criteria for interpretive rigour in section 3.4.2.2 below.
- At performance or evaluation level (the extent to which participation in the program enhances student performance in a standardised critical thinking skills test), the use of more than one method in this study ultimately allows the researcher to answer the research questions, as each method “yields complementary results regarding the same phenomenon” (Teddlie & Tashakkori, 2009, p.265). Standardised critical thinking skills tests are moreover used frequently to assess critical thinking skills development, as set out in section 2.4.2.

(2) *Fidelity or adequacy of the design*

Design fidelity relates to the adequate implementation of sampling, data collection and data analysis procedures (Teddlie & Tashakkori, 2009, p.301).

Each of these design components have been described at a level of detail that allows for the necessary rigour in application. Section 3.3.3 has set out the data collection strategies and procedures for both the qualitative and quantitative components, paying specific attention to the types of data and their sources as listed in Table 3.4. Data analysis strategies have similarly

been set out in detail in section 3.3.4, and each strategy for analysis has been aligned with the research question that it is intended to answer.

The sampling strategy in the qualitative component has been based on relevance to the research questions and relevance to the critical thinking process being examined. Section 3.3.3.2 has commented in more detail on the selection of documentary data. Limiting the sampling of documentary evidence to projects undertaken during the first year of study ensures that only tasks that took place in the period between the pretest and posttest are taken into account. No further sampling took place within the selected data types, as all project instruction documents in the first year have been included. Data collection in the qualitative component is moreover unobtrusive, which assists in avoiding reactive and investigator effects that can pose threats to construct validity (Yin, 2009, p.42).

The quantitative component relies on convenience samples, and strategies for limiting threats to validity have been incorporated into the data analysis strategy as explained in item (4) below.

(3) *Within-design consistency*

Within-design consistency is determined by the extent to which the components in the study form a cohesive whole. The type of data collected and the strategies for analysing each data type in this study are integrated within a framework that addresses the conceptualisation, operationalisation and evaluation of the central phenomenon of critical thinking skills development (which constitutes the objective of the research), and which also provides a high level of within-design consistency by aligning strategies with the questions, each of which addresses a particular level of particularity in the development of critical thinking skills. The approach explained in item (1) above also includes strategies for enhancing within-design consistency.

Additional consistency is established by using the elements of critical thinking as conceptualised in the expert consensus statement of the Delphi Report (APA, 1990) in the categorical analysis of infusion of critical thinking skills (Part 2A of the case study), as this conceptualisation also provided the basis for the California Critical Thinking Skills Test which has been used as instrument in the quantitative analysis (Part 2C of the case study).

(4) *Analytic adequacy*

It would not be appropriate to apply calculations of validity or reliability coefficients in more qualitative approaches, and “perceptions of the fit between the problem and the method ... may be the most appropriate way to evaluate mixed methods research projects” (Hesse-Biber,

2010, p.91). The “fit between the problem [the research questions] and the method” has been addressed in section 3.3.4.1 and in item (1) above.

The main strategies that have been employed to ensure the validity of the quantitative results are included in a detailed consideration of the impact of the characteristics of the data and the assumptions to be satisfied, which has been presented in section 3.3.4.2(c). The group design and the recognition that participants from non-English-speaking backgrounds require special attention in data analysis, as well as specific attention to the potential practical significance of causes of variability all contribute to ensuring construct validity and analytic adequacy.

The overall effectiveness of data analysis strategies will become evident in answering the research questions, and the contribution of each analysis will be reflected in the credibility and interpretive rigour applied in drawing meta-inferences (drawing together the findings of different parts of the case study) in reaching conclusions (Teddlie & Tashakkori, 2009, p.300).

3.4.2.2 Interpretive rigour or inference quality

Interpretive rigour or inference quality can be seen as ensuring the **internal validity** of the research, which is the second logic test proposed by Yin (2009, pp.40 & 42-43), and which should be seen as extending “to the broader problem of making inferences” (Yin, 2009, p.43). Yin comments that in essence, “a case study involves an inference every time an event cannot be directly observed”, and highlights the importance of addressing rival explanations and possibilities (p.43).

Section 3.2.3 of this chapter has addressed the key issues within a pragmatic approach that are likely to determine the inference quality (Tashakkori & Teddlie, 2003, p.37) of this study in some detail:

- the connection of theory and data (the abductive approach)
- the researcher’s relationship to the research process (characterised by intersubjectivity), and
- inference from data (complementarity and corroboration, explanation building through instrumental analysis and testing)

By systematically applying these three characteristics of the pragmatic approach (Morgan, 2007, p.71) to this study, I have addressed the strategies adopted to ensure the quality of this research in terms of both design and methods:

- Approaching the connection between theory and data abductively strengthens the link between data and propositions, and between inferences drawn from the data and interpretation of results.
- Recognising the intersubjective nature of the research serves as a safeguard against unwarranted claims in interpreting results. The intersubjective nature of research has been addressed in more detail in section 3.2.3, item (2).

- Adopting a strategy that relies on theoretical propositions in analysing the case study evidence strengthens the interpretive rigour of the study (Yin, 2009, p.130), as does the use of both qualitative and quantitative data, and paying specific attention to rival explanations.

Whether the study meets the six criteria for interpretive rigour proposed by Teddlie and Tashakkori (2009, pp.303-308) can to some extent be determined only at the conclusion of the study. The criteria are addressed here to make explicit the precautions taken by the researcher to ensure interpretive rigour in drawing inferences and conclusions.

(1) interpretive consistency

Interpretive consistency includes ensuring that the type of inference is aligned with the type of evidence, and that the magnitude of effects is appropriately interpreted (“inference of intensity”) (Teddlie & Tashakkori, 2009, p.304). By developing theoretical propositions prior to data collection and analysis is a particular strength of the case study, as it establishes the logic that links the data to the propositions and makes explicit the criteria to be used in interpreting the findings (Yin, 2009, pp.33-34).

Strategies that will ensure interpretive consistency have been identified in the design of the study and the data analysis strategies adopted. For example, no statistical inferences will be drawn from qualitative data. As set out in section 3.3.4.1 (c), transformation of qualitative data will include coding for purposes of display (visual examination) and pattern matching, but codes will not be counted or subjected to statistical analysis.

The quantitative component uses effect sizes to determine the magnitude of the effect of the program on student performance in a standardised critical thinking skills test. Reporting effect sizes rather than null hypothesis significance testing will contribute to the validity of the study in that it avoids many of the pitfalls inherent in interpreting results based on statistical significance. This issue has been addressed in some detail in section 3.3.4.2(c). Calculation of effect sizes requires the data to meet certain assumptions, and these have been addressed in Appendix 4.5. Reporting effect sizes moreover allows for subsequent comparisons and meta-analyses when the research is replicated in other settings.

To facilitate interpretation of effect sizes, Cohen (1988, p.25) classified an effect size of +0.2 as ‘small’, 0.5 as ‘medium’ (“large enough to be visible to the naked eye”) and 0.8 as “grossly perceptible and therefore large” (eg the difference in height between 13- and 18-year-old girls), but Coe (2002, p.5) cautions that “Cohen does acknowledge the danger of using terms like ‘small’, ‘medium’ and ‘large’ out of context”, and Glass, McGaw and Smith (1981, p.104) argue that effect sizes as indication of the effectiveness of an intervention should be interpreted “in relation to other interventions that seek to produce the same effect” (Coe,

2002, p.5). Other studies involving critical thinking skills test results often adopt the operational definitions that Cohen proposed, but Cohen encouraged a search for alternative standards of interpretation. He also highlighted difficulties in comparing results of different effect size measures, for example a direct comparison of d and r effect sizes (Cohen, 1988, pp.79-81). Olejnik and Algina (2000) reiterated Cohen's concerns, stating that "at best these statistical indices are relative measures of effect, not absolute measures" (p.277), and pointed out that reliability, the nature of the populations (heterogeneity), the levels of the variables studied and the strengths of treatments can all affect effect sizes (p.281). This study has paid careful attention to any violation of assumptions in analysing the quantitative data, and the effect sizes obtained in this study will be interpreted with due regard for the caveats offered above.

(2) theoretical consistency

In describing theoretical consistency, Teddlie and Tashakkori (2009, p.304) indicate the need for "each inference ... to be consistent with current theories and empirical findings of other researchers". This may appear to run contrary to the primary purpose of research as aiming to develop and test new theories (which may not necessarily be consistent with current theories) and not only to confirm the findings of other researchers, but also to disconfirm the findings of other studies. However, if it is viewed as similar to the foundational component of Dellinger and Leech's (2007) framework, the review of the literature in Chapter 2 of this study has provided a comprehensive look at current theory and other research in the area of critical thinking skills development. Theoretical consistency is attended to by building explanations in the case study based on clearly articulated theoretical propositions. Yin (2009, p.141) considers the reflection of "some theoretically significant propositions" to be a characteristic of "better case studies" and as an aid in identifying causal links.

(3) interpretive agreement

This criterion relates to the credibility of inferences. Qualitative research often relies on triangulation, member checking, rich or thick descriptions and other validity strategies. In the qualitative component of this study, the infusion analysis is reported in detail and mapping the "coverage" of critical thinking skills components and subskills across the projects is overt and open to inspection. The strategy to be used in the contextualising or process analysis is to include discrepant information from student reflective journal entries. Not all students will experience the critical thinking process during the projects in the same way, and example entries from students will include both substantiating and negative information.

This does not mean that the study assumes that there would be complete agreement on interpretations. Disagreement may arise from alternative plausible interpretations (Teddlie & Tashakkori, 2009, p.305). The strategy adopted to ensure interpretive agreement is to take into account rival explanations for results (to the extent that this is possible, as it would be unrealistic to claim to have considered *all* possible explanations), and to ensure that conclusions are not contradictory. Potential rival explanations are also discussed in section 3.7 (Methodological limitations).

(4) interpretive distinctiveness

This criterion is closely aligned with the strategy adopted in (3) above in relation to considering alternative explanations. The measure proposed by Teddlie and Tashakkori (2009, p.305) is that “the investigator must be clearly able to refute (eliminate, discount) other possible interpretations of the results”. It may be more realistic to address the alternative explanations of which the researcher is aware, and to acknowledge that other potential explanations may exist. The qualitative component draws on both a conceptual framework in instrumental analysis and the emic perspective (addressed in section 3.3.3) in an endeavour to ensure that other plausible explanations are identified in interpreting results.

(5) integrative efficacy

Integrative efficacy is determined by the extent to which both qualitative and quantitative strands of the study are integrated in drawing meta-inferences in reaching conclusions. Integrative efficacy does not necessarily require data integration during analysis. Where the purpose of mixed methods is one of complementarity, as in this study, where “different methods are used to measure overlapping, but also distinct facets of a given phenomenon ... integrative analysis strategies are not generally useful” (Caracelli & Greene, 1993, p.204). Instead, the researcher integrates and synthesises the results obtained from separate analyses when drawing conclusions.

In this study, different components of the research (the parts of the case study) make distinct contributions to drawing conclusions, so that the design acknowledges the complementary purpose of different measures and thereby contributes to integrative efficacy. Integration should not be interpreted as “creating a single understanding on the basis of the results” (Teddlie & Tashakkori, 2009, p.305). Both consistent or confirmatory and inconsistent or contradictory results obtained in different components are taken into account in drawing conclusions. The use of effect sizes in the quantitative component (rather than testing for statistical significance) as set out in section 3.3.4.2(c) further facilitates integration of findings in meta-inferences.

(6) interpretive (integrative) correspondence

This criterion is met through “the extent to which meta-inferences satisfy the initial purpose for using an MM design” (Teddlie & Tashakkori, 2009, p.308). The extent to which the conclusions drawn answer the questions that required the use of mixed methods will determine the extent of interpretive correspondence. Within the pragmatic paradigm, where the questions determine the methods used and the strategies adopted to answer the questions, this study has consistently aligned the research with the research questions. The interpretation of the findings will be similarly aligned with the research questions.

3.4.3 Measurement validity

The construct validity of the CCTST (California Critical Thinking Skills Test) as instrument for obtaining critical thinking skill scores is important in this study not only because measurement validity is necessary to ensure data quality, but also because the test had been based on the conceptualisation of critical thinking in the Delphi Report (APA, 1990), which has also been used in the categorical strategy for measuring the infusion of critical thinking skills in the projects under investigation.

The CCTST has been subjected to a series of validation experiments which have been reported in four technical reports. In *Technical report 1* (Facione, 1990b), experimental validation and content validity were tested in four experiments. Three of the four experiments found that students who had completed a course in critical thinking performed (statistically) significantly better in the test than students who were entering the course (courses included Introduction to Philosophy, Reasoning and Problem Solving, Argument and Reasoning, Logic, and Critical Reading as Critical Thinking). The report concluded that the CCTST can be used successfully to detect increased critical thinking ability as a result of “college level instruction specifically designed for the purpose of critical thinking development” (p.13). The overall internal consistency results from the validation studies reported KR-20 values between .68 and .70. The test-retest reliability (alternate form reliability) was estimated at .78. Facione et al (2002, p.15) point out that “internal consistency estimates like the KR-20 and other estimates of reliability may vary from sample to sample”. They further suggest that where tests such as the CCTST are scored dichotomously, it is not reasonable to expect the same reliability coefficient as for instruments that test a single homogenous skill or ability (where the expected reliability coefficient would be .80), as “there is no theoretical reason for believing that items should correlate highly with one another” (Facione et al, 2002, p.15), and therefore suggest that reliability ratings of .65 to .75 should be considered sufficient (Norris & Ennis, 1989, in Facione et al 2002, p.15).

Technical report 2 (Facione,1990c) examined factors that could be predictive of critical thinking skills, using pretest scores only, and found that other measures of academic achievement at high school, such as GPA and SAT scores, could be predictive of improvements, but that age, units of study completed, and the teaching experience of lecturers (among others) had no significant predictive value.

Of importance to this research is that the investigation found a positive correlation between scores in the CCTST (obtained from a posttest administered to students enrolled in a “Critical Reading as Critical Thinking” course) and students’ scores in reading and comprehension using the Nelson-Denny Reading Test. Scores of non-native English speakers were found to remain virtually unchanged from pretest to posttest and to remain at significantly lower levels than the scores achieved by native English speakers (such lower levels also being reflected in all other standardised testing instruments, in spite of very similar levels of GPAs). The conclusion in *Technical report 2* was that the CCTST was not suitable for assessing students who were non-native English speakers.

Technical report 3 (Facione, 1990d) investigated the impact of other factors – gender, ethnicity, course major, and students’ own estimation of their critical thinking skills – on performance in the CCTST. That investigation showed that at pretest and in control data the test revealed no gender bias, did not favour any particular ethnic group (using the test results of only “self-identified native English speakers), and that pretest results were not affected by the major that a testtaker had selected for study.

At posttest, however, the investigation found gender differences after students had completed a course in critical thinking. Results also showed that not all ethnic groups derived the same benefit from having completed a course in critical thinking. Posttest results varied significantly by major studied. Majors were clustered into six categories, and the largest increases in CCTST scores were among the cluster of mathematics/engineering/statistics/computer science majors. The cluster of business/administration/management/government/military science majors ranked fourth in terms of improvement, and fifth in terms of mean posttest score.

Students were also asked to rate their own critical thinking ability, and their critical thinking self-confidence was reported to appear unrealistically high, but nevertheless correlated with relative student achievement in the CCTST. The impact of critical thinking self-confidence after controlling for SAT scores and native language, however, was not significant (Facione, 1990d, p.1).

The report concluded that “although important when considered in isolation from everything else, none of these factors is statistically significant when one controls for the impact on the

CCTST of SAT scores, college GPA, and native English language on student performance” (Facione, 1990d, p.10).

Technical report 4 related to the interpretation of results and covered the establishment of pretest and posttest norms that are valid for Forms A and B of the test (but not Form 2000), as well as percentile rankings. In terms of subscores, *Technical report 4* indicated a strong correlation among the three sub-scores as well as between sub-scores and total score.

As stated in the conclusion to *Technical report 1*, “we can be confident that the CCTST succeeds in detecting the growth in CT skills which is hypothesized to occur during college level instruction specifically designed for the purpose of critical thinking development” (Facione, 1990b, p.13). The test therefore measures critical thinking skills development as a result of specific interventions, and not the development that is likely to occur naturally as a “by-product of good college instruction” (Facione, 1990b, p.12).

3.4.4 Reliability

In line with the methodological considerations and the ecological validity of educational studies expressed by Thompson (1999, p.9) and discussed in section 3.3.4.2(c), reliability in this discussion is viewed primarily as a characteristic of data rather than as a characteristic of analytic instruments. This relates reliability specifically to data quality, which not only depends on the data selection strategies and data collection procedures that are part of the design, but is ultimately determined by the actual data obtained.

The quality of data is a necessary, although not necessarily sufficient, prerequisite to ensure the quality of answers to the research questions (therefore the quality of inferences) (Teddlie & Tashakkori, 2009, p.208). Unless the data obtained are reliable, or at least limitations in the reliability of data are recognised, the quality of inferences can be questioned.

In mixed methods research, the same criteria are applicable to each type of data as would pertain to the quality of such data in single-method studies. An additional criterion relates to data integration, in other words the process of either quantitising qualitative data or qualitisising quantitative data. In this study, qualitative data will not be quantitised for purposes of analysis. Codes are assigned to components and examples of critical thinking as well as to tasks identified in the content analysis of documents for the purposes of pattern matching and generating data displays, but no statistical analysis is performed on qualitative data.

Teddlie and Tashakkori (2009, p.212) propose the term *trustworthiness* as a global concept pertaining to data quality that incorporates the criteria for qualitative studies, namely credibility, transferability, dependability and confirmability, introduced by Lincoln and Guba

(1985, in Teddlie & Tashakkori, 2009, p.212-213). Yin (2009, p.41) relates reliability to the data collection phase and suggests the use of a case study protocol and developing a case study database as tactics to ensure data quality. As this case study makes use of documentary data sources, it is less susceptible to the threats to reliability that are present when collecting field data. Strategies for data selection and collection have been explained in section 3.3.3.2.

The strategies employed in this study to ensure reliability of qualitative data include

- using unobtrusive measures which limit or avoid researcher effects
- using more than one type of data and more than one data source (project documentation, student reflections and quantitative data) and applying triangulation strategies for purposes of corroboration or disconfirmation
- limiting the amount of reinterpretation of qualitative data (in other words, the actual documents that were used in class for the projects are analysed) thereby enhancing authenticity of the data
- reviewing the documents on more than one occasion, which is a particular strength of using documentary data

The validity and reliability of the CCTST as measure has been addressed in section 3.4.3. Some of the caveats suggested in the Test Manual (Facione et al, 2002, p.15) may have a specific impact on the reliability of scores obtained from students in this study, and need to be taken into account when drawing conclusions. These cautions include the fact that the motivation of test-takers can affect the reliability of the scores obtained. The validation studies conducted between 1988 and 1989 showed that students were highly motivated on the pretest, but only marginally motivated at posttest (Facione et al, 2002, p.19). Lesser motivation at posttest was evident from the fact that students spent less time on the posttest (Facione et al, 2002, p.20).

3.4.5 Generalisability

Generalisability relates to the **external validity** of a study (Yin, 2009, p.43). One view is that generalisation is not the aim of case study research, that “the real business of case study is particularization, not generalization” (Stake, 1995, p.8). Morgan (2007, p.72) adopted the term *transferability* from Lincoln and Guba (1985, p.297) and advocates a pragmatic focus on the usefulness of the knowledge generated for other contexts and the need to identify factors that can influence the applicability of knowledge in other circumstances. The background to the program described in Chapter 1 and the context of the projects set out in Part 1 of the case study identify the factors that distinguish the context and that can guide consideration of applicability in other contexts.

From a pragmatic, mixed methods perspective, this study is neither as context-bound as a purely qualitative study, nor does it aim at generalisability to other populations or universes as in traditional quantitative studies. As set out in section 3.2.3, item (3), this study makes no

claim to generalisability as defined in the scientific paradigm, and it further views claims of transferability in terms of analytic generalisation. It presents an approach to explanatory case analysis that may be transferable to other contexts, and provides insights into an immersion approach to critical thinking skills instruction that can inform practice in other contexts.

3.5 Ethical considerations

Ethics approval for the study was obtained from the Human Research Ethics Committee in terms of the National Statement on Ethical Conduct in Research Involving Humans. Initial collection of data in the form of student scores in the CCTST prior to confirmation of candidature took place with ethics approval under a project evaluating generic skills development in the course that incorporated the units of study that are the object of this study. Ethics approval for using the collected data as well as data collected subsequently was obtained upon confirmation of candidature (Project 2338, ID 07-241).

Participation was voluntary. Each participant received an information letter (participant information statement) setting out the purpose of the research and the proposed use of the data, as well as a consent form and a form to be used for withdrawing consent at any stage of the research process (Appendix 3.1). Only data for which written consent was obtained from participants have been included in the study. Where a participant was under the age of 18, written consent from a parent or guardian was required and obtained. No withdrawals of consent have been received from participants.

Data have been de-identified after matching pre- and posttest scores (but remained potentially re-identifiable). Names have been removed from reflective journal entries, and where journal entries make reference to other students, identifying information has similarly been removed to ensure anonymity.

The name of the program being investigated has been changed not only to afford a measure of anonymity, but also because the case study examines the program at a specific period in time (over a period of one year), and as such does not take into account subsequent changes in the program. A more generic name allows the researcher to delimit the scope of the case.

The use of documentary data removes some of the pitfalls inherent in case study research where ethnographic methods are used and where the researcher has to guard against misrepresentation or misinterpretation of respondents' views. The researcher's interpretation of documentation is nevertheless not entirely objective, as no research can claim to be value-free. To compensate for any bias inherent in interpretation, the data used in this study are presented in the analyses and can therefore be inspected.

3.6 Limitations of the study

This study is situated within the broad field of critical thinking skills development, an area that encompasses many aspects of the higher education endeavour. Given the extent of the field,

there are many more areas of interest and many more questions to be answered than can be covered in a single study. Some limitations of the study therefore arise from practical constraints that require delimitation of the scope of the study rather than as a result of oversight or because such areas were not deemed to be of interest or relevant to an inquiry into critical thinking skills development.

The case study method adopted here also acknowledges that “there will be many more variables of interest than data points” (Yin, 2009, p.2). It has been necessary to focus the study on but one aspect of the educational context, which is acknowledged as intricate and complex. Within such environments, there may well be unknown factors that will impact results.

The design of the case study has been guided by the recommendations suggested by Halpern (2001), as discussed in section 3.3.1. Some of the recommendations fall outside the scope of this study and should be mentioned here. The first is the identified need to assess both critical thinking ability and the disposition to think critically (Halpern, 2001, p.273). While the disposition to think critically may be discernable in the student reflective journal entries used in this study, analysis from a specifically dispositional perspective falls outside the scope of this study to any extent beyond identifying that at a particular point in time a journal entry may or may not reflect that the student is engaging in a phase of the critical thinking process.

The second is the need for a longitudinal study to evaluate the development of critical thinking skills beyond the years of formal study – in other words to examine the issue of transferability that has been a key concern in critical thinking skills instruction. This study does not examine the transfer of critical thinking skills to new contexts, and the case study is confined to the first year of study.

The study makes use multiple comparison groups in order to separate out maturational and other gains that may result from participation in the higher education process in general from gains attributable to the development of critical thinking skills during the first year of the program. Although this study has made use of multiple comparison groups in analysing student scores on a standardised critical thinking skills test, it can at most provide an indication that gains are potentially attributable to the intervention. Using multiple comparison groups will compensate for the inherent weaknesses of testing single groups repeatedly (where students may become test weary or test wise) (Halpern, 2001, p.275), but it would remain impossible to account for all potential confounding factors.

Case study research is often associated with data obtained from observations and interviews (Yin, 2009, p.15), and the use of data obtained from source documents not generated for the specific purpose of this study may be regarded as either a strength or a limitation. On the one

hand, the student reflections were not generated for the specific purposes of this study, and on the other they nevertheless represent the emic perspective and give participants a “voice”. In addition, the fact that the reflections were written in response to questions that were not aligned with the critical thinking process may be seen as a limitation, or it may be seen as more credible evidence, as students were not responding to the researcher’s interest. The question nevertheless lingers: Would a different picture have emerged if the students were responding more directly to questions relating to the critical thinking process? Perhaps. Any inferences or conclusions drawn from the evidence will moreover need to be tempered by the realisation that “absence of evidence is not evidence of absence” (Carl Sagan, US astronomer, 1934-1996).

3.7 Summary

This chapter has covered methodological aspects of the current research, beginning with relevant considerations relating to the field of mixed methods research and the adoption of pragmatism as paradigm. It has made explicit the paradigmatic and epistemological views of the researcher and the influence of the pragmatic approach on research methodology (sections 3.1 and 3.2). The pragmatic approach is characterised by an abductive connection between theory and data, an intersubjective relationship with the research process and transferable inferences from data, and each of these characteristics have been applied to the current study in section 3.2.3.

The rationale for employing mixed methods were set out in section 3.2.3. Mixed methods in this study serve as a means for triangulation in corroborating findings as well as a complementary purpose, and importantly allow the researcher to answer the research questions. The mixed methods research process has been outlined in section 3.2.4, addressing specific aspects of the research strategy: the stage and timing of mixing methods, the weighting assigned to each method, the nature of mixing at each stage, and theorising within the mixed methods strategy.

Section 3.3 presented the research methods and outlined the explanatory case study method and the case study design that is intended to answer the research questions (section 3.3.2.1) and the propositions that guide the study (section 3.3.2.2). The first year of the employability skills development program (ESDP) serves as primary unit of analysis for the case study, and the embedded units of analysis (student scores in a standardised critical thinking skills test and four student projects undertaken in the first year of the program) were set out in section 3.3.2.3

Section 3.3.3 covered the data collection strategies, including the use of unobtrusive and nonreactive data collection strategies, and the use of documentary data sources. The California Critical Thinking Skills Test (CCTST) as instrument and the procedures for collecting quantitative data were explained in section 3.3.3.3.

Section 3.3.4 addressed the data analysis strategies that will be employed in the case study, including the categorical approach to the infusion analysis to determine how and the extent to which critical thinking has been infused into the tasks that students undertook in the projects, the contextualising analysis in terms of a conceptual framework derived from collaborative constructivist theory to determine how students engaged in the critical thinking process during the projects, and performance analysis to determine how effectively the immersion approach is as reflected in student scores in the CCTST.

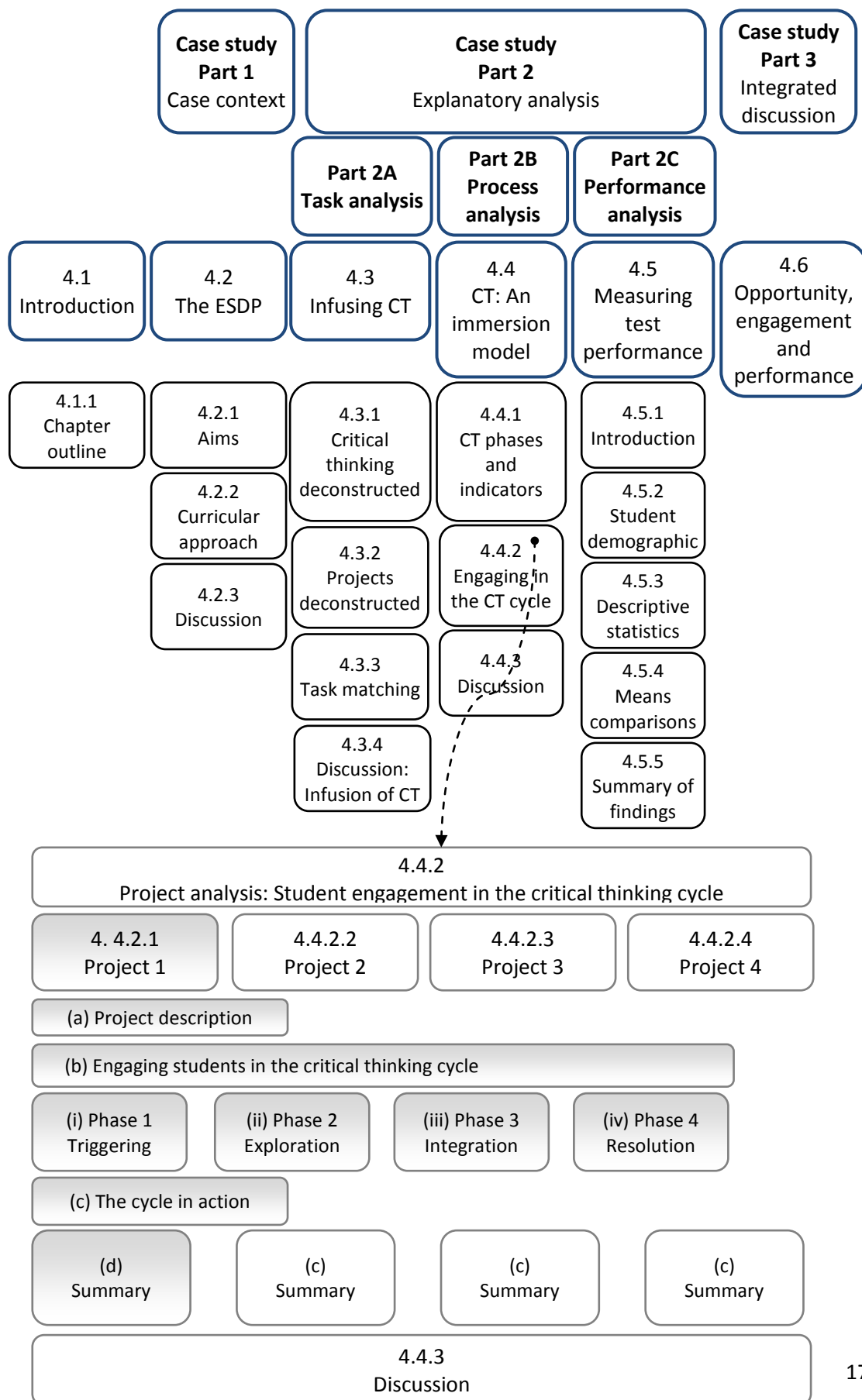
The specific analytic techniques to be applied were set out in section 3.3.4.1, and include categorical and contextualising instrumental techniques applied in content analysing data as part of the explanation-building process in the case study. Section 3.3.4.2 presented the rationale for reporting effect sizes in the performance analysis and the contrasts of interest in multiple group comparisons.

Matters of validity, reliability and generalisability were addressed in section 3.4. Validity was considered in terms of the design quality and the interpretive rigour and associated criteria which are applied in the context of mixed methods research and the case study design. Section 3.4.3 reported on the validity studies that had been conducted on the CCTST. Reliability and strategies to enhance the trustworthiness of the study were explained in section 3.4.4, and section 3.4.5 considered generalisability from the perspective of analytic generalisability and transferability which pertain to mixed methods and case study research.

Ethical considerations were addressed in section 3.5.

Chapter 4 presents the data analyses and discussions in an explanatory case study.

Chapter 4: Analysis



The case study

Infusing critical thinking into an employability skills development program (ESDP): An immersion approach

4.1 Introduction

This is an explanatory case study. It seeks to explain how critical thinking skills are infused into the first year of an employability skills development program (ESDP) that follows an immersion approach by analysing the tasks that students perform during four projects in the first year of the program in terms of a comprehensive conceptualisation of critical thinking and explaining how students engage in critical thinking by analysing the projects and student reflections in terms of a conceptual model of practical inquiry that makes explicit the critical thinking cycle. Critical thinking performance is then measured through a standardised critical thinking skills test and multiple group comparisons.

Chapter 1 has set out the relevance of employability within the international skills agenda and identified the interrelated nature of such skills and the centrality of critical thinking skills in generic skills development (section 1.2.2).

Showing how critical thinking skills have been infused into the development of employability skills in the employability skills development program, and that the tasks that students are required to complete in the projects immersed them in a learning process that engaged them in a critical thinking cycle and facilitated the development of critical thinking skills, leads to the proposition that students who completed the ESDP projects successfully will have developed increased capacity for critical thinking, and that enhanced critical thinking skills will be reflected in student scores in a standardised critical thinking skills test.

The main analytical focus of the case study is on the learning processes implemented in the employability skills development program, and it evaluates each of four projects, as embedded units of analysis, on the basis of a model of critical or practical inquiry (Garrison, 1991).

Through a process of step-wise explanation building, the case study answers the research questions:

RQ1 *How does the immersion approach followed in the program provide opportunities for developing critical thinking skills*

RQ2 *How effectively does participation in an employability skills program develop students' critical thinking skills as measured in a standardised test?*

Research question (1) will be answered by examining the learning tasks that students undertake during the first year of study in order to answer two subquestions .

RQ1A *How are critical thinking skills infused into learning activities during the first-year of the ESD program (employability skills development program)?*

Subquestion 1A is answered in the **task analysis** that intends to show how critical thinking is infused into the project tasks. The analysis is conducted by using content analysis to deconstruct the four first-year projects to identify their constituent tasks and matching individual tasks against examples of critical thinking tasks in each of the critical thinking components and subskills identified in the expert consensus conceptualisation of critical thinking (APA, 1990; Facione, 1990a).

RQ1B *How do students engage in a critical thinking process during the learning activities undertaken in the first year of the ESDP (employability skills development program)?*

Subquestion 1B is answered through the **process analysis**, by examining how students engage in the four phases of the critical thinking cycle during the projects. The critical thinking cycle is derived from a conceptual model of inquiry proposed by Garrison (1991) and Garrison, Anderson and Archer (2000).

Both analyses follow an instrumental approach by applying established conceptualisations and theoretical constructs and using pattern-matching techniques. During the process analysis, indicators of critical thinking will be identified iteratively to construct a comprehensive list of indicators. The process analysis is further augmented by presenting the student perspective through extracts from student reflections, and content analysing student reflections to identify the critical thinking indicators that are evident.

Question (2) is answered through the **performance analysis** by calculating the improvement in student scores in the California Critical Thinking Skills Test (CCTST) in a pretest-posttest design. The performance analysis will examine four contrasts to answer the following subquestions:

RQ2A *Do testtakers perform better in the CCTST after participating in the first year of the program than at the start of the program?*

- RQ2B *Do testtakers who have participated in the first year of the program perform better in the CCTST than students who entered the program in the second year?*
- RQ2C *Do testtakers from an English-speaking background perform better in the CCTST than students from non-English-speaking backgrounds?*
- RQ2D *Do students from an English-speaking background show greater improvement in CCTST performance after participating in the first year of the program than students from non-English-speaking backgrounds?*

4.1.1 Outline of the chapter

The parameters of the case have been defined in the case study design in section 3.3.2 which highlighted the questions, the propositions and the units of analysis. Data collection strategies have been described in section 3.3.3 of Chapter 3, and data analysis strategies have been set out in section 3.3.4.

The case study has been divided into three parts:

Part 1 describes the context of the case. The context is an employability skills development program (ESDP). The main unit of analysis is the first year of the ESD program, with the projects within the first year and student performance on a standardised critical thinking skills test serving as embedded units of analysis. Section 4.2 outlines the aims and principles of the program and provides details of the curricular approach in the program. This description is considered in the discussion in Part 3 of the case study to establish how it fits with the established view of immersion approaches to teaching critical thinking skills.

Part 2 is explanatory and contains the project analyses and findings. The data analysis strategies have been set out in detail in section 3.3.4 in Chapter 3. The structure adopted in part 2 is to follow each analysis with an explanation of the interpretation and a summary of the findings in the particular part of the case study (Liamputtong, 2009, p.318) in order to make explicit the line of reasoning and to facilitate explanation building.

The three components of analysis are presented sequentially starting with the task analysis in part 2A, followed by the process analysis in part 2B, and the performance analysis in part 2C. All four embedded units of analysis – projects – are analysed in parts 2A and 2B. Part 2C contains the analysis of student test scores.

Part 3 presents the discussion that integrates the qualitative and quantitative components in drawing meta-inferences based on the findings.

Chapter 5 concludes the study by considering the implications of the findings and identifying areas for further research.

The next section describes the employability skills development (ESD) program, the development and aims of the program , the curricular approach and the approach to teaching and learning in order to present the specific context in which the projects, as embedded units of analysis, are situated.

Part 1: The context

4.2 The employability skills development program (ESDP)

The employability skills development program (ESDP) was introduced into a bachelors degree against the background of the international skills agenda. Its curricular context reflects an approach that differs from conventional approaches to generic skills instruction.

The most common approaches to incorporating generic skills such as communication skills and numeracy, and indeed any set of graduate attributes, into existing courses is either to add skills development in “stand-alone” optional modules or workshops, or to embed such skills development into existing discipline studies or subjects. Optional modules may not be effective across courses if participation rates are low, and questions persist as to the transferability of skills acquired in either generic or subject-specific contexts. Discrete modules are moreover usually offered at first-year level, which can mean that there is little further development of skills as students progress through their courses unless deliberately promoted within discipline studies.

Embedding skills development in subject content faces a number of barriers: reluctance on behalf of lecturers to divert attention away from the subject-specific knowledge that they deem to be most important, limited preparedness of teaching staff to facilitate skills development, demands on the time of teaching staff to incorporate skills-development components into their subjects, and the inappropriateness of lecture formats for engaging students in the types of learning tasks that facilitate skills development (Livingston et al, 2004, pp.50-54, 58-61).

4.2.1 Aims

In explaining the approach followed within the program and examine how it relates to different approaches to critical thinking skills instruction, it is necessary first to look at the aims of the program.

The aim of the employability skills development program is for students to develop integrated business knowledge and the skills necessary for career success.

The broad aims of the program are to

- adopt a teaching and learning model that will enhance student participation, interaction between teaching staff and students and among students, as well as among teaching staff in the program

- leverage the use of technology to enhance student learning and work-readiness
- develop student knowledge, skills and attitudes so as to enhance the learning experience and student success by focusing on five skills areas:
 1. Learning management and lifelong learning
 2. Ethics
 3. Communication and business process integration
 4. Teamwork and leadership (including negotiation and entrepreneurship)
 5. Information literacy (including numeracy and research), critical thinking, and reflective practice

Documentation (Program Overview) identified the following principles for the ESDP:

- flexible teaching and learning resources that are responsive to student needs
- student-centred teaching and learning activities that enhance student participation, interaction between teaching staff and students, student-to-student interaction, and team teaching
- learning contexts that build civic awareness and respect for the environment
- an international focus and an understanding of the way in which differences in culture can impact on decision-making and behaviour
- opportunities for students to develop writing, communication and study skills
- use of technology to facilitate learning and develop workplace skills

In order to achieve these outcomes, a curriculum was mapped across the four units, each building consecutively on the outcomes achieved in preceding units. Learning outcomes were carefully crafted to achieve the goals of each of the units, and assessment activities were matched to the learning outcomes. A deliberate intention in the curriculum development process was to ensure that the program would improve the overall student experience, not just their learning experience. This meant that teambuilding had to be conducted in a manner likely to build friendships, as well as building an understanding of individual differences and cultural issues, and capacity to work collaboratively. Assessment in the program was to be continuous through a series of assessable project outcomes, with no summative written examination at the end of semesters, as the targeted outcomes did not lend themselves to examination within the limited timeframe and the environment of exam conditions.

4.2.2 The curricular approach

The employability skills development program (ESDP) consists of four core units of study incorporated into a three-year Bachelor of Business degree: two semester-long units of study are offered in the first year, and one in each of the second and third years. The program is based within the business discipline but crosses over the available majors or areas of study (management, marketing, finance, accounting, economics, management information systems).

So while the ESDP is a core component of the bachelor degree, it is also a discrete program of study intended to develop the employability of students from all specialist studies within the business discipline.

The following have been identified as distinctive elements of the approach followed in the ESDP: class sizes, teaching teams, connected learning spaces, collaborative and active learning, and reflective practice.

Class sizes

Whereas year groups in course units can consist of several hundred students per class, sessions in the program are limited to class groups of 35 who participate as teams of five in all in-class activities. Class sessions are hands-on and students participate actively.

Teaching teams

Lecturers in the ESDP teach in teams, with several lecturers assigned to each unit of study. Each class group attends a three-hour session per week, facilitated by one of the lecturers in the teaching team. The team-teaching approach is a departure from the individualistic academic culture. Lecturers act as learning facilitators within a student-centred learning environment. Staff were selected from all majors in the degree course, which meant that the program had multi-disciplinary staff who also had to learn a very different way of teaching that stood in contrast to large-group lecturing as the norm for most units of study. Staff were guided through a formal training program to ensure consistent adoption of the learning approaches. Moderation to ensure a consistent approach took place via weekly staff team meetings as well as staff reflections on each week's sessions which were emailed to the teaching team.

Learning spaces

Technology and the learning spaces play a special role in the teaching and learning model adopted in the ESDP. A purpose-built room was designed to create a learning environment that would best support the targeted outcomes. This room accommodated students working in seven groups of five, each student using a laptop at customised desks equipped with power and data ports for internet access and a desk monitor at the end of the table. Students may use their own laptops, or one supplied by the University (for a small bond). The connectivity was provided for displays on laptop screens to be diverted to the desk monitor to share with the team, as well as to the data projector to display to the class as a whole. Whiteboards were fitted to all walls of the learning space for teams to use in brainstorming activities.

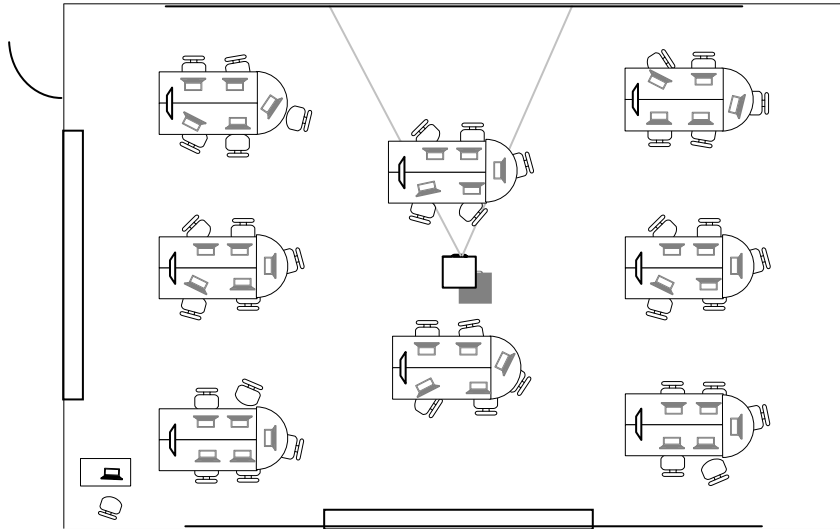


Figure 4.1: The learning space

The learning space therefore supported active, hands-on learning and in-class access to the resources of the worldwide web and peer-to-peer communications.

Collaborative, active learning: Students undertook the projects in teams, and assessment of outcomes was based proportionately on team and individual performance.

The projects in the program were based on topics of current social or societal interest which had to meet several criteria:

- suitability for devising authentic tasks that can be sustained over a period of several weeks
- ability to engage students cognitively, with no singular clear-cut answers
- a requirement for multiple modes of information, eg, news reports, databases, websites and academic publications
- a strong ethical and/or civic component

The projects were scenario-based, situated in an organisation or business, and in most of the projects student teams were assigned a position and a task within the scenario. Each project was undertaken over a period of several weeks (two projects per semester).

Students worked in teams during the planning, exploration and decision-making phase of each project, collaborating on the tasks, networking both face to face and via the online learning environment, where they could engage in asynchronous communications and overcome some of the constraints of teamwork presented by full-time study schedules. In the process they were required to accommodate individual points of view and resolve any issues relating to

team dynamics. The typical composition of classes ensured that students also gained skills in cross-cultural communications.

At the start of each class session, one student had to report back on the progress of their particular team, so they became accustomed to taking responsibility for their own progress and to speak to an audience in a non-threatening situation.

The learning opportunities and engagement in the critical thinking process are examined in the analysis of the four main projects (embedded units of analysis) in part 2 of the case study.

Reflective practice: At the end of every session, students were asked to reflect on their own learning experience and to make an entry in the online reflective journal. These reflections were private, to be viewed only by the lecturer who commented on student posts to encourage and provide support at individual (and more personal) level and to encourage more self-directed learning.

4.2.3 Discussion

As seen in the description above, the structure and location of the program within the overall course curriculum overcame several limitations to generic skills development.

- (1) All students enrolled in the course were required to complete the four employability skills units, which ensured universal coverage across the major areas of study.
- (2) Structuring the four units vertically through the program, rather than compressing them into a common single semester or year of studies, made it possible to develop skills at progressively more challenging levels, building on skills and capabilities developed in preceding units.
- (3) The ESDP incorporated all major areas of study into the contexts of projects and activities in a “whole-of-business” approach, avoiding a narrow focus on specific areas (such as accounting or marketing) and increasing the likelihood of transferability of skills gained.
- (4) Teaching staff in the program were drawn from discipline areas and training was provided to ensure preparedness in facilitating skills development.
- (5) Unit design and development were undertaken within the office of the director of undergraduate studies, limiting the demands on teaching staff time and ensuring a consistent approach across the ESDP.
- (6) Custom learning spaces were designed to facilitate learner activity and engagement within a collaborative context. Although the physical or classroom environment has

not been identified in the literature reviewed here as presenting a barrier to engaging students in the kinds of activities that promote critical thinking, standard learning spaces that are tailored to lecture formats can be a significant obstacle when considering the nature of the tasks and projects in the case study.

The ESDP was therefore based on an innovative approach to teaching and learning that differs from the standard “stand-and-deliver” lecture format of disciplinary studies.

Much of the debate on models of instruction and approaches to critical thinking skills instruction as reviewed in section 2.3.3 has been focused on where in the curriculum critical thinking skills should be taught. Should it stand alone (Ennis, 1981; and others), be embedded in discipline subjects (McPeck 1990a, 1990b, and others), or follow an immersion approach (Prawat, 1991; Angeli & Valanides, 2008)?

The same considerations can be applied to where in the curriculum, and how, employability skills should be taught. The debate in terms of approaches to critical thinking skills instruction is far from settled (Livingston et al, 2004). In similar vein, as the demand grows for institutions to deliver work-ready graduates, the question would be how best to approach the development of employability skills (of which critical thinking skills is but one aspect).

The program as context for this case study can best be classified as an immersion approach as defined by Angeli and Valanides (2008) which emphasises dialogue, ideas, and engaging students in considering, analysing and evaluating different points of view (p.324). This should be contrasted with the immersion approach defined by Ennis (1989, p.5) which made use of “only standard subject-matter content” but without making explicit the general critical thinking principles. During the 1990s, there was some debate, especially between Ennis (1989) and McPeck (1990) as to definitional aspects of “subject” and “domain” surrounding subject-specific or domain-specific thinking skills instruction. Here, the primary distinction is seen as being the purpose of the instruction. It is accepted that thinking is always about something (whether that be considered a domain-specific or general topic). Two features distinguish the approach followed in the ESDP as an immersion model: students do not receive instruction in discipline-specific content to be learned and on which they are to be assessed, and they are not instructed in the general principles of critical thinking (as in informal or formal logic courses).

The ESDP presented an opportunity to develop critical thinking skills within a broader employability skills development program, thus justifying the resources and “curriculum space” required and overcame institutional and disciplinary resistance to integrating thinking skills instruction in subject curricula (the integrated or embedding approach). Following a

model-based approach to developing resources removed demands on teaching staff and helped overcome problems with instructor readiness, although it did not necessarily remove general resistance to such innovation. Additional support was provided through a team-teaching model.

However, the aim of the program is for students to develop a range of employability skills. It is not aimed specifically at developing critical thinking skills. The fundamental role of critical thinking in the development of employability skills has been discussed in Chapter 1 (section 1.2.2). It is therefore necessary to examine how critical thinking skills development is infused into the ESDP, and that is the purpose of Part 2 of the case study.

Parts 2A and 2B of the case study provide a detailed analysis of the opportunities for critical thinking as infused into the tasks that students undertake in the projects, and the process of inquiry in which students engage during the projects. Part 2B analyses the projects that students undertake in the program in depth and provide a clear explanation of how students engaged in the critical thinking cycle.

Part 2: Explanatory analysis

Part 2 of the case contains the three components of the analyses and findings:

Part 2A presents the task analysis which consists of the deconstruction of critical thinking skills and a deconstruction of the tasks undertaken in four projects during the first year (content analysis of documents has been included in Appendix 4.2). Matching of tasks with skills at deconstructed level is presented in the matrices in tables 4.1(a) to 4.1(d) to identify the extent to which examples of tasks that develop critical thinking skills are represented within the project tasks.

In part 2B, each project is analysed in terms of the critical thinking cycle. Section 4.3.3 presents the framework for analysis, adapted from Garrison and Anderson (2003), followed by the explanatory analysis of the critical thinking process in the four projects in the first year of study. The analysis of each phase in the critical thinking cycle is followed by an explanatory section setting out how the data were interpreted, and each project is concluded with a summary of the indicators identified in the students reflections during the project. Part 2B concludes with a discussion of the findings.

Part 2C presents the performance analysis, a quantitative analysis and effect sizes of student gains in critical thinking after completion of the first year of study.

Part 3 presents an integrated discussion of the findings in the three components of the Part 2.

Part 2A: Task analysis

4.3 The infusion of critical thinking skills

To examine the proposition that the learning tasks in the ESDP represent an infusion of opportunities to develop critical thinking skills, it is necessary to deconstruct the projects and examine the extent to which individual tasks or activities are aligned with the examples of activities that are likely to develop critical thinking as set out in the Delphi Report (APA, 1990).

Part 2A is intended to answer subquestion 1A:

RQ1A *How are critical thinking skills infused into learning activities during the first-year of the ESDP (employability skills development program)?*

If the project tasks approximate the examples of tasks for developing each of the subskills in the Delphi Report it will be able to assert that critical thinking skills can be infused into a program targeting employability skills.

The categorical analysis comprises a series of processes:

- (1) deconstructing critical thinking to task level based on the Delphi Report (APA, 1990) and assigning a code to each example of a critical thinking task (Appendix 4.1)
- (2) deconstructing the projects to task level using content analysis and assigning a code to each task (Appendix 4.2), and representing the deconstruction in Appendix 4.3
- (3) matching a project task against a critical thinking task (Appendix 4.4)
- (3) constructing matrices to examine the alignment between the critical thinking tasks and the project tasks (tables 4.1a to 4.1d in section 4.3.1.3).

4.3.1 Critical thinking deconstructed

Appendix 4.1 presents the critical thinking skills deconstruction in six components, together with the related categories for each component and the examples of tasks for each category as set out in the Delphi Report (APA, 1990):

Component	Subskill	# Examples
Interpretation	categorisation	17
	decoding significance	
	clarifying meaning	
Analysis	examining ideas	15
	identifying arguments	
	analysing arguments	
Evaluation	assessing claims	19
	assessing arguments	
Inference	querying evidence	12
	conjecturing alternatives	
	drawing conclusions	
Explanation	stating results	18
	justifying procedures	
	presenting arguments	
Self-regulation	self-examination	21
	self-correction	

The data contained in Appendix 4.1 are then used to construct the tables used in the matrices in section 4.3.3.

4.3.2 Projects deconstructed

Content analysis of the projects was performed manually. The original project instruction documents showing the code generated for each task (during content analysis) in context have

been included in Appendix 4.2. The deconstruction diagrams in Appendix 4.3 represent the outcomes of the content analysis process for each project.

4.3.3 Task matching

The matrices in tables 4.1(a) to 4.1(d) show the alignment between the examples proposed in the expert consensus definition of critical thinking skills (Appendix 4.1) and the tasks undertaken in the projects (Appendix 4.3)

In constructing the matrices, each task identified in the project instructions has been considered in turn for its alignment with or similarity to the example mentioned in the consensus statement (APA, 1990) using pattern-matching as technique. The tasks are not identical, but can be deemed at face value to present students with opportunities to perform tasks that will engage them in similar or the same cognitive activities as those deemed to develop critical thinking skills. A record of the detailed matching of tasks has been included in Appendix 4.4 to make the interpretive process explicit. Each matrix is formed by a table containing the critical thinking skills components and subskills. Each cell in the matrix has been coded to represent an example of a task described in the expert consensus statement (Delphi Report, APA, 1990), and each cell that has a corresponding tasks in the project instructions has been shaded.

This section is followed by a discussion section that interprets the extent to which the projects provided opportunities for critical thinking skills development.

Table 4.1: Task matching key

Critical thinking skills components and subskills

CTC1_interpretation	CTC2_analysis	CTC3_evaluation
CTC1.1 categorisation	CTC2.1 examining ideas	CTC3.1 assessing claims
CTC1.2 decoding significance	CTC2.2 detecting arguments	CTC3.2 assessing arguments
CTC1.3 clarifying meaning	CTC2.3 analysing arguments	

CTC4_inference	CTC5_explanation	CTC6_self-regulation
CTC4.1 querying evidence	CTC5.1 stating results	CTC6.1 self-examination
CTC4.2 conjecturing alternatives	CTC5.2 justifying procedures	CTC6.2 self-correction
CTC4.3 drawing conclusions	CTC5.3 presenting arguments	

Project tasks

P#_TA	P#=project number; TA=project task. Each task has been assigned a number as set out in the deconstruction document in Appendix 4.3. Appendix 4.4 shows a detailed analysis of the tables below.
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Table 4.1(a): Project 1 infusion of critical thinking tasks

CTC1	P1-TA	CTC2	P1-TA	CTC3	P1-TA	CTC4	P1-TA	CTC5	P1-TA	CTC6	P1-TA
1.1.1		2.1.1	1.2	3.1.1		4.1.1		5.1.1	1.1	6.1.1	1.3
1.1.2		2.1.2	3.1	3.1.2	3.5	4.1.2		5.1.2		6.1.2	
1.1.3		2.1.3	3.2	3.1.3		4.1.3	4.2	5.1.3		6.1.3	1.3
1.1.4	2.1	2.1.4		3.1.4	3.4	4.1.4		5.1.4		6.1.4	
1.1.5	1.4	2.1.5	3.2	3.1.5	3.5	4.1.5	1.2	5.1.5		6.1.5	1.3
1.1.6		2.1.6		3.1.6		4.1.6		5.1.6		6.1.6	
1.1.7		2.1.7	3.2	3.1.7		4.1.7		5.1.7	4.3	6.1.7	1.4
1.1.8	2.2	2.1.8		3.1.8	3.5	4.1.8		5.1.8	4.1	6.1.8	1.2
1.1.9		2.1.9		3.1.9				5.1.9		6.1.9	5.1 5.2
1.1.10	2.1	2.1.10		3.1.10		4.2.1	1.4			6.1.10	
				3.1.11		4.2.2	3.6	5.2.1		6.1.11	
1.2.1		2.2.1	3.1	3.1.12	3.5			5.2.2		6.1.12	
1.2.2		2.2.2	3.2			4.3.1		5.2.3		6.1.13	
1.2.3		2.2.3		3.2.1	3.5	4.3.2	4.4	5.2.4		6.1.14	
1.2.4	2.1			3.2.2						6.1.15	
		2.3.1		3.2.3				5.3.1		6.1.16	
1.3.1	1.3 4.2	2.3.2	3.3	3.2.4				5.3.2		6.1.17	
1.3.2	1.1 2.3			3.2.5				5.3.3	4.4		
1.3.3				3.2.6				5.3.4		6.2.1	
				3.2.7				5.3.5		6.2.2	
										6.2.3	1.3
										6.2.4	

Table 4.1(b): Project 2 infusion of critical thinking tasks

CTC1	P2-TA	CTC2	P2-TA	CTC3	P2-TA	CTC4	P2-TA	CTC5	P2-TA	CTC6	P2-TA
1.1.1		2.1.1		3.1.1		4.1.1	3.1	5.1.1	4.1 4.2	6.1.1	
1.1.2	1.1	2.1.2		3.1.2		4.1.2	3.4	5.1.2	4.1 4.2	6.1.2	
1.1.3		2.1.3	1.3	3.1.3	2.1	4.1.3		5.1.3		6.1.3	
1.1.4		2.1.4		3.1.4		4.1.4		5.1.4		6.1.4	
1.1.5	1.1	2.1.5		3.1.5		4.1.5		5.1.5		6.1.5	5.1
1.1.6		2.1.6		3.1.6		4.1.6		5.1.6		6.1.6	
1.1.7		2.1.7	3.2	3.1.7		4.1.7		5.1.7		6.1.7	5.1
1.1.8		2.1.8	1.3	3.1.8	3.3	4.1.8	2.1	5.1.8		6.1.8	
1.1.9		2.1.9		3.1.9	3.4			5.1.9		6.1.9	
1.1.10		2.1.10		3.1.10		4.2.1	3.4			6.1.10	3.2
				3.1.11	3.5	4.2.2		5.2.1	1.4	6.1.11	
1.2.1	1.1	2.2.1	3.1	3.1.12				5.2.2		6.1.12	
1.2.2	1.1	2.2.2				4.3.1		5.2.3		6.1.13	
1.2.3		2.2.3		3.2.1	3.3	4.3.2	3.4	5.2.4		6.1.14	
1.2.4				3.2.2						6.1.15	
		2.3.1	3.1	3.2.3	3.4			5.3.1	4.1 4.2	6.1.16	
1.3.1	1.2	2.3.2		3.2.4				5.3.2		6.1.17	
1.3.2				3.2.5	3.5			5.3.3	3.5		
1.3.3				3.2.6	3.2			5.3.4	1.2	6.2.1	
				3.2.7				5.3.5		6.2.2	
										6.2.3	
										6.2.4	

Table 4.1(c): Project 3 infusion of critical thinking tasks

CTC1	P3-TA	CTC2	P3-TA	CTC3	P3-TA	CTC4	P3-TA	CTC5	P3-TA	CTC6	P3-TA
1.1.1	2.2	2.1.1		3.1.1	2.3	4.1.1		5.1.1		6.1.1	7.1
1.1.2		2.1.2		3.1.2		4.1.2		5.1.2		6.1.2	
1.1.3	2.2	2.1.3		3.1.3		4.1.3		5.1.3	3.2	6.1.3	7.3
1.1.4	2.1	2.1.4		3.1.4		4.1.4	3.3 3.5	5.1.4		6.1.4	7.3
1.1.5		2.1.5		3.1.5		4.1.5		5.1.5	6.1	6.1.5	
1.1.6	2.2	2.1.6		3.1.6	2.3	4.1.6		5.1.6	7.3	6.1.6	
1.1.7		2.1.7		3.1.7	2.4	4.1.7	3.1 3.4	5.1.7	2.1	6.1.7	
1.1.8		2.1.8		3.1.8		4.1.8	4.1	5.1.8		6.1.8	7.1
1.1.9		2.1.9	1.1	3.1.9				5.1.9		6.1.9	
1.1.10	5.1	2.1.10	2.3	3.1.10		4.2.1	7.2			6.1.10	
				3.1.11	2.3	4.2.2	3.3	5.2.1		6.1.11	
1.2.1		2.2.1		3.1.12				5.2.2	6.3	6.1.12	
1.2.2	1.1	2.2.2				4.3.1		5.2.3		6.1.13	
1.2.3		2.2.3	2.2	3.2.1		4.3.2	6.2	5.2.4		6.1.14	7.3
1.2.4	2.2			3.2.2						6.1.15	
		2.3.1		3.2.3				5.3.1	6.2	6.1.16	
1.3.1		2.3.2		3.2.4				5.3.2	6.1 6.2	6.1.17	
1.3.2				3.2.5				5.3.3			
1.3.3	2.3			3.2.6	2.4			5.3.4		6.2.1	7.2
				3.2.7				5.3.5		6.2.2	
										6.2.3	
										6.2.4	7.2

Table 4.1(d): Project 4 infusion of critical thinking tasks

CTC1	P4-TA	CTC2	P4-TA	CTC3	P4-TA	CTC4	P4-TA	CTC5	P4-TA	CTC6	P4-TA
1.1.1		2.1.1	1.5	3.1.1		4.1.1	1.4	5.1.1		6.1.1	
1.1.2		2.1.2		3.1.2	1.3	4.1.2	2.4	5.1.2	4.3	6.1.2	
1.1.3		2.1.3	1.2	3.1.3	1.2	4.1.3	4.2	5.1.3		6.1.3	
1.1.4	1.1	2.1.4	4.3	3.1.4		4.1.4	2.2 2.3 3.1 3.2	5.1.4	2.4	6.1.4	
1.1.5		2.1.5		3.1.5	1.2	4.1.5		5.1.5	4.1	6.1.5	
1.1.6		2.1.6		3.1.6		4.1.6		5.1.6	2.4	6.1.6	5.2
1.1.7		2.1.7		3.1.7		4.1.7	2.2	5.1.7		6.1.7	
1.1.8		2.1.8		3.1.8		4.1.8	2.3	5.1.8		6.1.8	
1.1.9		2.1.9	1.1	3.1.9				5.1.9		6.1.9	
1.1.10		2.1.10		3.1.10		4.2.1				6.1.10	
				3.1.11		4.2.2	1.6	5.2.1	2.1 3.3	6.1.11	
1.2.1		2.2.1		3.1.12	1.4			5.2.2	4.3	6.1.12	1.2
1.2.2		2.2.2				4.3.1	4.1	5.2.3		6.1.13	5.1
1.2.3		2.2.3		3.2.1		4.3.2	1.4	5.2.4	1.5	6.1.14	2.5
1.2.4				3.2.2						6.1.15	1.1
		2.3.1		3.2.3				5.3.1	5.3	6.1.16	
1.3.1	4.2	2.3.2	1.3	3.2.4				5.3.2	4.3	6.1.17	5.3
1.3.2				3.2.5				5.3.3			
1.3.3				3.2.6				5.3.4		6.2.1	
				3.2.7				5.3.5	1.5	6.2.2	
										6.2.3	
										6.2.4	2.5

4.3.4 Discussion: The infusion of critical thinking

The matrices in tables 4.1(a) to 4.1(d) above present the categorical analysis of the four projects. The examples of tasks that develop critical thinking skills are listed in the CT deconstruction diagrams (Appendix 4.1), and the project deconstruction diagrams (Appendix 4.3) presented the tasks matched with each cell in the matrices (detailed in Appendix 4.4). This section offers a discussion and interpretation of the findings. The analysis is based on tasks made explicit in the project instructions. The contextualising analysis that follows in section 4.4 will elaborate on the findings in this section to examine the process of critical thinking that takes place while students engage in the process of inquiry.

The matrices in tables 4.1(a) to 4.1(d) above show that the tasks undertaken in the projects during the first year of the ESDP were similar to many of the examples of critical thinking skills tasks identified in the Delphi Report (APA, 1990) and that project tasks involved all six critical thinking skills components.

Analysing the project instructions and aligning specific tasks with the examples provided in the expert consensus statement (APA, 1990) required a balance between interpreting the text representing a task literally, on the one hand, and interpreting the task taking into account activities that would be implied in the tasks, on the other. Details of alignment between tasks and subskills are provided in Appendix 4.4. However, to lend credibility to the interpretations, the following two instances serve to demonstrate the approach followed in interpreting tasks.

In the Project 1 matrix, one subskill has not been identified in analysing the project instructions, namely justifying procedures (CTC5.2). Examples of justifying procedures (CTC5.2) include keeping a record of procedures in solving a problem, justifying statistical tests, stating the standards used in an evaluation, and defining key concepts. While it may be reasonable to assume that students may at some point justify the procedures they follow in analysing their data or progressing their projects (either to the facilitator or to members of their teams), such justifications are neither required nor captured in the project instructions. In other words, such justifications are not evidenced in any of the tasks that are stated explicitly in the instructions for project 1, and therefore no assumption has been made that students would have justified their procedures.

Similarly, in project 2 (table 4.1(b)), no task has been “tagged” as an opportunity for self-correction. We might reasonably infer that a student would change their conclusion if they realised that some factors carried more weight than they initially assumed, but students were not required to report on or demonstrate such instances, so that an opportunity to develop this subskill has not been identified in the project instructions.

On the other hand, the tasks in Project 1 do not include explicit instructions for students to “draw conclusions”, but one of the consensus statement examples of drawing conclusions (CTC4.3.2) is: “given a controversial issue, to examine informed opinions, consider various opposing views and the reasons advanced for them, gather relevant information, and formulate one’s own considered opinion regarding that issue”. In this instance, it is reasonable to assume that students would draw conclusions from the data and information that they examined as they would then use their conclusions as the basis for their presentations to the Small Enterprise group on the “restrictions that could be put in place for new drivers, and the implications these restrictions could have”, and for the recommendations that they make in their reports. Drawing conclusions is therefore a requirement for completing explicitly stated tasks that will also result in some output that can provide evidence of such conclusions, and an opportunity for developing this subskill has accordingly been noted as being represented in project 1.

Part 2A was intended to answer subquestion 1A:

RQ1A *How are critical thinking skills infused into learning activities during the first-year of the ESDP (employability skills development program)?*

Deconstructing the project instructions into tasks and mapping these to the CT components and subskills show that the projects, at face value, presented students with opportunities appropriate to the development of critical thinking skills. The matrices do not represent specific levels of critical thinking. The CT components are not hierarchical, and nor are they discrete. It would therefore not be appropriate to attempt to quantify the results of this analysis.

Interpreting the matrices does not tell us anything about the level at or extent to which students engage in the critical thinking aspects of the tasks (or even whether they have done so), and we can at most conclude

that the projects that students complete during the first year of study are infused with opportunities to develop critical thinking skills.

The next component of Part 2 analyses and explains the process of critical thinking within the projects based on the conceptual framework of critical inquiry. It considers how the tasks engage students in critical thinking, and incorporates students’ own comments on the process (by way of weekly reflections).

Part 2B: Process analysis

4.4 The process of critical thinking in an immersion model

This section provides an explanatory analysis of the process of critical thinking in the four projects that students in this study completed during their first year of studies in the Employability skills development program (ESDP). Each project is described and explained in terms of a conceptual framework which is applied in analysing the critical thinking process. Whereas the previous analysis explained the infusion of critical thinking skills development opportunities in the project tasks, this section focuses on the *process* of critical thinking in pursuit of the learning outcomes.

The framework representing a conceptual model of practical or critical inquiry proposed by Garrison et al (2000) has been used to analyse each of the projects in terms of the four phases as shown in figure 4.2. Figure 3.7 in Chapter 3 provides an elaborated diagram of the framework.

Part 2B is intended to answer subquestion 1B:

RQ1B *How do students engage in a critical thinking process during the learning activities undertaken in the first year of the ESDP (employability skills development program)?*

The reflections have been analysed to illustrate student engagement in the four phases of the critical thinking cycle. It is not intended as “proof” that all students, or even certain groups of students, developed their critical thinking skills to specific levels. The analysis is intended to examine the proposition that students engaged in critical inquiry during the projects, and therefore that the immersion approach enabled critical thinking skills development.

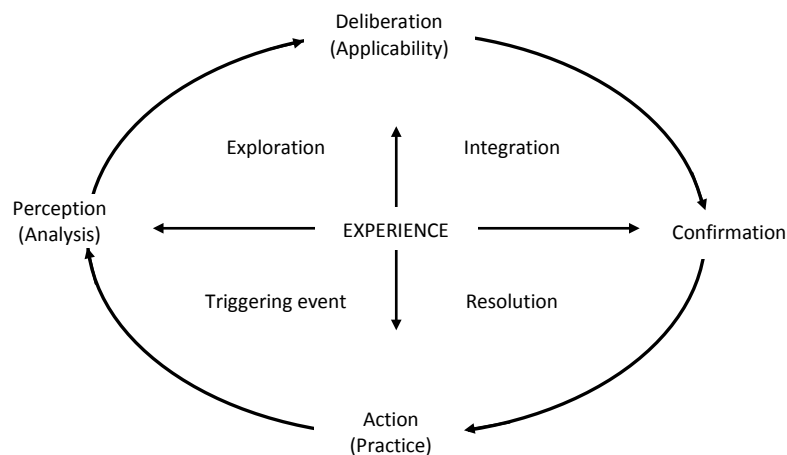


Figure 4.2: The critical thinking cycle

Source: Garrison, 1991

In-class interactions in the ESDP projects were carefully facilitated through a process of weekly report-backs by teams and feedback from facilitators (lecturers) who guided the students to ensure that they moved from problem recognition (triggering event) through the phases of exploration, integration and resolution. Weekly staff debriefing sessions created opportunities to moderate in-class interactions, ensuring that all facilitators were following a similar approach in guiding student activities. Further guidance was provided through comments posted by facilitators in response to student reflective journal entries.

The process of critical thinking skills development

This section analyses each of the four projects in the first year of the ESDP to provide an explanation of how students engage in a process of critical thinking. The projects target similar learning outcomes, including:

1. researching, analysing and commenting on ethical issues in society
2. making an effective oral presentation, delivering results supported by relevant descriptive statistics and using appropriate presentation tools
3. participating constructively in groups and teams, using groupwork techniques to critically analyse problems and identify alternative solutions
4. applying descriptive statistics to analyse data sets using appropriate software and graphing techniques
5. developing an understanding of the nature of business by critically evaluating a range of scenarios

Each project requires progressively more in-depth analysis, dealing with greater volumes of data and progressively more complex scenarios, for example:

Project 1 is triggered by a fairly brief press article and the ethical considerations are more personal and social.

Project 2 introduces more complex ethical issues that encompass personal, societal and business considerations.

Project 3 requires students to collect and analyse primary data and present their conclusions as recommendations in a business context.

Project 4 similarly requires collection and analysis of primary information, and introduces more diverse potential interpretations of findings.

The process is explained in terms of the four critical thinking phases in the cognitive component of the model of critical inquiry that serves as conceptual framework for analysis, and extracts from student reflections illustrate student progression (or otherwise) through

each of the phases. In project 1, the explanation is followed by an example of a student discussion that illustrates how they engaged in the phases of the cycle.

The analysis for each project has been structured as follows:

4.4.1 The critical thinking cycle and associated indicators (describes each of the four phases in the critical thinking cycle and the indicators associated with each phase

4.4.1.1 Project #

(a) Project # description (explains the context in which tasks are undertaken

(b) Engaging students in the critical thinking cycle (explains how the project is intended to engage students in each particular phase of the critical thinking cycle

(i)-(iv) Student engagement in phase # (examines selected relevant reflections in each phase to illustrate student engagement, using tags to identify the indicators present in each reflection, followed by a brief interpretation of student engagement in the particular phase; interprets the analysis)

(c) Project # summary (*Note that in project 1, section (c) is The cycle in action, followed by the discussion in section (d))

4.3.4 Discussion

Section 4.4.1 sets out the four phases and related indicators. For purposes of this analysis, the indicators proposed by Garrison and Anderson (2001, p.61) and presented in section 3.3.4.1(b) have been augmented in an iterative process of analysis which is described in section 4.3.3.

4.4.1 Phases in the critical thinking cycle and associated indicators: Project analyses

“The challenge is to choose indicators that are specific enough to be meaningful, but still broad enough to be usable in the actual analysis of transcripts. Furthermore, these indicators must be parsimoniously categorized within the main elements of a community of inquiry such that coherence and meaning are apparent” (Garrison et al, 2000, p.94).

The approach to content analysing the four projects has been iterative, both in terms of selecting the relevant reflections to illustrate student engagement in each of the phases and in terms of the indicators used to tag each of the selected reflections.

This section defines the phases of the critical thinking cycle conceptually. Each phrase is presented with a quote from Garrison (1991), followed by a description of the typical tasks associated with each phase.

The indicators listed for each phase have been based on Garrison and Anderson (2003, p.61) as set out in table 3.5 (Practical inquiry descriptors and indicators). Further indicators have been added on the basis of the typical activities identified in each phase. This has made it possible to gain a more detailed view of how students engage in the critical thinking cycle.

Asterisks indicate that the indicator appeared in Garrison and Anderson (2003, p.61). Other indicators have been added, based on the typical activities in each phase of the cycle.

Phase 1	The triggering event
<p>This phase is best described by Garrison (1991, p. 294)</p> <p><i>“One of the most important activities in the process of critical thinking is to understand or to redefine the issue or dilemma. ... this requires some deliberation and information gathering The individual begins to question basic assumptions which may have directed and constrained his/her thinking. This may be done individually or, more likely, through collaboration or interaction with others. Through this preliminary questioning process the individual gains a better understanding of the problem and is ready to consider alternative courses of action and possible explanations.”</i></p>	
<p>Typical tasks in this phase include critical reading, analysis and mind mapping (Garrison, 1991, p.294). It is associated with the dimension of perception or awareness</p> <p>Recognising the problem may therefore require students to</p> <ol style="list-style-type: none"> 1. redefine the issue, through a process of 2. deliberation, 3. supported by information, and to 4. question their own assumptions and those of others, and to 5. consider alternative courses of action <p>Indicators <tags>: *puzzlement; *problem recognition; problem redefinition; deliberation; information; questioning assumptions; proposing courses of action (tentative)</p>	

Phase 2

Exploration

Garrison (1991) provides two descriptions that are relevant to phase 2. The first relates to the process of exploration:

“The exploration phase takes us from the world of facts to the world of ideas. This is where the individual searches for an explanation by exploring alternative ideas to resolve the issue or dilemma. There must be some elaboration of the issue to explain sufficiently the original triggering event. This is also where the creative-thinking process predominates. ... At this point we are never entirely sure where our insights and ideas originate,... scepticism and the questioning of assumptions may be temporarily suspended.” (p.294)

The exploration phase is also associated with the deliberation/applicability dimension which Garrison (1991) describes as follows:.

“During this phase ideas are explored through abstract thought to determine with greater certainty the applicability of an idea in resolving the dilemma. At this point scepticism and the questioning of assumptions re-emerges strongly when critically analyzing alternatives as a possible resolution to the dilemma. ... the individual may well return repeatedly to the exploration phase to generate a more satisfactory explanation, or as a check before proceeding to confirm and integrate the idea.” (p. 294)

This is therefore a divergent phase which is characterised by deliberation and creative thinking. Exploring the issue may require students to

1. elaborate on the issue, and
2. enhance their understanding (by sharing perspectives and exchanging information)
3. develop new insight (by imagining or brainstorming to identify alternative ideas/solutions)
4. consider multiple perspectives (by re-questioning assumptions)
5. test applicability (by applying critical analysis and logical reasoning)

Indicators <tags>: *divergence/elaboration, *information exchange, *suggestions (sharing perspectives), insight (*intuitive leaps/*brainstorming), multiple perspectives (re-questioning), applicability

Phase 3

Integration

“This stage in a social context is seen as the integration of a new perspective. This integration is sometimes satisfactory while at other times it simply triggers a renewed search for a more satisfactory resolution to the dilemma. In this situation the cyclical process of critical thinking begins anew. ... confirming and integrating knowledge is crucial While verification emphasizes the collaborative and interactive aspects of critical thinking, it is important to realize that throughout the critical thinking/learning cycle there is an alternation of collaboration and reflection. This process is essential to the development of knowledge in the best sense of an educational experience.” (Garrison, 1991, p.294)

Typical tasks in this phase include reaching consensus and confirmation of alternatives or solutions. It is a convergent phase during which students synthesise information and tentatively verify their potential solutions. The emphasis is on collaboration and interaction, alternating with reflection. In some instances, potential solutions are not deemed satisfactory, and this triggers a new phase of exploration. The latter is illustrated clearly in the synchronous exchange between two students presented in section 4.4.2.1(c): *The cycle in action*.

The convergent nature of phase 3 may require students to

1. synthesise information
2. confirm perspective/s thought interaction with team members
3. integrate knowledge
4. reach consensus in the team
5. reflect on insights gained

Indicators <tags>: *synthesis, confirmation/verification, integration/*convergence, consensus, reflection, re-exploration

Phase 4

Resolution

“The fourth phase, resolution, critically assesses the viability of the proposed solution through direct or vicarious application. Resolution requires a commitment to test the solution deductively, perhaps through a vicarious implementation or thought experiment. This ... could take the form of a presentation and defence with other participant critiquing the suggested application [or] ...the form of a direction application or action research project – either an individual or group project.” Garrison et al (2003, p.62)

During the resolution phase, positions and perspectives are confirmed, and solutions are tested by applying them to the practical contexts. Solutions offered are then defended by presenting them to others in the form of recommendations or proposed implementations.

Phase 4 requires students

1. formulate their solutions
2. apply their solutions to a practical situation or dilemma
3. test the acceptability of their solutions by critically assessing the viability of their proposed solutions in interaction and collaboration with team members
4. make recommendations for action supported by evidence
5. defend their solutions by presenting rational arguments in support of proposals

Indicators <tags>: application (*apply), *solutions (moved from phase 3), *test, action (practice), presentation (*defend)

4.4.2 Engaging students in the critical thinking cycle

4.4.2.1 Project 1: New drivers

(a) Project 1 description

This section explains the context in which tasks are undertaken.

The topic for Project 1 was restrictions on young (or novice) drivers (L- and P-platers). Students were presented with a scenario that placed them in a real-world (authentic) context. They were required to analyse a newspaper report that commented on supervised driving hours for learner drivers (L-platers). Analysis of the comments in the article and data to be obtained from the “Fatal crash database” revealed certain assumptions that students could contest. The article also raised ethical considerations that affect all road users, and introduced awareness of personal and social responsibilities. Students researched, analysed and commented on

measures that were in place and designed additional or revised measures that they deemed to be potentially more effective.

Students were required to select another state or country and to make an interstate or cross-country comparison to substantiate their recommendations. Cross-country or interstate comparisons required students to work inductively through exploration as well as deductively by considering the applicability of their tentative solutions to the context presented in the instructions.

The project instruction document has been included as Appendix 4.2.

(b) Engaging students in the critical thinking cycle

This section explains how the project is intended to engage students in each particular phase of the critical thinking cycle.

Project 1 started with students analysing an article that appeared in the West Australian newspaper: "Double supervision of L-platers: expert". (Previously available at <http://www.thewest.com.au/printfriendly.aspx?ContentID=4907>)

The article reported on a federal government proposal for more stringent regulation of novice drivers, longer supervision periods, and much steeper penalties.

Students were prompted "to identify the real issues at stake. What is the real problem? What has been done about it? Are there other things that can be done?"

The article included three specific claims:

- (1) that young drivers (aged 17-24) were "*twice as likely* to be killed as other licence holders"
- (2) that "evidences shows that novice drivers who commit traffic offences are *much more likely* to be involved in a crash in the future, and will continue to accumulate demerit points throughout their lives"
- (3) that similar changes in New Zealand have '*nearly halved*' the number of young drivers and passengers killed and maimed on their roads".

Students were guided to read critically and not to accept the statements or information at face value. Wide exploration was encouraged. To prompt students to access and interpret information that had not been "pre-analysed", and to base their views on evidence, they were required to interrogate a specific online database: the *Fatal crash database* at http://www.atsb.gov.au/includes/apps/fatal_crash/fatalCrash.aspx.

In sections (i) to (iv) that follow, examples of reflective journal entries have been selected to examine and illustrate student engagement in each phase of the critical thinking cycle. Each entry has been “tagged” according to the indicators identified in section 4.3.3 above.

Where an indicator represents a subsequent phase, a directional arrow is added. For example, the tag <integration→> indicates the presence of this element from a subsequent phase, and the tag <←exploration> indicates a return to an element of a preceding phase.

The analysis of each phase is followed by a brief interpretation of the indicators identified in the reflections. A summary section concludes the analysis of each project, drawing together the interpretations and relating the findings to the propositions and theory.

(i) Student engagement in Phase 1: Triggering

The triggering event in phase 1 set up the topic for the activity. Newspaper articles are often headlined to create an emotional response. This was used to engage the students at the outset.

This analysis examines selected relevant reflections to illustrate student engagement in phase 1 of the critical thinking cycle.

Reflective journal extracts

- 1 *Just thought I'd write a entry on one of the news report that made headlines today. A 42 year old female learner driver managed to lose control of her car and wipe out almost a dozen people on the side of the road, killing one, and putting others in hospital. As far as I can remember, I don't think I've ever heard of an accident such as this. Usually headlines read "P plater kills one, injures another. Never have I heard, for e.g. 18 year old boy kills one, injures 9!!*

... it just goes to show that statistics sometimes don't tell the whole story. Sometimes by analysing statistics, people will start to focus on areas such as, in this case, 'young drivers at night', and then forgetting about the unexpected outcomes that can occur i.e. accidents caused by, what most people consider, the safest drivers on the road (middle aged woman). [27 March 2007 Student A]

<puzzlement> <questioning assumptions>

- 2 *I want to just take this opportunity to provide a thought, and that is; instead of focusing on minority groups (17-20yr olds) maybe focus more on the big picture, e.g. (ALL L-drivers in general).*

<problem redefinition>

- 3 *Well we have started our group activity on learner drivers which is funny as my brother and I have been talking about the new rules that may be coming into effect as he is getting his licence this year. I think more hours (around 50) would be good if people did them because I know some people cheat on them so increasing them may not change anything. I think not being allowed to drive at night is a bit silly because if they can't drive at night how are they to get experience and especially when 16 yr olds can drive scooters at night. [29 March 2007 Student B]*

<deliberation> <proposing courses of action> <questioning assumptions>

- 4 *But anyway I wanted to find out the different procedures of the states for getting their licence and then seeing if the state with more testing would have less fatalities thus telling us that maybe these things worked but from what I found NSW has the better testing at the moment and also has the highest fatalities in 17-25yr olds. Just looking at that on a general basis doesn't look very good for my theory so maybe it isn't just inexperience that's the cause. [29 March 2007 Student B]*

<information> <problem recognition>

- 5 *The assignment is a topic that I had never really thought about, even though at my age I fall into the youth drivers category. In Darwin there is a monument (if you can call a smashed car a monument) which reminds drivers of the NT road toll. In WA you only really hear the road toll after someone else has died. The monument in Darwin is a more in your face approach, but sometimes a graphic reminder may be what is needed. [2 April 2007 Student C]*

<puzzlement> <proposing courses of action>

- 6 *One thing I started to think about when I was researching the issues around at the moment was... Is it really inexperience? Or is it immaturity?? You could put a million laws or procedures in place to give the young drivers more experience, but is there a cure for teenageism?! For wanting to show off in front of friends? [2 April 2007 Student C]*

<information> <questioning assumptions> <puzzlement>

- 7 *Canada stats are posing a problem, as I am not able to find a site equivalent to or as good as the ATSB site and that you are able to manipulate to gather the stats you want. [3 April 2007 Student E]*

<information>

Interpretation of reflections in phase 1: Triggering

During phase 1, students attempted to understand the problem and began to question assumptions made about young drivers and the effectiveness of restrictions. Both indicators for phase 1 – recognising the problem and a sense of puzzlement – are evident in the selected reflections.

It is evident that students were cognitively engaged in this phase. They were able to relate the topic to their own experiences and concerns. Directing the students to interrogate the online database enabled them to check on the claims made in the article, and to make their own interpretations of the situation. Reflections 4 to 7 show that students are beginning to consider alternative courses of action.

Student reflections did not specifically address the anomalies contained in the article that they analysed. As that discussion took place in class, this observation does not mean that students did not identify the claims as vague or did not check on the hard figures in the database.

The first phase reflects the inductive nature of the beginning of the critical thinking cycle. Student reflections as yet did not rely on evidence to support their opinions, and their opinions were of an intuitive nature.

The reflections provide evidence that students were considering alternative measures and used examples to provide explanations for their views.

(ii) Student engagement in Phase 2: Exploration

Activities during class sessions in this phase focussed on deliberation, working together as a team, analysing and evaluating information, and then working towards a consensus opinion for the team in phase 3.

During the exploration phase students further analysed the issue/situation and gathered information to help them explore the problem and gain greater understanding. Students were presented with opportunities to share multiple points of view. While some basic information sources were provided, key tasks included finding, accessing and evaluating information.

At this stage of the project, students should be conducting literature searches and interrogating an online database. Working collaboratively in teams allows for multiple points of view to be presented by different members of a team, and the in-class report-backs bring the views of different teams into the mix, as does a clear expectation for students to apply the information and insights that they gain to more than one context by conducting a cross-country comparison.

Reflective journal extracts

8 *I find this a useful forum to get ideas from others and evaluate own team members' capabilities and thought processes . [29 March 2007 Student E]*

<multiple perspectives>

9 *Funniest thing today happened, [team member] added some notes to the File Exchange and gave me perspective where I feel I have gone wrong with this entire exercise. Too much data overload, and I had not approached it like I generally do and break it down... it gave me a jolt to simplify not complicate the issue. ... Then it might be easier to come to some ideas on our recommendations. [30 March 2007 Student E]*

<information exchange> <insight>

10 *Have got a better idea of what the deal is with Australia/WA and Canada from reading the Monash Report and found a fantastic report (only last night) [at www.monash.edu.au/muarc/reports/atsb136.pdf] that gave a lot of detail I needed in the one document. [3 April 2007 Student E]*

<elaboration> <information exchange>

11 *We have decided to compare Australia to New Zealand because apparently information on that country is easy to get, my only concern is that the laws might be too similar, but I*

didn't want to mention it because I thought that at least everyone was starting with the assignment- I didn't want to 'rock the boat too early'. But when we get some more information about New Zealand if it's too similar I might mention it... I just had a thought- it might be a good idea if the laws are the same to focus more on how effective they are for each country???? could be interesting! [26 March 2007 Student D]

<insight> <→confirmation>

- 12 *A lot of recommendations in various reports I have read seem to be very similar. Whether policy makers take on these recommendations is another thing.. Must be frustrating for those that prepare all these reports and see that a lot of advice is not acted upon. [4 April 2007 Student E]*

<re-questioning> <applicability> <→integration>

- 13 *One thing I've noticed so far, from this Driving Activity is that WA seems to be quite far behind in regards to regulations and conditions of young drivers. I haven't necessarily picked this up from the research I've undertaken, instead it became obvious during my time on certain car forums. ... [5 April 2007 Student A]*

<elaboration> <sharing perspectives>

Interpretation of reflections in phase 2: Exploration

Reflections 8 to 11 show that the collaborative nature of phase 1 continues during the exploration in phase 2, and that working in teams not only supported exploration, but helped the students to adopt a more workable way to categorise the information found. Reflection 11 indicated that some teams had entered phase 3, and illustrates that different phases in the critical thinking cycle can telescope and that the phases are not immutable (Garrison & Anderson, 2003, p.60).

It has been evident from the reflections that working in teams during phase 2 can both enhance and inhibit the levels of cognitive engagement and progression. There are some indications that students may adjust their own contributions to the level of contributions made by other team members:

... given more time and effort I would have liked to make improvements on the evaluation of possible solutions and the WA novice driver focus section. Although if I'm honest, towards the end I didn't put in as much effort as I would have normally done because, with the exception of [team member] - there has been limited input from the other group members which has frustrated me a little. [2 April 2007 Student F]

In teams where not everyone participated actively, the collaborative process placed an added burden on more active members, and gave rise to a level of frustration that can hamper progression in the critical thinking cycle and negatively impact the likelihood of reaching consensus:

... we have one week left!!! How are you supposed to plan it better when members don't go to the discussion board!!!!... it's hard enough trying to get everyone to communicate rather than come to a consensus... that will need a miracle ... [4 April 2007 Student D]

Difficulties also arose where team members were at different phases of the cycle at a point in time, or where not all team members had the same level of understanding of the task and the issues:

So far the contributions made by individual members of the group have been reflective of their individual levels of participation in group discussion, which I anticipate to continue. Individual levels of understanding of the task, and the issues which surround it, are also evident in the discussion content. [4 April 2007 Student K]

In a number of teams, the selection of a state or country for comparison was based on the availability of useful information. This may be regarded as a limiting strategy from an exploration perspective, but it may also be viewed as a means to achieve integration and resolution in order to ensure successful completion of the project.

In this first project, students were still coming to terms with an approach that was unlike their experiences in other units or studies, and in some instances appeared to find the collaborative environment somewhat challenging. It is nevertheless clear that the tasks encouraged exploration and deliberation.

Analysis of the reflections shows that students valued the opportunities to share perspectives and that the collaborative context that allowed for deliberation, with no clear distinction between the shared and private worlds (reflection 8), moving from the “world of facts to the world of ideas” (Garrison, 1991, p.294). The value of shared environment not only facilitated contributions by way of ideas, but also added value in terms of the research process, so that some students benefited from strategies employed by team members and became more focused in their analyses (reflections 9 & 10), but that as yet their ideas have not become integrated. The trend is towards clarifying their own perspectives, although integration during phase 3 will require that the views of team members be incorporated in reaching consensus (reflection 9 & 10).

Reflection 11 shows that the student (in a process of internal deliberation) gained insight that allowed them to transform what they believed to be a limitation (two countries being too similar) into an advantage (eliminating some variables that may impact results). This entry also

shows the beginning stage of integration (phase 3) in “we have decided to ...”, although there is as yet no indication that the team has reached consensus as to their recommendations.

There are indications that the exploration phase enters the application dimension as students compare the relative success achieved in other contexts in looking for effective solutions in the current context (reflections 12 & 13). Students start considering the applicability of their recommendations and whether recommendations could be effective if formulated into policy – therefore testing the applicability of ideas or perceptions generated during these first two phases against the real situations in practice. Reflection 12 also indicates the beginning of the integration phase as the student is noting similarities that can lead to confirmation. Reflection 13 shows that students were willing to explore more widely and bring in their experiences outside of the learning task when deemed applicable.

(iii) Student engagement in Phase 3: Integration

Having taken into account alternative points of view, investigated the evidence critically and weighed various options, and having considered the validity of all arguments (applicability of potential solutions), teams were required to arrive at a position that the team could justify and present to the class in a convincing manner.

During the integration phase, students integrated information and constructed their proposed solutions and alternatives. A degree of consensus was necessary for team-based outcomes. The outcome had to be a clear recommendation for action.

Reflective journal extracts

- 14 *In this last section of the assignment, I have found that we have all been discussing our thoughts and findings a lot more than before, which has been great. We even had a debate going on about rewards for good driver's and whether or not it was a good thing. Everyone was confident enough to speak their mind and put forth their own thoughts. It has been very interesting to see how our team dynamics have influenced the outcome of the project. We all seem to be quite independent on how everything will end up in our own reports, but we are willing to share information and ideas ... Sometimes I noticed that there were a lot of discussions on the different issues but nobody was linking them together or putting them in an organised format. [20 April 2007 Student L]*

<<deliberation> <<sharing perspectives> <<multiple perspectives> <<information exchange>

- 15 *These meetings have helped us to bond as a group and to begin discussing ideas. We have set out the oral assignment into sections and have delegated different tasks to different members. We will then come together to join together these parts and create the presentation. ... it wasn't too hard to reach a consensus. ... the group worked together to try and incorporate everyone's ideas into the plan. [12 April 2007 Student CC]*

<<deliberation> <<sharing perspectives> <convergence> <consensus> <synthesis>

16 *We have managed to complete (well, semi-complete) our comparisons and have pretty much all agreed on the group recommendations which means the group task is almost at its end. [6 April 2007 Student F]*

<integration> <consensus>

17 *Looks like we are in agreeance on recommendations but just need confirmation that I have interpreted all the data recommendations correctly. It is great we are just a fraction away from group task completion. It does help getting input from others as I learnt things along the way. [6 April 2007 Student E]*

<consensus> <synthesis>

18 *I can see a picture forming but it's hazy and I can't put my finger on it. Every time I try to focus on one direction, I see another (and another and another). [25 April 2007 Anon]*

<←divergence> <←re-questioning> <reflection>

Interpretation of reflections in phase 3: Integration

During the integration phase, reflections provide evidence that in some teams information was successfully being synthesised and that different views converged (reflections 15-17). In some cases, progression through the phases appeared to lag, for example in reflection 14 the reference to “last section of the assignment” indicates that team discussions are taking place during a subsequent phase and had not taken place earlier. This is evidence that not only individual students, but the team as a whole can return to an earlier phase.

Reflection 15 may provide an illustration of the phases “telescoping”, although it is necessary to bear in mind that this may be a function of the reflection, rather than being indicative of the critical thinking cycle. Disassembling and re-assembling different components of the task may be interpreted as lacking collaboration, although the reflection clearly indicates sharing of perspectives and inclusion of inputs into a coherent whole.

In addition to returning to earlier phases (reflection 14) and meshing different phases (reflection 15), the use of “semi-complete” in reflection 16 is significant, as it shows that the process of integration may not be complete until the resolution phase is reached, and that the potential for re-exploration remains.

In reflection 17, information has been synthesised and team consensus has been reached. The student is still seeking “confirmation” from the team, although this should perhaps not be seen as a need for confirmation of understanding or agreement, but as confirmation for resolution. Reflection 18 shows that the student remained in a divergent loop, not reaching integration or convergence.

There is also evidence that in some teams a “strategic” approach was followed whereby individual tasks were assigned for completion and later compilation, with little evidence of collaboration or sharing of perspectives:

I do however feel that this 'team' project has turned into a group of individuals doing their own thing and occasionally informing others of what they are doing. [9 April 2007 Student G]

We're getting heaps of information but we're not "discussing" it. Mostly, we're just sharing information. [15 April 2007 Student CC]

I don't think our group has come to a consensus at all, everyone is doing individual work and just informing every other member of it- which isn't group work at all! I am not sure whether this is because of the communication barriers. [11 April 2007 Student D]

There is also some evidence of teams and individuals returning to the earlier exploratory phase and that deliberation which was absent during phase 1 can continue in later phases (reflections 14 & 18). Analysis of these reflections confirms the need for integration to be deliberately facilitated. Garrison and Anderson (2003, p.60) note that “this is a particularly challenging phase ... The tendency is to become entrenched in the exploration phase and not move to the more advanced phases of enquiry.”

(iv) Student engagement in Phase 4

During phase 4, students were required to present their recommendations or solutions, having critically assessed the viability of the proposed solution. Students were required to develop rational arguments supported by evidence and present these to the class as a team. Students were also required to write an individual report in which they explained their recommendations.

Reflective journal extracts

19 *Well we have now all but reached the end of the team work section of the report and I have to admit it has been interesting if nothing else. ... Despite all our problems getting together we still managed to come up with some ideas that we thought were good... [20 April 2007 Student J]*

<solutions> <<confirmation> <<consensus>

20 *I believe we have worked quite well together both communication/discussion wise and collaborating ideas
I have learned a lot about driver safety also even though this is not really the point of the exercise. More importantly I have learned a considerable amount about team work. [20 April 2007 Anon]*

<<-confirmation> <<-convergence> <<-integration>

- 21 *This assignment ... has really grabbed my attention. I spent the Easter weekend listening to all the news about the road toll, the tougher stance the police took, and the new laws regarding seatbelts. Doing this assignment I have discovered quite a few things I didn't know about the laws... like I didn't know that WA is the only state or territory with a total mobile phone ban. I also didn't know that there is no law in the USA regarding seatbelts! This came as a huge shock!! They are currently running a 'BuckleUpAmerica' campaign to encourage drivers and passengers to wear the belts, but there is no law... very different to Australia, especially WA with the new laws put in place on the 6th. [11 April 2007 Student C]*

<<-confirmation> <<-convergence> <<-insight>

- 22 *We talked a fair bit about concluding the new driver assignment. We talked about where each other stood on the issue, what our stance was in terms of possible solutions taking into consideration all the stats and research we conducted. We also covered off if we should do any more research. As a group I believe we worked really well. We all had the same viewpoint which was to be expected since we did all the research together and discussed our findings each week. I think we have come a long way from the first few weeks when we could hardly get everyone together to being able to work together quite successfully. [26 April 2007 Anon]*

<<-convergence> <solution> <application> <action> <presentation/defence>

Interpretation of reflections in phase 4: Resolution

The reflections relating to phase 4 provide some evidence that the goal of integrating new knowledge has been achieved in some instances (reflections 20 & 21).

There is also some evidence that during this final phase some students were reflecting on the “strategic” approach followed by their teams, and were aware of the absence of a resolution based on integration and consensus:

No real effective conclusions were drawn as a combined effort, as the decision to cover separate parts of the whole issue meant individual conclusions were drawn. In hindsight this was perhaps a mistake, as some issues have been covered in a lot more detail than others and additional research is required in the areas lacking. Also the fact that we will be compiling individual reports may have lead to a reluctance to share fully as a team, with a preference to just "do our own thing".
[18 April 2007 Student K]

Interestingly, reflections in the late stage of the project have provided evidence of student engagement in the Integration phase which was not evident in many of the reflective journal entries during that time. Not only is the critical thinking cycle not fixed in its phases, but in analysing student reflections, it is important to recognise the retrospective nature of the reflections.

The reflections generally show that teams agreed on solutions (eg “thought were good” in reflection 19), indicating that consensus and confirmation were achieved. Evidence of convergence and integration appear once the resolution phase has been reached, and insights are confirmed (reflections 20 & 21). Reflection 20 also shows a level of metacognitive awareness of the benefits of the collaborative process. Reflection 22 shows resolution leading to action. The team has reached consensus through ongoing deliberation and is confident in being able to defend their position.

The following is a record of two students interacting in a synchronous chat forum that illustrates the phases of the critical thinking process. The students have responded to the triggering event and have largely concluded the exploration phase. They are in the deliberation/applicability dimension and are testing their facts before continuing to the integration phase, working towards confirmation and resolution. The exchange shows the iterative nature of the critical thinking cycle and provides evidence that they loop back to test their perceptions.

(c) The cycle in action

“This integration is sometimes satisfactory while at other times it simply triggers a renewed search for a more satisfactory resolution to the dilemma. In this situation the cyclical process of critical thinking begins anew. ... confirming and integrating knowledge is crucial While verification emphasizes the collaborative and interactive aspects of critical thinking, it is important to realize that throughout the critical thinking/learning cycle there is an alternation of collaboration and reflection. This process is essential to the development of knowledge in the best sense of an educational experience” (Garrison, 1991, p.294).

Phase 3: Integration

Both students are offering potential solutions to the problem that has been identified. They identify the recommendations that they have in common and elaborate on their individual perceptions of the common recommendations as well as explain the details of novel recommendations that they did not have in common at the outset (testing under specific conditions – student 1; more stringent testing and higher demerit points drawn from an interstate comparison – student 2).

18/04/2007 20:03:33 **Student 1:**
... did you wanna talk about the recommendations? ... OK. I have 5 of them.

18/04/2007 20:04:55 **Student 1:**
I tell you mine and you can see if yours are similar: increase public awareness by advertising campaigns to help change attitudes.

18/04/2007 20:06:44 **Student 1:**

the second is more rigorous enforcement of road safety incl speeding, alcohol, drugs and seatbelts. 3rd raise standard of tuition offered by driving instructors & improve the driving test to help young drivers understand some of the risks not just passing the test. 4th More focus on the period post-test eg restrictions during solo driving/limited night driving. 5th tougher penalties for inappropriate behaviour eg loss of licence

18/04/2007 20:12:41 **Student 2:**

some of mine are similar

18/04/2007 20:17:03 **Student 2:**

I think the test should be harder, I think zero alcohol limit on L and P plates, more testing - in NSW they have a test before L's then one before 1st P plate then 2nd P plate and then once u get off P plates - thought that was a good idea

18/04/2007 20:19:02 **Student 1:**

I sort of elaborated a bit on each but only in a couple of sentences eg. the test should include certain situations/conditions the learner must experience. yours sound good

18/04/2007 20:19:54 **Student 2:**

I also agree tougher penalties for P plates because here we get the 12 demerits in NSW for 1st P plate they either get 3 or 6 and then 2nd P plate they get 6 or 9 so if the P plates here didn't have the 12 demerits they might not be as careless

Confirmation

The students appear to be reaching confirmation. Both students then loop back to the beginning of the integration phase to test the applicability of their recommendations against their own experiences and practical constraints. They then move rapidly to confirm/disconfirm their recommendations.

18/04/2007 20:20:34 **Student 1:**

how about we do a combo of both and tell [Team member] what we agreed on - he can choose whether or not to use.

...

18/04/2007 20:20:48 **Student 2:**

I agree with ur testing more conditions because when I did test about 3 yrs ago it didn't take that long and they mainly do parking test with u and three point turns which are good but a lot of other things are needed in driving

18/04/2007 20:22:16 **Student 2:**

well I think we both agree on tougher testing; tougher penalties;

18/04/2007 20:23:30 **Student 1:**

you have a point about the demerits - I was thinking about that one myself. the situations I thought of cos of my sis who is on P plates and got freaked out in really heavy rain

18/04/2007 20:23:37 **Student 1:**

the one I had about the more tougher penalties - I don't really think that would work so probably for deletion

18/04/2007 20:24:59 **Student 2:**

the only hard thing with that is planning a test when it's raining; the other thing could be that u HAVE to drive in different conditions for the log book but the same thing if u do it during summer it doesn't rain much

18/04/2007 20:25:15 **Student 1:**

sounds good.

18/04/2007 20:26:04 **Student 1:**

I think the post P plate follow up test or further instruction would be a good idea even as a refresher

18/04/2007 20:27:02 **Student 2:**

I think that's a good idea

18/04/2007 20:27:25 **Student 1:**

I did a hazardous conditions driving lessons for work and it saved me from having an accident when I drove over some oil and my car went sliding on a turn

18/04/2007 20:27:53 **Student 2:**

I know when I was getting my licence this extra stuff would have seemed like a pain but now its better to do extra testing because driving is dangerous

18/04/2007 20:28:18 **Student 1:**

I also think they should make it tougher for overseas students who already hold a licence – a lot of them don't know how to drive properly and are allowed to do so for 3 months after arrival

18/04/2007 20:29:22 **Student 2:**

one solution I don't think would make much difference would be the increase on log book hours because a lot of young people don't do them and the parents sign it anyway

18/04/2007 20:29:23 **Student 1:**

I agree - the log book gets cheated on, the focus should be on the 'skill' of driving not amount of time spent

...

18/04/2007 20:30:30 **Student 2:**

especially for overseas ppl who are used to driving on the wrong side of the road or in some places like Canada u can turn left or right in their case or however it works

18/04/2007 20:30:35 **Student 2:**

so the log book hours should stay the same but the type of driving - night, in rain, long distance, higher speeds etc should be a must on them

18/04/2007 20:31:24 **Student 1:**

yep. agreed.

Looping between Exploration (phase 2) and Integration (confirmation) (phase 3)

Both students then loop back to the exploration phase, including deliberation and applicability testing.

18/04/2007 20:31:47 **Student 1:**

looks like we have a few recommendations here - do you think that's enough?

18/04/2007 20:32:53 **Student 2:**

there are 2 more I found on net restricting all mobile phone use and high-powered vehicle restrictions for provisional

18/04/2007 20:33:49 **Student 1:**

Sounds like a good idea. I didn't think of those. With the advertising I was thinking of a real life person in the ad talking about their 'bad' experience not just any ad & maybe visits to high schools by survivors of crashes

And again move to integration and confirmation (phase 3)

18/04/2007 20:34:53 **Student 2:**
yea got a quite a few I'll write it out and leave a msg on our group discussion board for [team member] and I'll leave our week 6 progress report on main board

18/04/2007 20:36:02 **Student 2:**
yea I like that making the younger people actually aware that these bad things can happen

Followed by further sharing of perspectives and confirmation with supporting evidence.

18/04/2007 20:36:30 **Student 1:**
you know this is a coincidence but my dad was saying the other day he thinks young women P platers drive like psychos - and I told him the stats show they have most fatalities!

18/04/2007 20:36:38 **Student 2:**
I would have thought male P plates would be higher just because they seem to drive more stupid although I do know a few girls who are kinda bad

...

18/04/2007 20:39:04 **Student 1:**
overall in Australia males do but the numbers I looked at for WA in 2005 showed women - I could be wrong - left my assignment at work on a discette. ...

...

The final reflective journal entry by student 2 shows a level of metacognition that supports the value of the project and the collaborative approach in engaging students in the critical thinking cycle.

Well our 1st group assignment is coming to a close and it was harder than I thought ... This is ... latest chat that we had tonight regarding solutions. We both had some but just wanted to compare them to each other. I think we have done a lot of research into this assignment as well as some judgment from past experiences.

(d) Project 1 summary

The presence of indicators within each of the cycles is presented below. Indicators that appear repeatedly are not counted, but are interpreted as confirming the nature of student engagement. Similarly, the absence of indicators within a cycle has not been interpreted as a diminished level of student engagement, but instead is seen as reflecting the nature of student engagement in the particular phase.

Phase	Indicators	Tags
1	puzzlement problem recognition problem redefinition deliberation information questioning assumptions proposing courses of action (tentative)	<puzzlement> <questioning assumptions> <problem redefinition> <deliberation> <proposing courses of action> <questioning assumptions> <information> <problem definition> <puzzlement> <proposing courses of action> <information> <questioning assumptions> <puzzlement> <information>
The full range of indicators has been identified in the selected reflections in this phase.		
2	divergence/elaboration information exchange suggestions (sharing perspectives) insight (intuitive leaps/brainstorming) multiple perspectives (re- questioning) applicability	<multiple perspectives> <information exchange> <insight> <elaboration> <information exchange> <insight> <→confirmation> <re-questioning> <applicability> <→integration> <elaboration> <sharing perspectives>
The full range of indicators has been identified in the selected reflections in phase 2.		
3	synthesis confirmation/verification integration/convergence consensus reflection re-exploration	<<deliberation> <<sharing perspectives> <<multiple perspectives> <<information exchange> <<deliberation> <<sharing perspectives> <convergence> <consensus> <synthesis> <integration> <consensus> <consensus> <synthesis> <<divergence> <<re-questioning> <reflection>
The full range of indicators has been identified in the selected reflections in the integration phase, as have indicators that relate to the earlier exploration phase. The latter indicators were not interpreted as re-exploration, as the reflections showed that students were still engaged in the exploration phase, rather than returning to the earlier phase.		
4	application (*apply) solutions* (moved from phase 3) test* action (practice) presentation (*defend)	<solutions> <<confirmation> <<consensus> <<confirmation> <<convergence> <<integration> <<confirmation> <<convergence> <<insight> <<convergence> <solution> <application> <action> <presentation/defence>
Most of the indicators for phase 4 were identified in the selected reflections, although a large number of indicators related to the previous integration phase. The <test> indicator was not identified. This may be attributed to the students not yet being able to critically assess their solutions vicariously as part of the reflective process. It may also be because students needed more deliberate prompts by way of guiding questions to steer them to a more metacognitive level of engagement with the critical thinking process.		

In summary, the full range of indicators has been identified in the first two phases of the cycle. Indicators that relate to the earlier exploration phase have also been identified during phase 3 (integration). Most of the indicators for phase 4 have been identified in the selected reflections, although a large number of indicators relate to the previous integration phase. The <test> indicator has not been identified in phase 4. This may be attributed to the students not yet being able to critically assess their solutions vicariously as part of the reflective process. It may also be because students need more deliberate prompting to steer them to a more metacognitive level of engagement with the critical thinking process.

4.4.2.2 Project 2: Nuclear energy

Analysis of project 2 follows the framework set out in section 4.3.3: The critical thinking cycle and associated indicators.

(a) Project 2 description

The topic for project 2 was nuclear power as alternative energy option and uranium mining and trading. The students faced ethical decision making that required them to weigh up the negative effects of carbon emissions and climate change against the use of nuclear power as a low-emissions energy source that has the potential to mitigate against climate change but which presents a different set of ethical and environmental concerns. Students were also required to recommend a position on uranium mining and trading, which brought the economic imperative into play. They were instructed to take into account ethical, environmental and economic considerations.

The project contained both a collaborative and an individual component. Students were required to research the topic in teams and to discuss their views and report as a team on their progress. The end product, however, was an individual presentation.

The project was intended to expand students' views beyond the personal interest and primarily safety concerns of Project 1 and to bring societal concerns and corporate social responsibility into the equation. To prompt students to research the topic, while recognising the need to keep the task topical within an evolving environment, the project instructions included a brief scenario which provided an authentic context. The project instruction document has been included in Appendix 4.2.

(b) Engaging students in the critical thinking cycle

In this project students were not required to venture into the scientific evidence of global warming or climate change. They were asked to review information in the media, which facilitated the demand for critical reading and evaluation of information.

The trigger for project 2 is an extract from the national nuclear energy review report: *Uranium mining, processing and nuclear energy: Opportunities for Australia?* (available online at http://www.aussmc.org/Nuclear_Energy_Review.php). The topic of nuclear energy in particular suits the requirement to provide a trigger that engages students. The extract states: "Participating in the nuclear fuel cycle is a difficult issue for many Australians and can elicit strong views. This report is intended to provide a factual base and an analytical framework to encourage informed community discussion." The challenge was for students to recognise their own emotional responses and rely on evidence to support their positions.

In the second week of the project students viewed a recorded television program (Four corners: *Earth, wind and fire*) on alternative energy sources which was provided to counter-balance some of the arguments in the Nuclear Energy Review and to guide students towards considering all potential solutions and not merely take a stance for or against nuclear energy as an option. The topic for this project is nevertheless particularly suitable for making students aware of their own perceptions and assumptions.

(i) Student engagement in Phase 1: Triggering

This section examines selected reflective journal entries to illustrate how and whether students engage in the first phase of the critical thinking cycle. Reflections have been selected to represent both engagement and non-engagement, and entries have been tagged to identify the indicators present in each reflection.

Writing reflective journal entries was not compulsory during projects 1 and 2. There was a marked decline in the number of entries made during project 2, and many of the entries were more descriptive or reported more on team interactions than on the process of engaging in the project topic.

Reflective journal extracts

- 23 *Well I have to say that this topic, the nuclear debate, must have been picked just to tease us. It is very difficult to know who to believe as both sides are convinced that they are right. You have in the middle the politicians who have both sides arguing against each other just for the sake of it and we all know not to believe a word they say anyway. I think I am on the side of the anti nuc's but then sometimes I am not so sure, I am very aware of how things get exaggerated to suit so it is not easy. Anyway it should be fun sifting through all the different information to see who I should side with in this argument and what advice to give to the company as to its position. Wish me luck... [6 May 2007*

Student J]

<puzzlement> <problem redefinition> <information>

- 24 *I think this topic is very controversial and even though there are a lot of positives related to nuclear energy and uranium mining the biggest problem is convincing the public to agree also because it has such a negative stigma about it.* [6 May 2007 Student D]

<questioning assumptions> <tentative course of action>

- 25 *As for the topic, I am finding it very interesting. There is a lot of published information relating to nuclear and Uranium with most of it being negative. It is important to really flesh out the positive story to offer a balanced opinion to the board.* [6 May 2007 Student H]

<questioning assumptions> <information>

- 26 *Although a controversial topic, I was not very familiar with the content and hadn't come across this subject matter much in my personal experience. It is interesting to develop both sides of the argument though.* [7 May 2007 Student M]

<puzzlement>

Interpretation of reflections in phase 1: Triggering

Analysis of reflections during phase 1 shows that the “two sides” of the debate are very much at the forefront of students’ minds (reflections 23, 25 & 26). In reflection 23 the student is experiencing a real dilemma and makes clear the need for information to resolve the dilemma. Students show awareness that relying only on information that supports one side of an argument can constrain their thinking (reflection 25) and that it is necessary to address two sides of the issue (reflection 26).

Students expressed the need to become familiar with the topic (reflection 26) and to “gain a better understanding of the problem” (reflection 25). There appears to be a sense of other positions being unnecessarily negative. There is almost a sense of vacillation in the recognition that there are likely to be different points of view, and some reluctance to express their own tentative views (reflection 25). Reflection 24 indicates that the student has adopted a position but recognises that others may hold a contrary position.

Overall, there is a sense of puzzlement and awareness that assumptions need to be questioned, and that there is a need for information to resolve the dilemma.

(ii) Student engagement in Phase 2: Exploration

Following initial discussions, class sessions focussed on the exploration phase, with students researching the literature and discussing issues in teams. They spent the final half hour of each session putting together their progress reports. During this phase students analysed the issue

and gathered information. Apart from the Report, no other resources were provided for students.

Reflective journal extracts

- 27 *I am finding that the research side of the nuclear power is easier and more enjoyable than the driver assignment. I believe that is because I have a better idea of what I am doing in regards to researching the topic and finding both sides of the argument. I have definitely learnt from the previous assignment. (obviously the desired outcome from studying. hehe). [5 May 2007 Student M]*

<multiple perspectives>

- 28 *... a DVD of a four corners episode on renewable energy resources which was very informative. It is an amazing process, because when I first read the topics and assignments that we are going to be doing I initially think how will I learn about and know about these issues enough to write an assignment and discuss them. But then once you get started it all just snowballs and the information starts to sink in. The group discussion board is very useful because you can read what other students' opinions are and this helps to get different ideas of looking at the topics. [13 May 2007 Student N]*

<insight> <divergence> <multiple perspectives>

- 29 *I have found with the topic, nuclear energy, that I would not be against it. The DVD [Four Corners: Earth, wind and fire] angered me as it included all the political arguments and shows the game playing that is included. When there are so many options becoming available for a cleaner environment, the financial costs seem to be greater than the options causing more damage! [17 May 2007 Student M]*

<<problem redefinition> <re-questioning>

Interpretation of reflections in phase 2: Exploration

In this second project, students appear to be more adept at researching the topic during the exploration phase (reflection 27). Students are also more aware of alternative points of view and multiple perspectives on an issue than in the previous project (reflections 27 & 28). In some instances, it is not clear whether students are sharing perspectives among themselves (reflection 27) while in others students do confirm that deliberation is taking place (reflection 28).

Additional information was provided to ensure students would be aware of the alternatives and to stimulate discussion. In reflection 29 it appears to have clarified the student's own views, and the student is also becoming aware of the trade-offs between different solutions.

In project 2, the exploration phase appears to be more individualised than in project 1. This may be a result of the individual end product for this project. Students show awareness of alternative points of view, although there appears to be some reluctance to express a view that the class may find unacceptable.

(iii) Student engagement in Phase 3: Integration

The integration phase can be challenging when dealing with topics such as nuclear energy and uranium and mining and trading that have the potential for emotive responses from others. There is no need for consensus among students in this project as the end product is an individual presentation. Students nevertheless need to integrate what they have learned and the insights they have gained.

Reflective journal extracts

30 *I would be interested to see if I am in the minority by recommending a pro stance - my gut and the voices on the discussion board says I probably am! I think that given I have been in the workforce for a number of years I am able to really delineate the emotion from business fact and ultimately profitability. There will always be negatives to taking a form of action, however if I can be sure that these are mitigated then normally the economic reasons will prevail - is that shallow? [19 May 2007 Student H]*

<confirmation> <reflection> <→defend>

31 *I have enjoyed immensely the nuclear assignment. Although I was quite happy in my ignorant bliss on the subject. Now I know so much about it, I have to care about it. I found myself starting out with a pro-nuclear outlook and then swinging the other way the more I researched it. Although the positives are large and fantastic the negatives outweigh. I am concerned that my assignments come across too anti-nuclear but that is the conclusions I came to after many hours of research and reading. [20 May 2007 Student M]*

<←information> <←insight> <←multiple perspectives> <confirmation> <reflection>
<→defend>

32 *The nuclear debate is an interesting topic which just doesn't have an end . . . There are so many different angles which lead to more angles. I'm trying to get my head around focusing on the environmental, ethical and economic issues but am having a time trying to decide which category many points belong in. For example, when I look at disposal of nuclear waste, yes we have a largely unpopulated area in Australia which is environmentally suitable for nuclear waste and would be economically sound to develop into waste facilities, however is it ethically correct to bury this waste on Aboriginal land which may be covered by land rights? This point covers all three categories. [27 May 2007 Anon]*

<←divergence> <←elaboration> <←multiple perspectives> <←re-questioning>

Interpretation of reflections in phase 3: Integration

In reflection 30 the student confirms their position, presenting and defending their view of the problem, while remaining aware that this view may be diverging from the general views expressed by others.

Reflection 31 combines a series of indicators across the critical thinking cycle. It indicates a change in position following information gathering and weighing the options. The student also moves to a “defence” position that is an indicator of the resolution phase. On the other hand, in reflection 32 the student has identified potential solutions but is still exploring divergent

views and the implications of solutions, and is re-questioning assumptions. There is no indication of having reached confirmation or committed to specific recommendations.

The three reflections show three different progressions through the cycle. In the first reflection the student has confirmed their views and justified their position, although remaining aware that this may not be shared by others. The second reflection (31) reported a clear move from one position to the other, moving through the exploration phase to integration and resolution. The final reflection shows that the student is still weighing alternatives and is considering the complexity of competing solutions.

(iv) Student engagement in Phase 4: Resolution

Student presented their recommendations in an individual presentation to the class. Very few reflections were posted that commented on the resolution phase. The majority of reflections at the conclusion of the project reported on the presentation process itself, rather than on the solutions presented.

Reflective journal extract

33 *Well it is all over now and I have to say it has been an enjoyable experience. I have found that I have learnt a lot both from an academic point of view and from a personal point of view. [27 May 2007 Student J]*

<←reflection>

Interpretation of reflections in phase 4: Resolution

At the conclusion of the project, this reflection (33) shows reflection on the experience. It also reports on the value of the project from both an academic and a personal point of view, which confirms that students engage in tasks that have personal value and relevance.

(c) Project 2 summary

The presence of indicators within each of the cycles is presented below. Indicators that appear repeatedly are not counted, but are seen as indicators of student engagement. As there are several indicators of engagement in each of phases, not all indicators need to be present in order to identify student engagement in a particular phase of the critical thinking cycle.

Phase	Indicators	Tags
1	puzzlement problem recognition problem redefinition deliberation information questioning assumptions proposing courses of action (tentative)	<puzzlement> <problem redefinition> <information> <questioning assumptions> <tentative course of action> <questioning assumptions> <information>
Most of the indicators for phase 1 (triggering) have been identified in the project, with the emphasis on questioning assumptions and reference to information, rather than on deliberation.		
2	divergence/elaboration information exchange suggestions (sharing perspectives) insight (intuitive leaps/brainstorming) multiple perspectives (re- questioning) applicability	<multiple perspectives> <insight> <divergence> <multiple perspectives> <←problem redefinition> <re-questioning>
During phase 2, some indicators have identified divergence in this phase, with the emphasis on multiple perspectives rather than consideration of applicability.		
3	synthesis confirmation/verification integration/convergence consensus reflection re-exploration	<confirmation> <reflection> <→defend> <←information> <←insight> <←multiple perspectives> <confirmation> <reflection> <→defend> <←divergence> <←elaboration> <←multiple perspectives> <←re-questioning>
Indicators during phase 3 relate mostly to the earlier exploration phase, with some evidence of reflection, confirmation and defence, but without a clear indication of convergence or consensus.		
4	application (*apply) solutions* test* action (practice) presentation (*defend)	<←reflection>
In the final phase, the only indicator was <reflection>.		

In summary, most of the indicators for phase 1 (triggering) have been identified in the project, with the emphasis on questioning assumptions and reference to information, rather than on deliberation. During phase 2, some indicators have identified divergence in this phase, with the emphasis on multiple perspectives rather than consideration of applicability. Indicators during phase 3 relate mostly to the earlier exploration phase, with some evidence of reflection, confirmation and defence, but without a clear indication of convergence or consensus. In the final phase, the only indicator was <reflection>.

4.4.2.3 Project 3: The Ribena debacle

This was the first project in the second semester unit ESDP2. Students advanced from accessing, evaluating and using secondary information in the first semester, to collecting, analysing and presenting primary data in the second semester.

The following learning outcomes were targeted:

1. discussing the consequences of ethical behaviour in an organisational context
2. demonstrating effective interpersonal communication and working effectively within a team
3. summarising and synthesising information
4. interpreting and evaluating data using a range of tools and technologies
5. using accepted techniques for managing electronic documents

(a) Project 3 description

The topic for the project was the Ribena “debacle” that unfolded when two school pupils in a science competition found that the health drink did not contain the amount of vitamin C claimed by the manufacturing company. The project tasks were based on the following business scenario:

“Inkling Inc is a marketing consultancy who have been commissioned by JoosEd, a health drink distributor who sells a variety of health drinks via vending machines on campuses and at schools. Following the Ribena debacle, JoosEd anticipates a possible drop-off in demand for health drinks and needs timely market information to manage supplies. You are a member of the Inkling team assigned to the JoosEd account.” (Project 3 instructions)

Students were required to work in a team to draft and administer a survey, analyse respondent data and report the results. The survey was “to test consumer sentiment relating to the health benefits of fruit drinks”. The teams had to report their findings to a JoosEd strategic planning representative in a group presentation. Teams were also required to write a briefing paper that contained a summary of the procedures they followed in developing and conducting the survey and that set out the results that underpinned their team presentations.

As in the two previous projects, students wrote weekly reflections. Students were prompted to reflect on aspects such as the diversity of views identified in the mindmapping process, and their experience of the data collection and data analysis process. Students did not always reflect close to the time of a specific activity. Some reflection dates show that entries were made several days after concluding an activity. Reflections in project 3 were a graded activity and as such the majority of students posted regular reflections.

(b) Engaging students in the critical thinking cycle

The Ribena advertisement apologising for the “error” in the vitamin C testing process was shown to students in class (then available at www.ribenathefacts.co.nz, now available on YouTube at <http://www.youtube.com/watch?v=3NpYJUnKMHY>) . Students were then required to read the article: *Ribena Vitamin C claims false and misleading* (available at <http://www.scoop.co.nz/stories/BU0703/S00478.htm>).

The article appeared on the independent news website “Scoop” Business and provided information on the Court findings in the case that the Commerce Commission brought against GlaxoSmithKline alleging that their claims on the vitamin C content of Ribena products were misleading. The article also provided background information on the events leading to the court case. The event that sparked the investigation was a science fair entry in which two students tested the vitamin C content in soft drinks and found that the Ribena drinks did not contain “four times” the vitamin C content of oranges claimed in the Ribena advertisements. Students were required to “analyse the sequence of events using concept mapping”.

In the advertisement, the CEO of Ribena asserted that the procedures used for testing vitamin C were to blame, maintained that the company did not intend to mislead, and apologised for any confusion. In the Court case, “GlaxoSmithKline ... pleaded guilty to ... charges of breaching the Fair Trading Act by making misleading claims about the Vitamin C content of Ribena ...[and] ... was fined \$227,500, and ordered to undertake a nationwide campaign of corrective advertising in newspapers to explain that some forms of Ribena contain no detectable level of vitamin C.”(*Ribena Vitamin C claims false and misleading*)

Upon initial analysis of the reflections in this project, two iterations of the critical thinking cycle emerged. The first iteration required students to make sense of the issues, explore and define the problem and come to some resolution that would inform their surveys. The cycle then loops back to the exploration phase in a second cycle when students were required to analyse and integrate their findings, and achieve a final resolution in making their recommendations.

Cycle 1

(i) Student engagement in Phase 1[1]: Triggering

Two triggers were provided for this project: a video showing a public apology and an article commenting on the case. Students had to read the article critically and develop a mindmap to help them “identify the issues in the case” so that they could establish the kind of information they needed and therefore which questions to ask in their surveys in order to respond to the brief.

The following questions guided students in their analysis of the article:

- What are the facts of the case?
- What are the ethical considerations in the case?
- Is the case likely to have any long-term effects on the product?
- Is this likely to have an impact on the company and/or the industry?

The advertisement and the background article presented two different perspectives on the issue. The article also provided information on the Fair Trading Act and other Commission actions relating to health claims in consumer products.

In a critical reading of the article, it was anticipated that students might identify a difference in meaning between claims being “false” and being “misleading”, and that none of the Ribena commercials in question claimed that the drink itself contained more vitamin C than oranges, but that “the blackcurrants in Ribena have four times the vitamin C of oranges” – and that the company subsequently maintained that the claim related “to blackcurrants and oranges in their natural whole fruit state”.

This provided a trigger to prompt students to consider their own reactions to health claims and brainstorm the issues before formulating questions for their surveys.

Reflective journal extracts

- 34 *The mindmapping activity that we completed in class last Tuesday (7/08/07) provided myself with an insight into the wide range of differences of opinions within our class. Each team at the beginning had the same center topic ("Ribena"). When asked to change it by [lecturer] to what we thought the main issue or main topic of the conflict was every single group had a different idea. Our groups was "Customer Trust", while other groups changed theirs to "Responsibility" or just simply "Trust".*

Previously when mindmapping for assignments or projects I never went in depth, I normally just thought of a few ideas put them down and thought that's that. In class we learned to expand on each idea that we came up with creating a larger and larger mind-map that contained several opinions, facts and information. I believe that this will personally help me a lot when I prepare for future assignments. [14 August 2007 Student P]

<problem recognition> <problem redefinition> <→elaboration> <→insight>

- 35 *I found that this activity was extremely interesting because it highlighted the diverse range of thinking within the class. Even within the group we had different ways of displaying our mindmaps. I also found that each of the groups' maps portrayed practically the same information but displayed it differently, even in the way that they were drawn and grouped together. I feel that this activity was important for me because it shows the different ways people think and that there are a wide range of ideas that can come from this activity and that it can broaden your own range of thinking. Brainstorming for ideas and then expanding upon those ideas has taught me that there is always more to the story than meet the eye. [7 August 2007 Student S]*

<deliberation> <→multiple perspectives>

- 36 *As a team we came up with 3 main areas to present to the class: legal Issues, ethical Issues and cost to company. Other groups came up with areas such as facts, impact, effect*

on company and community. From the groups presenting to the class I learnt that we should look beyond the article for issues and "think outside the box" e.g. looking at what impact the Ribena situation has had on the community. [6 August 2007 Student V]

<problem recognition> <problem redefinition>

- 37 *... our group had to make a mind map of everything that came to mind about the Ribena issue. ... Ethical issues also came up This places a negative perception on Ribena and I believe they will have to work hard to gain the trust again from the public. Although most views about Ribena were negative some were positive. People didn't care whether they had been lied to. They still believe that Ribena has a good taste and not worried about their vitamin C intake. I believe this was interesting as most people in the room were under the age of 25, so worrying about our vitamin C intake would not worry us. ... Some ideas that came up in our group I would have never come up with, and just proves that working as part of a team really does work, and is a great way to come up with great ideas. [8 August 2007 Student Y]*

<problem recognition> <questioning assumptions> <information>

- 38 *We had quite a productive lesson as we all expressed our ideas and thoughts and points of view on this Ribena case and what points we felt strongly about. We used these points and discussed why our opinions were suitable to use and if they will be able to be used in the survey and will they be able to get the information required to solve this problem. Mind mapping showed our opinions and stances were different but we all had valid and suitable reasons. I also learnt about the different group members' values and ethics. This has helped me to see other people's views and respect them if they are not the same and also listen to these opinions. 7 August 2007 Student VV]*

<deliberation> <information> <→applicability> <→suggestions> <→multiple perspectives>

Interpretation of reflections in phase 1[1]: Triggering

The mindmapping exercise was integrated into the class session during which the triggers were presented. The reflections contain all the indicators associated with the triggering phase, but also includes a noticeable number of indicators from the exploration phase, as mindmapping is an activity typically included during the exploration phase. For example, reflection 34 shows a strong indication of not only beginning to define the problem, but also elaborating on the issue and gaining insight by identifying alternative ideas (phase 2).

The divergent nature of the first two phases of the critical thinking cycle is evident in these reflections. The mindmapping process allowed not only for divergent views between teams but also resulted in different views among members of teams (reflection 35). The mindmapping process allowed for redefinition of the problem by exposing students to different representations (reflection 36).

Reflection 37 shows the creativity and free flow of ideas in the mindmapping process. The student is also questioning assumptions, identifying that different views are likely to be held by different people, depending on what they deem important. The students in some teams

(reflection 38) not only expressed their opinions but also considered the applicability of suggestions to ensure the survey will generate the information needed. There are strong indications of being receptive to multiple perspectives. A noticeable number of reflections show phase 1 telescoping into phase 2.

(ii) Student engagement in Phase 2[1]: Exploration

Students were asked to consider ideas for where they would conduct their surveys. They were required to conduct the survey in person, canvassing opinions from members of the public. The instructions suggested locations such as malls as well as train and bus stations.

During the exploration phase, all members of the team were to contribute ideas and brainstorm the team's approach to conducting the survey. They were also required to research information on survey construction. Students were required to find additional resources and information and to share these in an online class forum.

In preparing their survey questionnaires, students were asked to keep detailed notes of the development process (to use in a briefing report to their "client"), and to consider the following questions (Project instructions):

- Exactly what are we trying to learn as an outcome of the survey?
- How much time can we expect someone to spend answering our questions?
- Do we need to simplify and/or alter our objectives from their ideal to ensure that the survey can be answered in the expected time?
- Will the survey questions we have developed enable us to meet our objectives?

Reflective journal extracts

39 *It was interesting to see the different kinds of questions people were asking and what the aim they were trying to prove. Our group's aim is to determine whether the public was affected by the Ribena scandal. Something that stood out was that other groups were going to interview 100 people which is fair enough, however they were just interviewing students from around the campus. I believe that you need to interview all sorts of different age groups and status, as a student's answer will be different to a parent's answer. [14 August 2007 Student Y]*

<insight> <applicability>

40 *We also broke into our groups in the second half of today's lesson to further discuss our Ribena surveys and how we would go about collecting our data. We also discussed ethical issues that are related with surveys and this proved to be very helpful as a lot of these issues I was not aware of. The new knowledge of these ethical issues has potentially helped me from doing a lot of things wrong so this discussion proved to be very beneficial. [20 August 2007 Student WW]*

<elaboration> <information exchange> <insight> <→integration>

Interpretation of reflections in phase 2[1]: Exploration

Whereas some phase 2 indicators were present in the phase 1 reflections, here students are exploring different approaches to the survey process, rather than exploring the topic, so that there is a stronger emphasis on information exchange and considering applicability. There is also some evidence of awareness that some approaches would be more applicable to achieving the goals of the survey (reflection 39).

Reflection 40 indicates elaboration on ethical considerations. In addition to the ethical concerns relevant to the Ribena case, the student now also takes into account ethical considerations relating to the survey process. The reflection also indicates that the knowledge/insight gained will be integrated and applied, hence moving into phase 3.

(iii) Student engagement in Phase 3[1]: Integration

During this first iteration of the critical thinking cycle in project 3, the integration phase would require teams to integrate the input from all members in formulating their survey questions and reaching consensus on where and how to conduct their surveys. The outcome of the integration phase was to be a questionnaire and a procedure that the team adopted for their survey.

Reflective journal extracts

41 *Doing data collection is important for our assignment. The survey was made successfully by our group, but the location where we should go and collect data become a critical. We want to collect data from all age group, but we could not go to shopping centre to collect. And if we do it within the campus, the age group will be limited on young people, so we decide to divide into 5 sections of the collection, each one of us responsible for 10 surveys and try to reach as many age groups as possible.*

In order to do it better next time, we should define our target age group first. The location is very important because public place is not sure for us to do the survey, so we need to define the location first. [10 September 2007 Student BBB]

<synthesis> <←re-questioning> <←applicability>

42 *Today's team meeting was not a productive one as there was a difference in perception among team members, which have shown that work in a group is not always easy, as different people have different perceptions ... after the rule of give and take we finally come to some conclusion, and got the path how to progress further. [27 August 2007 Student AA]*

<←multiple perspectives> <re-exploration> <convergence> <consensus>

43 *Throughout the week we all put together a sample selection of questions each, when we met up Monday before class, majority of us had the same questions so the process of picking out the best ones was much easier than first anticipated! The only problem we encountered was the clarification of exactly what view point we were trying to focus on, meaning what aspect we were going to aim our survey at. Once this was resolved, things were running smoothly again! [26 August 2007 Student Q]*

<←problem redefinition > <←applicability> <confirmation>

Interpretation of reflections in phase 3[1]: Integration

Student reflections in the integration phase reveal that deciding on a set of suitable questions was not the only consensus to be reached, as other aspects of the survey process were also relevant, including location (the source of data) (reflection 41) and the need to clarify the goal of the survey (the purpose of the data) to ensure collection of useful information (reflection 43).

Reflection 41 shows that the team had synthesised their questions, but that they were reconsidering the location for conducting the survey, therefore re-questioning assumptions about the suitability of locations to resolve their information needs. In reflection 42 the different points of view (multiple perspectives) of the exploration phase persisted and were explored afresh before the team agreed and came to a consensus.

The indicators in the reflections (41 & 42) show that teams were able to achieve integration in order to progress to the resolution phase.

This phase was nevertheless not without difficulties and issues with team dynamics:

Also during class we were discussing questions and gathering the questions we made up whether or not they were suitable to the assignment. It was quite difficult for all of us to decide what questions best fitted our assignment as well as keeping the right questions that will give us more information for us in our assignment. We all got pretty uptight when we gathered the questions we wanted didn't flow along after the other. [25 August 2007 Student Z]

The team had to consider the applicability of the questions each member brought to the table. The above reflection shows that integration was challenging. It was not a simple matter of selecting the relevant questions, but also ensuring that the survey presented coherently.

The reflection below shows that although synthesis took place, this was not always the result of consensus.

Before we did survey, we discussed about the survey questions. We had a lot of conflicts. We had a problem of four against one person. That particular member is a nice person, he tried to lead the group, doing most of the things on his own which was really helpful for the rest of us. But on the flip side of that good situation was that he sort of created an atmosphere like "Either his way or no way". That made us really hard to work with him. Eventually, we all followed his way. [2 September 2007 Student TT]

(iv) Student engagement in Phase 4[1]: Resolution

Whereas in projects 1 and 2, the resolution phase was not strongly evidenced in the reflections (perhaps because resolution was to be achieved by teams making presentations to the class and therefore was not evident in the reflections), the iterative nature of the cycle in project 3 allows greater insight into the final phase.

The outcome of this first iteration of the critical thinking cycle is for students to conduct their surveys and collect data (action or application in practice). Student reflections comment on the survey process.

Reflective journal extracts

- 44 *Well so far I have only had 9 surveys filled out and I have found that it's a little too vague in some points. This becomes a problem because that means that the information that we are collecting is a little too vague and this may affect our research. There are some questions that are working quite well but I almost feel as though there are some questions that aren't really appropriate to the information that we are trying to accumulate. ... [20 August 2007 Student FFF]*

<action> <test> <←applicability>

- 45 *... hit the streets. Instead of doing it all at the University, our group decided to take 25 each and then picked an age group that they will interview. For example, I picked 20-30 year olds, and [team member] picked 30-40 year olds, this meant that we would not come back next week with the same results. Like I discussed last week we can't just interview students (18-30) because they have different views to what a mother (30-50) would have. [25 August 2007 Anon]*

<action> <defend>

- 46 *... If I was to conduct a survey like this again next time I would ask more questions to gain a greater understanding of the consumers thoughts, as in our survey we only asked the basic questions to cover the topic. [31 August 2007 Student GGG]*

<action> <test>

- 47 *I think I did very well in choosing the location to do the survey and designing the questionnaire. However, I also find there is a problem that is many people do not want to be surveyed. I consider that there are two significant reasons why people do not want to be surveyed. The first reason is that the questionnaire has too many questions, which are about sixteen. People do not have enough patience to answer all the questions. The second reason is that I made mistakes about the objects. Some people are in hurry with some other work or they have to leave immediately. Hence, when I survey those people, almost all of them reject my survey.
Next time, I will avoid these two demerits. I think that the questionnaire with ten questions is the best, which can also comprise all the aspects of the survey. In addition, I will choose people who are not busy. I can also try to survey people in the transport, such as in train or in bus. [26 August 2007 Student Z]*

<action> <application> <test> <←proposing (alternative) courses of action>

Interpretation of reflections in phase 4[1]: Resolution

The reflections in this phase all refer to conducting the survey, therefore applying their “solutions” in the resolution phase. Students also identified obstacles and problems in conducting their surveys that they did not identify prior to the action/resolution phase of the cycle.

Having moved into the resolution phase and actioned the proposed solution (conducted the survey), the student now re-examine the suitability of the information that the survey will provide (reflection 44). The reflections illustrate that resolution often triggers a renewed cycle of inquiry.

In reflection 45, the proposed solution was implemented (the survey conducted), and the justification of the approach is a good indication of the defence of a position or prior decision in the resolution phase.

A substantial number of the reflections during this phase showed students questioning the applicability of the questions (solutions) they had adopted (as in reflection 46) or the data they have collected (reflection 45).

Garrison et al (2000, p.102) include critical assessment of solutions in the resolution phase of the cycle. The <test> indicator here represents such critical assessment. There is clear resolution in the reflection 47, but also indicators that show that the problem was not resolved satisfactorily. The student has identified a new problem and is proposing courses of action, as in phase 1 of a new cycle. Students therefore identified new potential solutions to problems identified during testing in phase 4.

In several instances, the resolution was deemed unsuccessful not because of difficulty in applying the “solution”, but because the solution itself was unsatisfactory. Progressing to the resolution phase and applying solutions therefore did not guarantee a satisfactory solution to the problem:

In the future I would try and gather information from more people from different age groups. This is because most of the data I collected was from people either in the 10-20 age group or 20-30 age group. So my data that I collected would have been a bit biased because it was not an even spread over the age categories. [29 August 2007 Student EE]

After conducting my survey I found that the question were much too wordy and I found that I was explaining what we wanted to know with specific questions. I also found that some of the questions were not relevant to what we want to know. I

think that the questions should have been more specific and straight to the point.

[24 August 2007 Student S]

Nevertheless, application of the “solutions” triggered a new exploration phase in which the teams analysed their data, and an integration phase in which they interpreted their data and reached conclusions, which they presented to the client as an oral presentation and a briefing document in a final resolution phase.

The next section presents an analysis of this second iteration of the critical thinking cycle, beginning in the exploration phase.

Cycle 2

Student reflections reveal that having collected their survey data, students looped back to the exploration phase in analysing their survey data. They resumed the critical thinking cycle in the applicability dimension through a process of critical analysis and logical reasoning. This stands in contrast to the exploration phase in the first iteration of the cycle where “scepticism ... may be temporarily suspended” (Garrison, 1991, p.294). They have already elicited responses to their questions during the resolution phase of the first iteration of the cycle, so from that perspective, the resolution phase telescopes into a renewed exploration cycle, which is itself foreshortened because students have completed the more divergent part of the exploration phase in the first iteration.

(i) Phase 1[2]: Triggering

There was no new triggering event for the second iteration of the critical thinking cycle.

(ii) Phase 2[2]: Exploration

During this exploration phase, students conducted their analyses. They discovered patterns and uncovered the perspectives of their respondents. The objective nature of the data analysis makes this a less divergent phase than during the first iteration, and following initial insights, students moved rapidly to testing the applicability of their findings to establish whether the data they obtained would enable them to answer the question set out in the brief, which was to test the impact of the Ribena case on “consumer sentiment relating to the health benefits of fruit drinks” and advise the JoosEd company on the potential impact on their sales (Project 3 instructions). They are not yet integrating their findings to decide on recommendations.

Reflective journal extracts

- 48 *The survey results were bolt from the blue. Even though Ribena had a bad impact, most of the people are still willing to accept the drink if they made a few refinements. People put a lot of suggestions and ideas concerning with re-marketing, multi-branding, brand extension*

and shooting new ads about Ribena which were quite interesting. [2 September 2007 Student TT]

<elaboration> <suggestions> <multiple perspectives>

49 *The data analysis process was crucial in identifying whether consumers had lost trust in the Ribena brand. ... The most surprising result out of all the data we collected would have to have been whether people who were aware of the Ribena debacle drank Ribena before the incident on a regular basis. Out of the 48 people who were aware of the incident only 3 (6.25%) said they drank it often. I thought this was amazing considering the extensive advertising Ribena used to do for its product. [31 August 2007 Student HH]*

<insight> <re-questioning>

Interpretation of reflections in phase 2[2]: Exploration

Some entries during this phase indicated that the integration and resolution phases in the previous cycle were not satisfactory:

once we got together we couldn't really decide on what we should do with the data. ... To me this meant that they had just done the survey and not thought about what we would do next [28 August 2007 Student V]

In some cases the results may have been manipulated in the survey design:

There weren't too many surprises in our results at all and we were very happy with the way the results turned out as we had expected. Although this was the way we designed the survey so that we received a particular viewpoint from the survey respondents.[3 September 2007 Student PPP]

Reflection 48 confirms that this is a new exploration phase. It shows that the data obtained were not confined to aspects that the students had identified in their own teams while constructing their questionnaires. Additional suggestions from respondents have been added, which need to be integrated during the next phase.

Overall, the majority of entries indicated some unanticipated results that developed new insights. When the results were not as expected, the students had to re-question assumptions (reflection 49).

(iii) Phase 3[2]: Integration

In the second integration phase, students put their analyses and conclusions together.

Reflective journal extracts

51 *The data analysis was a very interesting process which posed many challenges. Completely summed up and dumbed down, we found that not many people cared about the Ribena incident, for those who did, the effect was minimal. This not only made devising any recommendations a challenge but also made the content (not the process) of the*

assignment seem slightly irrelevant. Analysing the data was challenging as we realised that results were often ambiguous and depending on how they were phrased, the questions could be used to support almost any argument. ... Many participants admitted to selecting the option which required no written response... . Another issue which presented itself was the interpretation of the meaning behind the Likert-type scales we used for many of the survey's items. The meaning of a number four, for example, may be very different to every participant and to the researchers. [13 September 2007 Student FF]

<synthesis> <integration> <reflection> <←re-questioning>

52 *The group that I was included in was made up of individual people all with different views and beliefs which made it surprising how well we all could come together to achieve the task set before us. As a group we worked well and were able to communicate everyone's views and opinions across without hesitation, and help achieve our group goals to maximise marks not just for the benefit of ourselves but all members in the group. [10 September 2007 Student BB]*

<consensus> <confirmation>

Interpretation of reflections in phase 3[2]: Integration

The reflective nature of verification during the integration phase is evident in reflection 51. Having integrated their findings, the student is re-questioning their interpretations.

Some entries do show (eg reflection 52) that the teams reached consensus and reconciled divergent views. On the other hand, reflection 52 may also be an indication that in the absence of awareness of the cycle in which they are engaging, students viewed success as completion ("to maximise marks") rather than as achieving some resolution to the issue first presented to them.

Some entries indicate that resolution – presenting a solution to the problem posed – would be unlikely:

We also found that if we had a much larger range of information we would be able to produce more accurate results which would make the survey far more interesting. In the future I hope to complete the survey with questions that directly ask a question and can achieve greater results by. I believe we had not fully identified what we were trying to learn as an outcome from the survey, which is a major priority. Hopefully from these mistakes, we can use them in the future to make our surveys more useful. (20 August 2007 Student QQ)

(iv) Phase 4[2]: Resolution

In the second resolution phase, students presented their findings in an oral presentation and reported on the survey process in a "briefing report" to the client.

Reflective journal extracts

- 53 *We were quite surprised to find that not many people were concerned with the misleading of Ribena and their perception of health drinks, as they generally drank it for the taste, not nutritional value. We came to the conclusion that as the main people we were asking, students on campus, that at this age they may not be as concerned as a parent and it is more what is convenient on campus.*
We believe that had we asked a broader target market our results may be different, as people may value their health and trust a little bit more. Also had we asked more people this may have also changed the result. But as JoosEd was looking to supply to vending machines on student campuses, we thought it best to target the students on our campus. [5 September 2007 Student DD]

<solutions> <defend>

- 54 *It was rather interesting to find out that most of the people we had surveyed did not buy Ribena or continued to buy Ribena after the health claims, however many said this did not affect their purchase of other health drinks and more than half consumed them. I believe our survey allowed us to come to the conclusion that the false claims of Ribena had no major impact on society as a whole, ... [28 August 2007 Student QQ]*

<<-confirmation> <application>

- 55 *I was also surprised to see that almost every group came to a different conclusion from their research and I would have expected all groups to have similar results. [4 September 2007 Student U]*

<<-multiple perspectives>

- 56 *In our recommendation, the company could be able to understand which situation they are standing on in the current market, and evaluate these data carefully to get the future plan. In the near future, the company should change the marketing strategy on Ribena. Moreover, the company could not lie to the consumers and we suggest they could get a new product such as Ribena with VE or Ribena Spring water. Then, they can get different result.*

<solutions> <action (practice)> <presentation (defend)>

Interpretation of reflections in phase 4[2]:Resolution

Some reflections in this phase confirm successful resolution of the problem set out in the task (reflection 54), as teams applied their results to reach a clear conclusion that they can justify (reflection 53). Even in the resolution phase, the structure and collaborative nature of the learning approach in the program enabled sharing of perspectives (reflection 55).

While the majority of the reflections at this stage of the project referred to the presentation process, the indicators here show clear resolution of the issue.

As in the resolution phase during the first iteration of the cycle, a noticeable number of reflections during this phase pointed back to weaknesses in the surveys, both in respect of the questionnaires and the survey process itself, as students critically assessed their solutions (Garrison et al, 2000, p.102):

When collecting data I found that it is not necessarily a good thing to go to a busy place because most places that are very busy are also full of people in a rush. Also it is good to change locations so that all of the data is selected from a broad spectrum of in this case potential consumers of the drink.[9 September 2007 Student C]

and

... but I think that we should have surveyed students. Due to the company putting the drinks in vending machines on campuses and schools. So I believe that the survey would have portrayed more relevant results to the company if we had surveyed those would be purchasing it and affecting the sales.[3 September 2007 Student S]

The reflections therefore presented strong indicators of critical thinking, particularly in the self-regulation component (self-assessment/self-correction subskills):

We could have worded some of our questions a bit better in order to get more information and more accurate results. I would spend more time on our survey questions in the future to ensure that they can only be interpreted in the way it was intended. We also used written surveys, which were great in that they allowed us to survey a lot of people quickly, however if we spoke to people, more information would probably have been gained and allowed better and more accurate marketing strategies to be found.[3 September 2007 Student TTT]

Personally if we are to talk about presentation skills our group was very good at that but I think in all the hurry of getting the right number of people to survey we missed what we were actually meant to do, we missed what our group was supposed to do. For example I think we forgot that JoosEd was not a health drink producer but a distributor and thus in the end our conclusion lacked the proper wrap-up on the strategies we think JoosEd should take up.[7 September 2007 Student QQ]

(c) Project 3 summary

A summary of the indicators identified during the two iterations of the critical thinking cycle is provided below.

Phase	Indicators	Tags
1	puzzlement problem recognition problem redefinition deliberation information questioning assumptions proposing courses of action (tentative)	Cycle 1: <problem recognition> <problem redefinition> <→elaboration> <→insight> <deliberation> <→multiple perspectives> <problem recognition> <problem redefinition> <problem recognition> <questioning assumptions> <information> <deliberation> <information> <→applicability> <→suggestions> <→multiple perspectives>
The indicators identified during phase 1 (cycle 1) centred on problem recognition and redefinition, rather than a sense of puzzlement. There is more evidence of deliberation, and the indicators show that students moved rapidly into the subsequent phase of exploration. No triggering phase was identified in cycle 2.		
2	divergence/elaboration information exchange suggestions (sharing perspectives) insight (intuitive leaps/brainstorming) multiple perspectives (re-questioning) applicability	Cycle 1: <insight> <applicability> <elaboration> <information exchange> <insight> <→integration> Cycle 2: <elaboration> <suggestions> <multiple perspectives> <insight> <re-questioning>
The indicators during phase 2 (cycle 1) show some elaboration but there is no clear indication of divergence during the first iteration of the cycle in project 3. During cycle 2, no indicator has been identified to indicate that students were considering the applicability of solutions, nor was there evidence to indicate information exchange.		
3	synthesis confirmation/verification integration/convergence consensus reflection re-exploration	Cycle 1: <synthesis> <←re-questioning> <←applicability> <←multiple perspectives> <re-exploration> <convergence> <consensus> <←problem redefinition > <←applicability> <confirmation> Cycle 2: <synthesis> <integration> <reflection> <←re-questioning> <consensus> <confirmation>
During the first cycle, the third phase (integration) was dominated by phase 2		

indicators, with only a few indicators showing convergence and consensus, while the last-mentioned indicators were more strongly represented in the second cycle.

4	application (*apply) solutions* test* action (practice) presentation (*defend)	Cycle 1: <action> <test> <<applicability> <action> <defend> <action> <test> <action> <application> <test> <<proposing (alternative) courses of action> Cycle 2: <solutions> <defend> <<confirmation> <application> <<multiple perspectives> <solutions> <action (practice)> <presentation (defend)>
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The reflections provided evidence of all phase 4 indicators across both iterations of the critical thinking cycle.

In summary, the indicators identified during phase 1 (cycle 1) centred on problem recognition and redefinition, rather than a sense of puzzlement. There is more evidence of deliberation, and the indicators show that students moved rapidly into the subsequent phase of exploration. No triggering phase was identified in cycle 2. The indicators during the first iteration of phase 2 show some elaboration but there is no clear indication of divergence during the first iteration of the cycle in project 3. Some indicators of exploration have been identified in during cycle 2, but no indicator has been identified to indicate that students were considering the applicability of solutions, nor was there evidence to indicate information exchange. During the first cycle, the third phase (integration) was dominated by phase 2 indicators, with only a few indicators showing convergence and consensus, while the last-mentioned indicators were more strongly represented in the second cycle. The reflections provided evidence of all phase 4 indicators across both phases of the critical thinking cycle.

4.4.2.4 Project 4: Internet censorship

The topic for project 4, the final project in the first year of studies, was internet censorship. Students were required to analyse the topic and identify the main issues and questions to explore. They then developed a draft survey, exchanged their drafts with another team, reviewed the other team's questionnaire and modified their own survey instruments in response to feedback (where they deemed it necessary), and conduct an online survey. They analysed their data in teams and reported their findings in an individual oral presentation.

The learning outcomes for the project included

- developing skills in self and peer assessment

- summarising and synthesising information
- producing business documentation to a professional standard
- collecting, interpreting, evaluating and using data to support oral and written arguments
- applying critical thinking in analysing different scenarios and issues

(a) Project 4 description

The students conducted their research in teams and reported on the research process as a team. The team reports were then used in class for each student to write an executive summary of the report. Students presented their findings in individual oral presentations. The tasks in this project were therefore structured to accommodate both divergence and convergence, and engagement in both the collaborative and individual domains.

Students moreover started evaluating aspects of their own learning and began to apply standards objectively to their own work and to the work of others by writing a critique of another team's survey instrument. They were expected to examine how they went about conducting their research to make explicit aspects such as the objectives of their surveys, evaluating their own preparation and conduct of the surveys, and to identify obstacles and difficulties that they encountered.

In contrast to the other three projects, students were not assigned a "business role" within an authentic scenario.

Students wrote weekly reflective journal entries during the project. The prompts for the reflections asked students to consider the impact of internet censorship on their own information needs, to comment on the peer assessment process, to consider the differences between in-person and online surveys and the appropriateness of each for specific types of information, and to reflect on their overall experience of the teamwork process.

(b) Engaging students in the critical thinking cycle

Students were introduced to the concept of internet censorship by asking them to access and report the URL of an internet site that they accessed regularly. They were then asked what impact it would have if the content on that site were censored (or they were denied access to that site). This establishes the relevance of the issue. Students then read the article [smh_news_int_censorship_grows_worldwide.pdf](#) and conducted online searches to find out more about the topic. They subsequently analysed the topic in teams using brainstorming and concept mapping (or mindmapping) techniques.

They were to identify the main issues and questions to explore, consider and share their own views on the topic. While analysing the article and researching the issue, they started writing

down potential questions to include in a survey. The survey was intended to establish whether a particular population was in favour of or opposed to internet censorship and the reasons for their positions.

In analysing the critical thinking cycle, the emphasis is on the survey development process, rather than conducting the survey and the results as such.

(i) Student engagement in Phase 1: Triggering

The triggering phase was introduced by asking students to consider the effect of being denied access to information that they used on a regular basis, followed by reading an article on the growth of internet censorship across the world. They were directed to additional resources such as the OpenNet Initiative.

The article reported on a study in 2007 that showed that social content on the web was being blocked or filtered in 26 of the 40 countries studied by four universities. It raised issues of censoring information that breached social norms, such as pornography, as well as censorship for the purpose of political control. The study also reported blocking of applications or domains in addition to blocking of static web pages.

The main tasks during the triggering phase included critical reading, analysis, and mindmapping.

Reflective journal extracts

57 *Censorship is a topic that isn't really known in Australia and has never affected me personally. I never knew about the level of censorship in certain countries and the extent to which some Governments go in blocking or filtering specific information so the residents of that country are unaware of certain facts.* [7 October 2007 Student PP]

<information> <questioning assumptions>

58 *Unfortunately I think that internet censorship is a grey topic that has no clear answers as to whether or not it should be a normal element of the internet. I am not particularly biased to one side or the other and am as yet undecided as to whether or not it is a good or bad thing as it can be both detrimental and beneficial to the greater good of society.* [3 September 2007 Student RR]

<puzzlement> <problem recognition>

59 *This ... example highlights the way access to information, or lack thereof affects people, the way they think and the choices they make. Censorship is however a difficult issue as it is in the public interest for some information to not be available to certain audiences, eg. suicide-guides are not appropriate viewing for teenagers. The problem of censorship is the grey area in between protecting people and stripping them of their rights.* [13 September 2007 Student TT]

<problem recognition> <problem redefinition>

Wednesday, 19/09/2007 [KG]

60 *I think that censorship is appropriate if you are censoring it yourself. Different people should be able to view different things even if other people don't agree with them. I do believe that some things (like child pornography) should be censored period because they are just wrong and illegal even if someone has an interest in it. Censorship has many differing views. [19 September 2007 Student GG]*

<proposing courses of action>

Interpretation of reflections in phase 1: Triggering

Reflections during the triggering phase provide support for the relevance of the topic and recognise that divergent views are likely to be associated with internet censorship.

Reflection 57 is representative of a noticeable number of entries indicating that students were unaware of the extent of internet censorship and filtering, especially at official level and at application/domain level, and they questioned the prevailing assumption that everyone has access to information on the internet.

Students recognized that the real dilemma or problem was that there were both benefits and disadvantages attached some control over content published on the internet (reflection 58). Students also redefined the problem as one that also affected the right to information and recognised the tensions between two opposing imperatives (reflection 59).

In some reflections students shared their own intuitive views and tentative solutions, while still recognising that not everyone necessarily shared their views (reflection 60).

(ii) Student engagement in Phase 2: Exploration

During the exploration phase students shared their own views, and importantly conducted online research to find additional information. They started drafting the types of questions they would include in their surveys.

Reflective journal extracts

61 *Through researching the issue of internet censorship I found that the most interesting part of it was what young minors are exposed to. I believe that new laws in place would help to reduce this. I think that this is the main issue of internet censorship, however political issues were also a concern. Information that other countries are exposed to is restricted for various reasons and I also believe this is another big issue. Internet censorship is a broad area and there are many parts we could explore. [17 September 2007 Student MM]*

<elaboration> <multiple perspectives>

62 *Doing research this week on Internet Censorship has opened my eyes a lot to how things are run in surrounding countries and how lucky we are as Australians. Other countries such as North Korea which is at the top of the list regarding "most censored countries" are very strictly driven by their government who dictates exactly what and how much information each individual can obtain. North Korea does this as the article mentions by not allowing internet access at all in this country. Although this is true, ...
... I will be continuing to research this topic and find out more about how other countries'*

freedoms are taken away. ... [17 September 2007 Student EE]

<insight> <elaboration> <←information>

- 63 *Finding the information regarding internet censorship was also another challenge during this lesson as there is a lot of information regarding internet censorship but finding the relevant information was tough. It was fascinating to learn about how restricted some countries are and the huge role that censorship plays e.g. ...* [21 September 2007 Student MM]

<divergence> <applicability>

- 64 *I think creating a survey as a group is a great process, you all contribute your ideas and what areas you need to focus on and then come to an arrangement of how the questions will be placed.
... Analysing another group's survey, and having ours critique by completely new people who hadn't read it before was a great process. Simple errors and confusion that we weren't able to see were spotted out, and vice versa.* [7 October 2007 Student FF]

<information exchange> <multiple perspectives> <applicability>

- 65 *The assessment process was very interesting in many ways. You realise that people will always view your work different from yourself and that people are different. While I might think that a certain question is easy to answer someone else might see it as long and hard.* [24 September 2007 Student EE]

<multiple perspectives> <applicability>

Interpretation of reflections in phase 2: Exploration

A substantial component of the exploration phase was for students to gather sufficient information to construct the first draft of their survey instruments and to critique another team's questionnaire, evaluate the feedback they receive and integrate the suggested changes. The exploration and integration phases therefore telescope in this project.

During the exploration phase, students identified what to them appeared to be the main issue, but acknowledged that other perspectives were relevant (reflection 61). Reflection 62 shows that the student has gained insight into one aspect of internet censorship and is intending to elaborate on that particular aspect in searching for additional information.

The entries during this phase illustrate the divergent nature of the exploration phase and the challenge of deciding whether information was applicable to the problem under consideration (reflection 63). In addition to assessing relevance of information, students exchanged views and suggestions, and had to decide on the applicability of contributions – will the questions to be included provide them with the answers they need? (reflection 64). This shows that students were engaged both individually (the private world) and collaboratively (the social world) during the exploration/integration phases.

Not all students deemed the feedback on their surveys to be valid. In reflection 65, while recognising that different perspectives apply, the student also appears to question the validity of the feedback they received from the peer assessment process.

(iii) Student engagement in Phase 3: Integration

The integration phase in this project telescopes into the exploration phase, as both relate to the questionnaire development process.

Reflective journal extracts

66 *The process was also easier than I imagined, because I didn't expect the mistakes to be so obvious to me. This is good though, because it means I am becoming more critical of things which I read. This is a fundamental skill which I will take away from this unit. Also, after doing this exercise I realised the importance of viewing and evaluating other groups' work, in order to make improvements to your own. [18 September 2007 Student NN]*

<<insight> <verification> <reflection>

67 *From learning about censorship in class I've come to discover that I have to be aware that information could have been censored to influence people's opinion in a certain way. I know now that I should research where my information is coming from before I decide whether or not it is fact/true. ...
I think it is important to learn from peer assessments to improve our future work. It also allows us to learn from our peers who may share different view to ourselves and also to our lecturers. We can then use these views to develop our own understanding and knowledge and apply them to future assignments.[25 September 2007 Student WW]*

<<re-questioning> <<insight> <<multiple perspectives> <reflection>

68 *When our group was evaluating the survey we were at first going through and choosing all of the negative points then we went back and said what was positive. ... When we chose the positives we actually thought about how we could incorporate them into our survey so it really helped us to think not only about the evaluation process of the other group but how it could aid our group. So basically we learnt that when evaluating you can be just negative if you want but having the positive outlook may aid you more than you think. [19 September 2007 Student GG]*

<<insight> <<applicability> <integration>

69 *I found the peer evaluation assessment process one of the most useful activities we have done in this unit. When our group received a survey from another team, we carefully analysed each question; its purpose, its structure, its wording, whether it was ambiguous etc. We carefully decided what could be changed to make the survey more effective. We also decided which elements of the survey were its strongest and should remain relatively untouched. We did not think this critically about our own survey and it surprised me how many skills we actually had when it came to critically analysing surveys that we just didn't use on our own surveys. Our survey came back from the other group full of comments and suggestions. We began to critically analyse our survey, as well as the suggestions from other groups and consequently made some much needed changes. Our survey became clearer, more concise, more effective and better in general. This process taught me the value of looking at your work as an outsider, and critiquing it in the same way a stranger would. [29 October 2007 Student TT]*

<confirmation> <integration> <reflection>

Interpretation of reflections in phase 3: Integration

A number of entries during this phase reflect the value of the peer assessment process in enhancing the students' awareness of the benefits of critical approaches to their own work and reasoning. Students confirmed the appropriateness of the questions included in the survey by integrating improvements as a result of insights gained when evaluating another team's questionnaire (reflection 66 & 68).

In reflection 67, re-questioning as indicator relates to the re-emergence of "scepticism and the questioning of assumptions" (Garrison, 1991, p.294) in evaluating information. The reflective nature of the entry indicates this retrospective aspect. The second part of the reflection confirms the value of multiple perspectives. This aspect of the experience was evident in several reflections. The student is clearly reflecting on the insights gained.

The description of the peer review and self-assessment components of the survey development process in reflection 69 illustrates a high level of engagement in the critical thinking process.

(iv) Student engagement in Phase 4: Resolution

In the resolution phase, students have applied their solutions by conducting an online survey and then reflected on the survey process by comparing it to the in-person surveys of the previous project. Students also commented on the team presentations which represented the final phase in the critical thinking cycle.

Reflective journal extracts

70 *We found the online survey to differ a little from an in-person survey. ... By using the online method you are also unable to connect with the person on a personal level, which I believe is integral in getting a better insight of their point of view on the situation. ... [22 September 2007 Student SS]*

<test>

71 *... we also found that an internet censorship survey was much better conducted online as there are questions which individuals may want kept confidential and survey monkey provides them with that reassurance. [5 October 2007 Student MM]*

<test>

72 *I think that both formats are fine for acquiring information. The online method is effective if you want total anonymity from participants but the in-person method is better if you want to gather personal views from respondents. Both methods do their job all the same though. The online method also takes the time out of having to approach people and the awkwardness of having to ask them if they want to take time to complete your survey should you have done it using the in-person method. [24 October 2007 Student LL]*

<test>

73 *We've got a lot of shocking answers and a lot of valuable feedback from people around the world. 91% of the internet users use internet everyday and among them, 68% of the users think that online censorship is the abuse of freedom of choice. ... It's totally different from in-person survey because, since it's anonymous, people dare answer what they really think.*
[14 October 2007 Student PP]

<presentation>

Interpretation of reflections in phase 4: Resolution

Students presented opposing views of the relative merits of in-person and online surveys. In reflection 70, the student expresses a preference for in-person surveys in order to “connect with the person on a personal level”, while in reflection 71 the student considers the online survey to be more likely to elicit the information sought, given the nature of the topic.

Some reflections alluded to a lack of integration which became evident in the presentations:

My team had different ideas of what was important and this came out during the speech and as a result created incoherence and confusion, and lead to a pretty poor speech. I thought our slideshow was the best of the class because of its simplicity and visual appeal. [27 September 2007 Student MM]

In most cases the results obtained through the survey answered students’ questions (as in reflection 73) and can be seen as a successful resolution of the issue/problem. The reflections did not indicate the same level of critical assessment and self-correction as in the previous project. This may be seen either as a result of the guiding question which steered them towards a comparison of in-person and online surveys, but it may also be interpreted as an indication of the value of the peer-assessment process included in this project.

(c) Project 4 summary

A summary of the indicators identified during the two iterations of the critical thinking cycle is provided below.

Phase	Indicators	Tags
1	puzzlement problem recognition problem redefinition deliberation information questioning assumptions proposing courses of action (tentative)	<information> <questioning assumptions> <puzzlement> <problem recognition> <problem recognition> <problem redefinition> <proposing courses of action>
In project 4, all indicators of the triggering phase have been identified in the reflections, with the exception of a sense of puzzlement. This may be as a result of the researcher’s interpretation of this indicator and will be considered in drawing conclusions in the		

discussion section in the final chapter.		
2	divergence/elaboration information exchange suggestions (sharing perspectives) insight (intuitive leaps/brainstorming) multiple perspectives (re- questioning) applicability	<elaboration> <multiple perspectives> <insight> <elaboration> <←information> <divergence> <applicability> <information exchange> <multiple perspectives> <applicability> <multiple perspectives> <applicability>
All indicators of phase 2 were identified in the selected reflections.		
3	synthesis confirmation/verification integration/convergence consensus reflection re-exploration	<←insight> <verification> <reflection> <←re-questioning> <←insight> <←multiple perspectives> <reflection> <←insight> <←applicability> <integration> <confirmation> <integration> <reflection>
Some indicators of integration have been identified during phase 3, with the emphasis on reflection. Several indicators during this phase related to the earlier exploration phase, and no indicator confirming consensus or synthesis has been identified.		
4	application (*apply) solutions* test* action (practice) presentation (*defend)	<test> <test> <test> <presentation>
Phase 4 indicators were confined to testing and presentation.		

In summary, all indicators of the triggering phase have been identified in the reflections, with the exception of a sense of puzzlement. This may be as a result of the researcher's interpretation of this indicator and will be considered in drawing conclusions in the discussion section in the final chapter. All indicators of phase 2 have been identified in the selected reflections. Some indicators of integration have been identified during phase 3, with the emphasis on reflection. Several indicators during this phase related to the earlier exploration phase, and no indicator confirming consensus or synthesis has been identified. Phase 4 indicators were confined to testing and presentation.

The next section presents the discussion of the findings in the process analysis.

4.4.3 Discussion: Engaging in a process of critical thinking

Part 2B has presented an analysis of student engagement in the critical thinking process in the four projects of the first year in the employability skills development program. It has shown how critical thinking skills may be developed in an immersion approach. The analysis is intended to answer subquestion 1B:

- 1B. *How do students engage in a critical thinking process during the learning activities undertaken in the first year of the ESDP (employability skills development program)?*

The reflections were content-analysed to identify the presence of critical thinking indicators adapted from a model of critical inquiry (Garrison 1991; Garrison, Anderson & Archer, 2000; Garrison & Anderson 2003). Analysis of the reflections support the proposition that the immersion approach followed in the program is appropriate to develop critical thinking skills.

In **project 1**, some reflections indicated that students may be prone to adopting a surface approach to the tasks, viewing them as information finding and presentation exercises, without engaging in the phases of integration and resolution which are essential to developing critical thinking. A number of entries moreover reflected the difficulties that students experienced in coordinating input from members of their teams. The need to complete their investigations in time for the presentations may also have been a contributing factor to some student not engaging fully in the critical thinking process.

There was clear evidence that the phases in the cycle are not fixed, and that students move back and forth, sometimes telescoping two phases and sometimes returning to an earlier phase. This is illustrated well by the synchronous exchange between two students in section 4.3.3.1(c). The exchange shows that students can and do engage in the critical thinking cycle.

While reflections in phase 4 presented a number of phase 3 indicators and few clear indicators of the resolution phase, this may be attributable to the fact that the resolution phase may be represented by the oral presentations at the end of the project and would therefore not be strongly evident in the reflections.

The general findings in project 1 confirm the presence of the indicators in each phase of the critical thinking cycle. Although this cannot be generalised to all students who completed the project, the purpose here is to show that the immersion model has the potential to develop critical thinking skills. An analysis of the student experience in this first project of the program has provided evidence that students do engage in the critical thinking cycle, and this supports the suitability of this type of project for engaging students in critical thinking.

The indicators identified in student reflections in **project 2** have shown that the exploration phase predominated during this project. A few reflections contained clear indicators of students having integrated new knowledge and taken a position, but generally there were few indicators of the resolution phase within the reflections. This may be attributed to the fact that many students did not write entries in the reflective journals during the latter stages of this project.

Two focal areas emerged from the evidence available in the students reflections in project 2: that students felt a need to become better informed on the topic before adopting a position for or against nuclear energy and uranium mining and trading, and that they were very aware of multiple perspectives on the issue.

The reflections in **project 3**, in the second unit of the program conducted in semester 2 of the first year of studies, provide much more in-depth information and detail on the activities and learning processes in which the students engaged. Students described their deliberations with reference to the context and content of the tasks. Two iterations of the critical thinking cycle were identified in project 3.

In the first iteration, there was strong emphasis on the mindmapping activity during the initial triggering phase. Although this may be a result of the specific prompting question that guided the reflections at that time, it is significant that so many students commented on the value of this activity in defining the problem.

It is also noticeable that during the second iteration of the cycle the collaborative context appeared to be less disruptive than in the first iteration, and in the first two projects during the first semester. This may be attributed to students having developed teamwork skills that may have been lacking during the first semester's projects.

Both resolution phases in project 3 contained strong indications of self-assessment and critical awareness of the success or otherwise of the solutions applied in the project (the surveys and the data obtained). Such critical assessment of the solutions and self-correction are not interpreted as a weakness in the cycle of critical thinking, but are seen as an indication that engaging in the set tasks has advanced the critical thinking skills of many of the participants.

Some entries in **project 4** commented that this topic (internet censorship) was seen as more relevant to students than project 3 (the Ribena case), which could be an indication that regardless of the skills and knowledge that students are likely to acquire during a project, the relevance of the topic may be decisive in determining the level to which they engage in the critical thinking process.

The reflections in project 4 showed that students were most actively engaged in problem definition and problem redefinition in the triggering phase, and in the integration phase where they reflected on the value of the peer-assessment process and the insights they gained as an outcome that process.

Although not many reflections commented on the successful application of solutions, this may have been a result of the guiding questions for the reflections during that stage of the project. Greater reflection on the outcomes of the research undertaken by students would have presented a good opportunity to gauge the level of engagement in the final phase of the critical thinking cycle.

Exposure to multiple perspectives can be seen as central to the development of both critical thinking skills and a disposition to think critically:

The ... ideas that other members in your group come up with are different. Which is great! ... learning how ... not to be just one-sided, as in to not think what you think is right and no one else knows better! In a team you learn to see other people's perspectives and ideas on the work at hand, and in the end hopefully do a better job than you even thought possible! [10 October 2007 Student MM]

The aim of this analysis has been to use the students' own reflections as a form of self-reporting to illustrate engagement in the critical thinking cycle. No claim is made that such engagement took place universally. Some examples of reflections that contained elements that may be interpreted as obstacles to critical thinking have been included in the analysis of the projects.

The reflections nevertheless presented strong evidence that even when team dynamics were not optimal, the value of the collaborative process was recognised:

I find group work very effective such benefits include:

*Becoming friends with new people,
Splitting up work load,
Gaining a larger range of ideas,
Learning from others attitudes and values.*

Aspects that could improve the teamwork process include:

*Group members being patient with one another,
Group members being open to new people,
Group members being open to new ideas,
Group members to be willing to work as equally hard as others. [17 October 2007 LL]*

The distinctive nature of in-class participation appears to be indispensable in promoting critical thinking skills development, and the reflective learning component encourages students to engage metacognitively in the critical thinking process :

In other units, group assignments usually only last a few weeks and you don't always even work together, you may just email each other with your section on the assignment. In [the ESDP], we sit together every week, write reports together, do presentations together, and meet up outside of class every week. This kind of experience is invaluable in my opinion. ...

This unit has also reinforced certain aspects of group work which I have already encountered. Such aspects include sharing of ideas, sharing knowledge and experience, learning how to resolve group disputes, helping each other, developing friendships, making sacrifices, distributing workload fairly and so on. (9 October 2007 Student NN]

In summary and in answering subquestion 1B, the process analysis has shown

that, without making a claim to universal engagement in the critical thinking process, student reflections indicate that they engaged substantively in the critical thinking process during the projects

Parts 2A and 2B of the case study have presented the task analysis (infusion of critical thinking) to determine the extent to which tasks that promote the development of critical thinking skills are represented in the projects that students undertook during the first year of the program, and the process analysis that determined the extent to which students engaged in the process of critical thinking during the projects.

Part 2C presents the performance analysis, in which student scores in a standardised critical thinking skills test (CCTST) at the start of the first year are compared with scores obtained in the same test at the start of the second year of studies.

Part 2C: Performance analysis

4.5 Measuring test performance

4.5.1 Introduction

Part 2C of the case study presents the analysis and findings of student performance in a standardised critical thinking skills test. The California Critical Thinking Skills Test was administered to students in the employability skills development program (ESDP) at the beginning of their studies in year 1, and again at the start of the second year of the program. The test was taken online (CCTST Form 2000) under test conditions in class. Tests were scored automatically as soon as they were submitted and participants received their individual results together with explanatory information and percentile rankings based on the 4-year US college student norms. Additional information on the testing procedure has been provided in section 3.3.3.3.

Comparing student performance in the test at the start of the program with their performance after they completed the first year of the program is intended to answer research question 2:

RQ2 How effectively does participation in an employability skills program develop students' critical thinking skills as measured in a standardised test?

Four contrasts of interest were identified to answer the following subquestions:

RQ2A Do testtakers perform better in the CCTST after participating in the first year of the program than at the start of the program?

Subquestion 2A is answered by contrasts 1 and 2.

RQ2B Do testtakers who have participated in the first year of the program perform better in the CCTST than students who entered the program in the second year?

Subquestion 2B is answered by contrast 3.

As set out in section 3.3.4.2, the student population in the program included students from English-speaking backgrounds (ESB) as well as students from non-English-speaking backgrounds (nESB), so that two additional subquestions arise:

RQ2C Do testtakers from English-speaking backgrounds perform better in the CCTST than students from non-English-speaking backgrounds?

RQ2D Do students from English-speaking backgrounds show greater improvement in CCTST performance after participating in the first year of the program than students from non-English-speaking backgrounds?

Subquestions 2C and 2D are answered by contrast 4.

As it is the relative performance of groups in the test that is of interest, effect sizes have been calculated as a measure of the mean differences in performance. Effect sizes have been calculated using Cohen's d and the pooled standard deviations of the two groups being compared in each instance. A further discussion on the rationale for reporting effect sizes rather than testing for significance has been provided in section 3.3.4.2(c).

The test scores of four groups have been used to answer the above four subquestions:

Group A comprises students who took the pretest at the start of the program and the posttest after completing the first year of the program. The difference in this group's performance is calculated to answer subquestion 2A (A_1 being the pretest scores and A_2 the posttest scores) in **contrast 1**.

Contrast 2 is intended to help answer subquestion 2A. In addition to group A scores, this contrast includes group D testtakers made up of students who completed only the pretest at the beginning of the program, and group C students who completed only the posttest but who, unlike group B have completed the first year of the program. In contrast 2, a comparison of the performance of all pretest and posttest scores (groups A_1 and D combined compared with groups A_2 and C combined) provides a result that eliminates possible test-effects in contrast 1 (group A).

Group B comprises students at second-year level who had not completed the first year of the program. It therefore serves as a control group, and comparing the scores of group B with the scores of group A_2 answers subquestion 2B in **contrast 3**.

Contrast 4 similarly uses the scores of all pretest-takers (group A_1D) and all posttest-takers (group A_2C) and compares first the overall results of students from English-speaking backgrounds with those of students from non-English-speaking backgrounds, all of whom have completed the first year of the program, and then calculates the standardised mean differences (effect sizes) of the two comparison groups. This contrast answers subquestions 2C and 2D.

The sections that follow present the following information:

Section 4.5.2 examines the demographic composition of the four groups of interest and presents the demographic data.

Section 4.5.3 presents the descriptive statistics and observations are made following each summary table. This is followed by visual inspection of the data for each group in section 4.5.3.3. This approach is in line with the procedures outlined in figure 3.10 and follows recommendation (4) of the Task Force on Statistical Inference (Wilkinson & the TFSI, 1999) set out in section 3.3.4.2(c) to apply graphical analysis of assumptions to identify threats to data integrity.

Section 4.5.4 presents the standardised means comparisons (effect sizes) for the four contrasts of interest. Each analysis is followed by a discussion of the findings. Findings are summarised in section 4.5.5.

4.5.2 Student demographics

Table 4.2 provides a summary of the demographic data (frequencies) for all four groups and the two composite groups, including gender, age, language, qualification, study experience and work experience.

Within the contrasts of interest, a total of 348 students completed the CCTST. A total of 237 pretest scores and 175 posttest scores have been included in the data. The 64 testtakers in group A completed both the pretest and posttest. A total of 412 test scores were therefore collected.

Overall, an equal number of male and female students took the tests (50:50), with slightly more males taking the pretest and slightly more females taking the posttest. Reported ages ranged between 16 and 55 (with 10 testtakers not answering this question) and almost equal percentages in the under-21 and over-21 groups.

Overall, and within group A (the pretest-posttest group), almost equal numbers of testtakers came from English-speaking and non-English-speaking backgrounds (overall 48:52; group A 55:45), but the proportions vary noticeably within other groups. The majority of pretest-takers were from English-speaking backgrounds (66%) with the highest proportion (77%) in group D (who had taken only the pretest), while the majority of posttest-takers were from non-English-speaking backgrounds (62%) with the highest proportion of 71% in group B (entrants into year 2 of the program).

The latter disproportion may be attributable to the intake of students from offshore partner institutions in the second year of the course. Students in that cohort would have completed

the comparable units of study at partner institutions (in the course curriculum as it was prior to the introduction of the ESDP, which was introduced at partner institutions a year later) and gained exemption from the first year units in the employability skills development program (ESDP).

In addition to gender and age, data were collected on three demographic factors that were deemed to have a potential impact on testtaker performance: previous higher education qualifications completed, study experience (that is, the number of units of study a testtaker had completed at the time of taking the test), and full-time work experience. The frequencies show that groups were reasonably homogenous on these demographics. Exploring the potential effects of demographic factors other than language falls outside the scope of this study. Frequencies have been reported to provide an overall picture of the population and the samples in the study.

In group A less than one percent of students, and less than five percent of students in any group, held prior tertiary education qualifications. Tertiary qualifications were not defined as university degrees, so it may be that respondents indicating previous higher education qualifications had completed an entry-level diploma at TAFE or a University Preparation Course. These figures therefore cannot be interpreted at face value as indicating that those testtakers were studying for a second degree, and for the purposes of this study the small percentages are considered unlikely to have had an effect on aggregate group performances.

Overall, 73% of students had completed fewer than four units of study (one semester of full-time study) at the time of taking the pretest. At posttest, after completing the first year of the program, it can be assumed that all testtakers will have completed four or more units of study. Overall, approximately 80% of testtakers had less than one year of work experience.

The significant demographics are therefore

1. an even balance between male and female testtakers
2. overall almost equal proportions of testtakers under and over 21 years of age
3. overall only slightly more testtakers from non-English-speaking backgrounds but with significant variation in the proportions in the pretest and posttest groups (apart from group A which comprises the same group of students for pretest and posttest),
4. a low percentage of students (<10%) with prior qualifications
5. a majority of students (73%) with little study experience, and
6. the majority of students (approx 80%) having no prior work experience.

Table 4.2: Demographics by group

Group	Testtakers		Gender		Age*		Language		HigherEd qual*		Study experience (completed units)		Work experience	
	n	%	male	female	16-20	21-55	ESB	nonESB	n	%	<4	≥4	≤1	2-4+
			%	%	%	%	%	%			%	%		
A₁₊₂: pre-posttest OXO	64	18.4	52	48	61	39	55	45	2	0.6	72	28	81	19
B: posttest entry U3 CO	79	22.7	43	57	43	52	29	71	10	2.9	24	76	82	18
C: posttest only U3 XO	32	9.2	50	50	25	72	31	69	5	1.4	6	94	78	22
D: pretest U1 sem 1, 2007	173	49.7	56	44	70	24	77	23	16	4.6	81	19	75	25
Total	348	100	50	50	50	47	48	52	33	9.5	46	54	79	21
A₁D: pretest OXO	237	68.1	55	45	67	30	66	34	18	5.2	73	27	78	22
A₂C: posttest OXO	96	27.6	51	49	49	50	43	57	7	2.0	2	98	80	20
Missing data: Age=10 testtakers (2.8%); Higher Education qualifications=1 testtaker (Group B)(.28%)														
A total of 237 pretest scores (groups A ₁ and D) and 175 posttest scores (groups A ₂ , B and C) were collected.														

Percentages have been rounded. Shaded rows indicate composite groups where data have been merged for purposes of analysis.

Higher Education qualifications completed are as at the time of writing the test for the first time, be it a pretest or posttest, since students are unlikely to have completed a different qualification between writing the pretest and posttest. One testtaker did not provide this information.

Study experience is shown as at the time of writing the test for the first time (be it a pretest or posttest). It can be assumed, where testtakers completed both a pre- and posttest, that they will have completed four or more units of study between pre- and posttests.

Representation

Table 4.3 sets out the percentage of students in each cohort (total enrolments in the program at the point of testing) who took the test in each group.

Table 4.3: Representation

Group	<i>n</i> results	Total enrolment in unit	%
A ₁	64	319	20
A ₂	64	296	22
B	79	296	27
C	32	296	11
D	173	319	54
A ₁ D	237	319	74
A ₂ C	96	296	32
A ₂ C + B	175	296	59

Each group represents between 11% and 54% of total enrolments in the relevant unit. Pretest respondents (groups A₁ and D) make up a total of 74% of students enrolled in the first unit of the program. Posttest respondents (including groups A₂, B and C) represent 59% of students enrolled at the beginning of the second year of the program.

While testtakers have been subdivided into four comparison groups, the overall representation of 74% and 59% in the pretest and posttest, respectively, is deemed satisfactory.

The next section presents the exploratory data analysis and provides summary descriptive statistics as well as visual inspection of data in each of the groupings. Means comparisons and observations follow in section 4.5.4.

4.5.3 Descriptive statistics

The first phase of the data analysis strategy involves data exploration and reporting of descriptive statistics. This section provides summaries of descriptive statistics in terms of location and spread (in section 4.5.3.1) and shape (in section 4.5.3.2) for the test scores in each group. Data are examined numerically and visually (in section 4.5.3.3) to detect violations of assumptions. Such inspection is prompted by the fact that data are assumed to display equality of variance (homogeneity) and to be normally distributed (homoscedasticity) when calculating standardised mean differences and confidence intervals, as such measures are generally sensitive to violations of assumptions (Grissom & Kim, 2005, pp.10-14). Observations are made following each analysis.

Results presented include calculations of the mean, median and mode, the standard deviation and variance, as well as the minimum and maximum scores, and the skewness and kurtosis of data for each group.

Data are analysed and interpreted for each group as set out in the *group design* in figure 3.8 (section 3.3.4.2).

All graphics and tables have been generated in analyses of data during this investigation.

4.5.3.1 Location and spread

The location of data concerns centrality or the measures of central tendency, while the spread of data is determined by the dispersion of test scores, including the standard deviation and variance in the data collected.

Table 4.4 shows the *mean, standard deviation, variance, standard error of mean, median and mode* for each group. Descriptive statistics measuring distribution are provided in Table 4.5 that follows. Statistics have been rounded to two decimal places. The lower and upper bounds of means (at 95% confidence interval) are reported in the observations.

Table 4.4: Descriptive statistics by group

Group	N	Mean	Std. Deviation	Variance	Std. Error of Mean	Median	Mode	
A ₁ CCTST pretest	64	15.52	4.78	22.889	.598	15.00	15	
A ₂ CCTST posttest	64	15.39	5.15	26.496	.643	15.00	17	
A ₁ D CCTST pretest	237	15.71	4.94	24.434	.321	15.00	15	
A ₂ C CCTST posttest	96	14.89	5.38	28.945	.549	15.00	17	
B	CCTST pretest	this group did not complete a pretest						
	CCTST posttest	79	12.96	4.57	20.883	.514	12.00	12
C	CCTST pretest	this group did not complete a pretest						
	CCTST posttest	32	13.88	5.77	33.274	1.020	13.50	11
D	CCTST pretest	173	15.79	5.01	25.123	.381	15.00	15
	CCTST posttest	this group did not complete a posttest						

Observations

The **means** for all test scores vary from 12.96 for group B (confidence interval (CI) 11.94 – 13.98) to 15.79 for group D (CI: 15.03 – 16.53). These lowest and highest group mean scores reflect a contrast that may be important. The median scores for these two groups also lie at the two extremes (12 for group B and 15 for group D), while the mode (the score that appears most frequently for the group) is 12 for group B and 15 for group D. Neither group had participated in any significant way in the program at the time of taking the test, but group B is

composed of students in their second year of study (the scores are therefore taken at posttest), while group D comprises first-year students (pretest scores), so this is contrary to expectations.

Similarly, and contrary to expectations, the mean scores for the group A₁ pretest group ($M_1=15.52$; $SD=4.78$; CI: 14.32 – 16.71) is higher than for the posttest group A₂ ($M_2=15.39$; $SD=5.15$; CI: 14.10 – 16.67).

Among the pretest groupings, group A₁ ($n=64$) has the lowest mean (15.52) and the smallest standard deviation ($n=64$; $SD=4.78$).

Among the posttest groupings, group C ($n=32$) recorded the lowest mean score, largest standard deviation and highest standard error of the mean ($M=13.88$; $SD=5.77$; $SEM=1.020$; CI: 11.79 – 15.95). Students in this group had completed the first year of the program but had not taken the pretest at the start of their studies.

Variance values range from 20.88 (group B, posttest) to 33.27 (group C posttest). Of the pretest groups, group D ($n=173$) shows the greatest variance (25.12) and therefore the highest standard deviation value ($SD=5.01$), and group A₁ ($n=64$) shows the least variance (22.89) and concomitantly the lowest standard deviation ($SD=4.78$). Overall, posttest scores are consistently more spread out than pretest scores, showing greater variability in student performance in the CCTST at posttest.

Variances nevertheless do not differ greatly. Kline (2004, p. 104) suggests a ratio of 4:1 as sufficiently large to warrant using Glass's Δ . The reported variances therefore support the use of Cohen's d .

The mode (=15) is the same for all pretest groupings. The mode for posttest groups ranges from 11 to 17.

Group-level analyses of means comparisons appear in section 4.5.4.

4.5.3.2 Shape

The shape of data is determined by their distribution and concerns assumptions of normality as determined by measures of skewness and kurtosis. Table 4.5 provides a summary of values for deviations from the norm observed in the test scores for each of the groups.

Table 4.5: Variance by group

Group		N	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis
A ₁₂	CCTST pretest	64	.367	.299	-.079	.590
	CCTST posttest	64	-.008	.299	.721	.590
A _{1D}	CCTST pretest	237	.271	.158	-.048	.315
A _{2C}	CCTST posttest	96	.018	.246	.090	.488
B	CCTST pretest		this group did not complete a pretest			
	CCTST posttest	79	.899	.271	.728	.535
C	CCTST pretest		this group did not complete a pretest			
	CCTST posttest	32	.170	.414	-.569	.809
D	CCTST pretest	173	.239	.185	-.013	.367
	CCTST posttest		this group did not complete a posttest			

Observations

The majority of skewness values are closer to zero than to one, indicating reasonably symmetrical distributions. One exception is group B for which the scores (posttest) are positively skewed (.899, which is more than twice its standard error), indicating a longer right tail than in a normal distribution.

Kurtosis measures for group A₂ (.721) and group B (.728) are approaching 1, indicating that scores are more clustered and have longer tails than in a normal distribution and are examined visually in section 4.4.3.3(c). The kurtosis value for group A₁ is negative (albeit very small at -.079), which would indicate that scores are less clustered with slightly *shorter* tails, in apparent contradiction of its small positive skewness value (.367) which would be indicative of a marginally *longer* right tail. The shape of this distribution is examined graphically in Appendix 4.6, section 1(a).

In Appendix 4.6, sections 1(a) to 1(d) examine graphic representations of the data to confirm or elucidate the statistics provided in section 4.5.3.1 and 4.5.3.2. The assumption that the data are independent is relevant when comparing independent groups, but in this case testtaker performance does not depend of the performance of any other testtakers, and so is not relevant to this analysis.

The visual inspection in Appendix 4.6 refers to statistics appearing in the summary tables when relevant, but the main focus is on graphical analyses by way of histograms, boxplots and stem-and-leaf plots. Of interest in data representations in the histograms and stem-and-leaf plots are the general location, spread and shape of the test results for each of the data groupings. The boxplots provide a further indication of overall data distribution.

For contrast 1, the analysis and visual examination of the location, spread and shape of the data for groups A_1 and A_2 in Appendix 4.6 show that inequality in variance between the two groups is caused by a small number of cases and is not sufficiently large to impact selection of an effect size measure. Examination of data for contrast 2 shows that the distributions for the two groups in contrast 2 meet the assumption of normality and equality of variance.

Examination of the distribution of group B data shows that given the skewness and the difference in the population from which group B has been drawn, it would be appropriate for the effect size for contrast 3 to be calculated using the standard deviation of group B (the “control” group).

Contrast 4 uses the same data as contrast 2 which meet the assumptions. Section 4.5.4 addresses each of the contrasts of interest. The standardised difference between the means (effect size) is reported for each contrast, and the findings are summarised in section 4.5.5.

4.5.4 Means comparisons

This section contains performance analysis to determine the effect of the employability skills development program on the development of critical thinking skills as reflected in student scores in a standardised critical thinking skills test (CCTST). The analysis is intended to answer each of the four subquestions listed in section 4.4.1. The results of these analyses will provide insight into the comparative performance of testtaker groups and will be integrated with the qualitative evidence of critical thinking in parts 1 and 2 of the case study. Part 1 analysed the projects undertaken in the first year of the program and found that the tasks that students performed were aligned with the examples of tasks that promote critical thinking as set out in the Delphi Report (APA, 1991). Part 2 analysed students’ reflective journal entries and found support for the proposition that the immersion approach engaged students in the critical thinking cycle.

Analysis in each section will then calculate the standardised mean differences (effect sizes) for each set of contrasts, selecting the relevant technique on the basis of observations made in the data.

4.5.4.1 Contrast 1: Groups A_1 - A_2

Contrast 1 is a within-subjects repeated measures design in which the sample group A_1 ($n=64$) provides pretest data and serves as the comparison for group A_2 which consists of the posttest scores for the same sample, as shown in Figure 3.8 (Group design). Testtakers in this group completed the pretest at the start of their studies and took the posttest at the start of their

second year of studies. All tests were taken within the same testing periods, and the group comprises students from all sessions (as explained in section 4.2.2, Teaching teams).

Standardised mean difference for contrast 1

As noted in section 3.3.4.2(c), a number of different effect size calculators are available. For purposes of this analysis, the calculator at Swinburne University (Deville, 2004) has been used to calculate Cohen's *d*. A comparison of results using the other available calculators showed no difference in the result obtained.

The effect size gain for group A₁₂ in contrast 1 is -0.026 (CI [95%] -0.37 – 0.32) . This is an extremely small negative change in scores from pretest to posttest.

Becker (2000) cautions against using the paired *t*-test (advocated by Rosenthal) in calculating effect sizes. However, it is interesting to note that using the paired *t*-test value for group A₁₂ illustrates that slightly greater values will be obtained (*d*=.049; *r*=.025). These values would still be interpreted as no gains in critical thinking as reflected in student scores on the CCTST in contrast 1.

*The results in contrast 1 answer **subquestion 2A**, namely that overall testtakers who had completed the pretest at the start of the program performed worse in the posttest after completing the first year of the program. The results also showed that some students did improve their performance in the CCTST, and that students who performed better at pretest performed worse at posttest, while testtakers whose scores were relatively lower at pretest improved their performance at posttest.*

Discussion

A number of explanations can be offered for the result of no difference in student performance from pretest to posttest in contrast 1:

- (1) It may indicate that a year of studies did not increase students' critical thinking abilities at all.

This would not explain why the scores of half the students in contrast 1 did increase.

Examination of change scores for testtakers in contrast 1 showed that changes in scores ranged between -23 and +9. Two testtakers (respondents 39 and 41) obtained identical scores of 10 and 15, respectively, in the pretest and posttest. Of the remainder, half (*n*=31) the testtakers achieved lower scores at posttest, with four scores dropping by 6 (17.6%) or more, and half the testtakers achieved higher scores, with six scores increasing by 6 or more.

The size of the effect based only on increased scores would be +0.78 ($M_1=14.03$, $SD_1=5.07$; $M_2=17.80$, $SD_2=4.56$), which can be interpreted as large. This raises questions about the usefulness of standardised performance testing at group level.

- (2) Students may not have been motivated to apply themselves when taking the posttest. Group A_{12} in contrast 1 had all taken the pretest and were therefore familiar with the instrument. Testtakers moreover received the results of their pretest scores after completing the test. Motivational differences may be the result of personal attributes, but it may also have been influenced by student experience at pretest, which raises two possibilities:
- (a) Students who found the test difficult the first time, may be reluctant to put in the effort again, for what they may have viewed as little “reward”.
 - (b) Students who performed well in the test the first time, may be disinclined to put much effort into the posttest, perhaps feeling that they have “proven” their performance or perhaps being concerned that they may not perform as well the second time.

A comparison in the mean pretest scores of the testtakers who improved their performance and those whose performance declined may provide an explanation. As seen above, students who performed better at posttest had a pretest mean of 14.03 ($SD=5.07$). In contrast, students who achieved lower scores at posttest had a pretest mean of 17.19 ($SD=4.02$), a little below the posttest scores of the improved performance group. Explanation 2(b) appears to be the most plausible.

This explanation is explored further in contrast 2, which is based on all pretest and posttest scores for student who participated in the first year of the program.

4.5.4.2 Contrast 2: Groups A_1D - A_2C

Contrast 2 is a between-subjects comparison of the results of all testtakers who took the pretest at the start of the program (groups A_1 and D ; $n=237$) and the posttest after completing the first year of the program (groups A_2 and C ; $n=96$). This comparison provides significantly larger groups than contrast 1, and including group D (who did not take the posttest or did not give consent to use their results for the posttest) and group C (who had not taken the pretest or had not given consent to use their results in the pretest) ameliorates against possible test effects in the within-group comparison of contrast 1.

Standardised mean difference for contrast 2

The data used in calculating the effect size for contrast 2 are $M_{A1D}=15.71$; $SD_{A1D}=4.94$ ($n_{A1D}=237$) and $M_{A2C}=14.89$; $SD_{A2C}=5.38$ ($n_{A2C}=96$).

Since the mean for the posttest scores is smaller than the mean for the pretest scores, the effect size for contrast 2 would be negative and has been calculated as $ES=-0.159$ (CI[95%] - 0.396 – 0.078). This is a greater deterioration than in contrast 1.

*The results in contrast 2 further answer **subquestion 2A**, that testtaker performance in the CCTST was weaker after completing one year of studies in the employability skills development program.*

It is therefore evident that test performance was poorer at posttest in both contrast 1 and contrast 2.

Discussion

As in contrast 1, there may be several explanations:

(1) Students' critical thinking ability had deteriorated during the first year of studies.

This would seem unlikely. It is important to bear in mind that the test scores represent student performance in a test, so that the observation is that student performance in the test was poorer at the time of the posttest, and not that students were worse at critical thinking after completing the first year of studies.

(2) Students were less motivated to do their best at posttest.

This is a possible explanation. In contrast 1 a potential reason offered to account for reduced motivation was that performance at posttest may have been influenced by testtaker experience at pretest as discussed in section 4.4.4.1(b). This may also account partially for the decline in performance in the composite groups. However, none of the students in group C (posttest) had taken the pretest, and none of the students in group D had taken the posttest. As shown in table 4.3, the means and standard deviations for groups D and C are as follows: $M_D=15.79$, $SD_D=5.01$; $M_C=13.88$, $SD_C=5.77$. This results in an effect size of -0.354. The posttest-only group C had therefore performed substantially worse than the pretest-only group D.

Although testtaker experience at pretest cannot account for this deterioration, it is notable that group D had the best average performance (the highest group mean) in the pretest. In line with the argument in contrast 1, it here be argued that testtakers in group D were disinclined to take the posttest because of they had already performed relatively well in the pretest.

While relatively good performance at posttest is therefore a common factor in a decline, or nonparticipation, at posttest, this does not rule out the possibility that other factors or events may have had an effect. Another explanation for the poor performance at posttest may have been a contagion effect, so that testtakers generally did not believe the test to be important enough to put in a great deal of effort.

Further research that falls outside the scope of this study would be required to determine whether contagion plays a role in test performance. Section 5.4.1 presents some suggestions for further investigation.

*The results of contrast 2 supports the results in contrast 1 and answer **subquestion 2A**, namely that testtakers who had completed the first year of the program generally performed worse in the posttest than those in the pretest at the start of the program.*

4.5.4.3 Contrast 3: Group A₂-B

Contrast 3 compares student performance at posttest between group A₂, comprised of students who had completed the first year of studies in the ESDP, and group B, consisting of students who entered the program in year 2 and who had therefore not participated in the program at all. Demographic data show that a large proportion (71%) of students in group B identified themselves as coming from non-English-speaking backgrounds, which would indicate that they entered the program after completing their first year of studies at an offshore partner institution.

As indicated in section 4.4.3.3(c), the standard deviation (SD=4.57) of group B has been used to calculate the effect size in contrast 3.

The effects, if any, of language as a factor are explored further in contrast 4. The purpose of contrast 3 is to compare the performance of students who had completed the first year of the program with that of students who had not completed the first year of the program but who are at the same year level in their studies, in order to answer subquestion 2B:

RQ2B Do testtakers who have participated in the first year of the program perform better in the CCTST than students who entered the program in the second year?

Standardised mean difference for contrast 3

The standardised mean difference in test scores for contrast 3 was calculated using the following data: $M_{A_2}=15.39$; $SD_{A_2}=5.15$ ($n=64$) for group A₂ and $M_B=12.96$; $SD_B=4.57$ ($n=79$) for group B.

The effect size gain (calculated as Cohen's d) is +0.53 (CI[95%]= 0.196 – 0.867).

This is typically considered to be a medium size effect (Cohen, 1988, p.25). Given cautions against interpreting effect sizes according to Cohen’s classification without due regard for the context (Coe, 2002, p.5), it is worth noting that in the CCTST validation study (Facione, 1990b), an effect size of 0.32 was obtained. The Hatcher study (2006) which reported results from a 15-year study at Baker University, showed effect sizes significantly greater than 0.5 on the Ennis-Weir Critical Thinking Essay (1990-1995), and a mean effect size of 0.57 over ten years using the CCTST (Hatcher, 2006, p.261). (Effect sizes in the previous five years from 1990 to 1995, using the Ennis-Weir Critical Thinking Essay were significantly greater with a mean effect of +0.97, which highlights the need to compare only results obtained using the same test instrument.)

Mean gains achieved in other studies reported in Hatcher (2006, p.262) ranged between 0.28 and 0.88. Any comparison again needs to be made with caution, as these results were obtained in classes using computer-assisted instruction in critical thinking (Hitchcock, 2004) which employed similar multiple-choice formats as the CCTST, and it can be argued that over the course of a semester students were made “test-ready”.

Given the range of results reflected in the literature, and the many different contexts of different studies reported, the effect size of +0.53 can best be interpreted in relation to the size of the effect in the other comparison groups within this study.

*The results in contrast 3 answer **subquestion 2B** and show that testtakers who had completed the first year of the program performed better at posttest than testtakers at the same level of study who had not completed the first year of the program. The effect size of +0.53 is deemed to be a medium effect, and is substantially greater than any other effect observed in this study.*

4.5.4.4 Contrast 4: Language as factor

Contrast 4 investigates language as factor by comparing the test performance of the composite groups separated by English-speaking background. The comparison is therefore between test gains (or losses) of students from an English-speaking background and students from a non-English-speaking background in groups A₁D and A₂C.

This analysis is intended to answer the subquestions:

RQ2C Do testtakers from English-speaking backgrounds perform better in the CCTST than students from non-English-speaking backgrounds?

RQ2D Do students from English-speaking backgrounds show greater improvement in CCTST performance after participating in the first year of the program than students from non-English-speaking backgrounds?

Standardised mean difference for contrast 4

The comparison groups are A₁D_ESB-A₂C_ESB (pre- and posttest results, English-speaking background) and A₁D_nESB-A₂C_nESB (pre- and posttest results, non-English-speaking background). Effect sizes are calculated on the following data:

Contrast 4		
	English-speaking background (ESB)	non-English-speaking background (nESB)
Pretest	A ₁ D_ESB 16.75 SD 4.95	A ₁ D_nESB 13.13 SD 3.89
Posttest	A ₂ C_ESB 16.24 SD 6.04	A ₂ C_nESB 13.69 SD 4.44
Average mean	16.50	13.41

*In response to **subquestion 2C**, contrast 4 has shown that testtakers from an English-speaking background in groups A₁D and A₂C scored on average 3.09/34 points (9.08%) higher than testtakers from non-English-speaking backgrounds.*

The effect sizes calculated from the above data are ESB = -0.09 (CI: -0.437 – 0.231) and nESB = +0.13 (CI: -0.228 – 0.499).

*In response to **subquestion 2D**, the effect sizes show that the performance of testtakers from English-speaking backgrounds declined marginally at posttest, while testtakers from non-English-speaking backgrounds performed better at posttest.*

Discussion

The size of this effect was small, but it stands in contrast to the findings reported after testing to establish the norms for the California Critical Thinking Skills Test. In that group, 19% of students in the sample reported that they did not come from an English-speaking background. Those students obtained a mean score of 13.75, and the Test Manual (Facione et al, 2002, p. 12) reported that they showed no improvement on their test scores after completing a college level critical thinking skills course.

There are two possible explanations for the improved scores obtained by nESB testtakers in this study:

- (1) That the students' English language skills improved sufficiently during the two semester of study for them to improve their performance on the test.

The strong focus on developing communication skills in the employability skills development program supports this explanation.

- (2) That non-ESB testtakers were more motivated than ESB testtakers to "do their best" at posttest.

This explanation would be supported if one accepts that students who performed worse at pretest were generally more motivated to do better at posttest, as suggested in contrasts 1 and 3.

The lower mean score of the nESB group at both pretest (M=13.13) and posttest (M=13.69) raises questions about interpreting the higher mean obtained by group A₂ (M=15.39) compared with group B (M=12.96) in contrast 2 as the result of group A₂'s participation in the program, since a large percentage (71%) of testtakers in group B came from non-English-speaking backgrounds, which may account for the lower mean score of group B, which is also lower than the nESB pretest mean in contrast 4. However, comparing the posttest score of nESB testtakers with the mean of group B shows that nESB students who completed the first year of the program outperformed group B entrants by an effect size of +0.161, which supports the findings in contrast 3.

Section 4.5.5 presents a summary of the findings.

Integrated findings, in-depth discussion with reference to the literature and final conclusions are presented in Part 3 of the case study.

4.5.5 Summary of findings

Part 3 of the case study is intended to answer research question 2

RQ2 How effectively does participation in an employability skills program develop students' critical thinking skills as measured in a standardised test?

Analysis of student scores in the CCTST constitutes the performance analysis component of the study. Testtaker performance has been interpreted on the basis of standardised mean differences between a number of comparison groups in four contrasts in order to answer four subquestions.

Table 4.6 provides a summary of the standardised mean differences (effect sizes) calculated in Part 3. A summary of the findings and discussion of explanations follow.

Table 4.6: Summary of standardised mean differences

Contrast	Data input	Effect size (Cohen's <i>d</i>)	CI (95%)
1	$M_{A1}=15.52$; $SD_{A1}=4.78$ ($n=64$) $M_{A2}=15.39$; $SD_{A2}=5.15$ ($n=64$)	-0.026	-0.37 - 0.32
2	$M_{A1D}=15.71$; $SD_{A1D}=4.94$ ($n=237$) $M_{A2C}=14.89$; $SD_{A2C}=5.38$ ($n=96$)	-0.159	-0.396 – 0.078
3	$M_{A2}=15.39$; $SD_{A2}=5.15$ ($n=64$) $M_B=12.96$; $SD_B=4.57$ ($n=79$)	+0.53	0.196 – 0.867
4	$M_{A1D_ESB}= 16.75$; $SD_{A1D_ESB}= 4.95$ ($n=169$) $M_{A2C_ESB}=16.24$; $SD_{A2C_ESB}=6.04$ ($n=45$)	-0.09	-0.437 – 0.231
	$M_{A1D_nESB}=13.13$; $SD_{A1D_nESB}= 3.89$ ($n=68$) $M_{A2C_nESB}=13.69$; $SD_{A2C_nESB}= 4.44$ ($n=51$)	+0.13	-0.228 – 0.499

A comparison of pretest-posttest scores in contrasts 1 and 2 showed a decline in student performance in the CCTST after completing the first year of the ESDP.

Contrast 3 compared the posttest scores of students who had completed the first year of the ESDP with the test scores of students who had not completed either of the two first-year units of study in the ESDP and showed a positive effect, with a standardised mean difference of 0.53.

Contrast 4 compared the performance of testtakers from English-speaking (ESB) and non-English-speaking (nESB) backgrounds, and found that although nESB scores noticeably lower overall, the performance of nESB testtakers improved after completing the first year of the program.

The findings can be summarised as follows in response to each of the subquestions:

RQ2A Do testtakers perform better in the CCTST after participating in the first year of the program than at the start of the program?

Compared with pretest scores at the start of the program, the scores of the same testtakers were lower at posttest after students completed the first year of the program.

RQ2B Do testtakers who have participated in the first year of the program perform better in the CCTST than students who entered the program in the second year?

Students who completed the first year of the program performed better than students who had not completed the first year of the program.

RQ2C Do testtakers from English-speaking backgrounds perform better in the CCTST than students from non-English-speaking backgrounds?

Students from English-speaking backgrounds performed better than students from non-English-speaking backgrounds.

RQ2D Do students from English-speaking backgrounds show greater improvement in CCTST performance after participating in the first year of the program than students from non-English-speaking backgrounds?

The scores of students from non-English-speaking backgrounds improved after completing the first year of the program, while the test performance of students from English-speaking backgrounds were lower than at the start of the program.

In part 3 of the case study that follows, the results, interpretations and potential explanations for the findings in part 2C are discussed and integrated with the findings from parts 2A and 2B.

Part 3: Discussion

4.6 Integration of findings: Opportunity, engagement and performance

Part 3 of the case study provides an integrated discussion of the results obtained in the three components of the study, of which two have been qualitative and one quantitative. The qualitative components of the study employed a categorical strategy in the task analysis (part 2A) and a contextualising strategy in the process analysis (part 2B). Part 2C presented the performance analysis and compared the standardised mean differences in student scores on a standardised critical thinking skills test.

Detailed discussions have been provided following each component in sections 4.2.3 (part 1), 4.3.4 (part 2A), 4.4.3 (part 2B). In part 2C, the results for each contrast have been discussed together with consideration of rival explanations following each analysis used to answer subquestions 2A to 2D in sections 4.5.4.1 to 4.5.4.4. Those discussions are not repeated here. This part of the case study instead focuses on drawing meta-inferences from the overall results obtained in the study.

Part 1 of the case study presented the context for the study, and through a process of step-wise explanation building, part 2 of the case study has answered the research questions and subquestions:

RQ1 *How does the immersion approach followed in the program provide opportunities for developing critical thinking skills; and*

RQ1A How is critical thinking skills development infused into learning activities during the first-year of the ESDP (employability skills development program)?

RQ1B How do students engage in a critical thinking process during the learning activities undertaken in the first year of the ESDP (employability skills development program)?

RQ2 *How effectively does participation in an employability skills program develop students' critical thinking skills as measured in a standardised test?*

RQ2A Do testtakers perform better in the CCTST after participating in the first year of the program than at the start of the program?

RQ2B Do testtakers who have participated in the first year of the program perform better in the CCTST than students who entered the program in the second year?

RQ2C Do testtakers from English-speaking backgrounds perform better in the CCTST than students from non-English-speaking backgrounds?

RQ2D Do students from English-speaking backgrounds show greater improvement in CCTST performance after participating in the first year of the program than students from non-English-speaking backgrounds?

The explanatory analysis of the tasks in part 2A answered subquestion 1A and showed

(1A) *that the projects that students undertook in the first year of the program were infused with critical thinking subskills and provided substantial opportunities for critical thinking skills development*

The findings in this component of the case study therefore confirmed the proposition that development of other skills in the program was dependent on the development of critical thinking skills – in other words, that critical thinking skills played a key role in completing the tasks in the ESDP. The learning tasks in the program were aligned with examples of tasks that develop critical thinking as defined in a comprehensive conceptualisation of critical thinking.

The analysis of student reflections in part 2B showed that

(1B) *the projects on which students worked collaboratively over a sustained period of time and active in-class engagement engaged students noticeably in a cycle of critical thinking*

The research was guided by the proposition that methods of instruction that engage students in authentic tasks and encourage them to think have the potential to enhance critical thinking. The analyses have shown that the approach in the program follows an immersion model (Angeli & Valanides, 2008; Prawat, 1991), and that the model of instruction adopted in the program contained most of the characteristics of learning environments that promote critical thinking, as reviewed in section 2.3. It is evident from the analysis and interpretation of the projects that students undertook that the program contained key elements of thinking skills program (as identified by Livingston et al, 2004; Butler, 1998; and others) in that students were challenged and guided to develop skills that would enable them to become independent learners. The program promoted collaborative learning and encouraged students to regulate their behaviour. The reflections showed that tasks had personal meaning for learners, and the facilitative collaborative approach emphasised learner engagement (Moseley et al, 2004). The authentic contexts of the projects required students to analyse, evaluate and interpret as well

as generate information, and in such environments it is likely that students would develop critical thinking skills (Halpern, 1998, p.454).

As shown in the project summaries and the discussion of the process analysis in section 4.3.4, student reflections did not provide evidence of engagement in all phases of the critical thinking cycle in all the projects, but across the four projects there was substantial evidence that students engaged in critical thinking during the projects.

Without explicitly addressing the dispositional component of critical thinking, analysis of student reflections have shown that the immersion model followed in the program elicited in students the main characteristics of critical thinkers as identified by Halpern (1998, p.452) and reviewed in section 2.3.4.2, in that students engaged in and completed complex tasks and made and followed plans in many instances. Reflections also showed that at least some students remained flexible and open-minded, were willing to self-correct and change strategies and were aware of the need to seek consensus and to compromise to achieve targeted outcomes.

An aspect in which the program departs from some of the models proposed for developing critical thinking skills and dispositions, is in the area of metacognition. While the analyses in part 2B showed evidence that students exercised self-assessment and self-correction in monitoring their progress and in achieving project outcomes, this awareness was not related specifically to critical thinking skills (Halpern, 1998, p.454). This may be because the guiding questions that were provided did not require them to report on such processes, or it may be that students did not engage, at least explicitly, in metacognitively monitoring their thinking processes (Moseley et al, 2004, p.1).

The findings in part 2B showed that the collaborative environment presented strong support for developing critical thinking skills, especially in respect of multiple perspectives (Schamber & Mahoney, 2006, pp.106-107). It was also found that collaborative tasks can present challenges, but the overall finding was that the collaborative environment enhanced the development of critical thinking skills. This finding confirms the findings of other researchers (eg Tynjälä, 1998) that emphasis on examining different perspectives and conducting analyses from the perspective of the students' own experiences can enhance critical thinking.

Parts 2A and 2B of the case study therefore addressed both the conceptual and operational aspects of critical thinking. Conceptually, the program has been found to be well aligned with the expert consensus statement on critical thinking (APA, 1990), and operationally the projects engaged students in a process of critical thinking.

The second research question has been addressed in part 2C of the case study. It has answered subquestions 2A to 2D in four contrasts that compared the performance of several comparison groups in a standardised critical thinking skills test. The findings as well as discussion and consideration of potential explanations for the results found in each contrast have been reported in part 2C.

The performance analysis provided the following results in each of the four contrasts:

1. Compared with pretest scores at the start of the program, the scores of the same testtakers were lower at posttest after students completed the first year of the program.
2. Students who completed the first year of the program performed better than students who had not completed the first year of the program.
3. Students from English-speaking backgrounds performed better than students from non-English-speaking backgrounds.
4. The scores of students from non-English-speaking backgrounds improved after completing the first year of the program, while the test performance of students from English-speaking backgrounds were lower than at the start of the program.

Some of these findings (contrasts 1 and 2) appear to contradict the findings of parts 2A and 2B. The discussion sections for each contrast (4.5.4.1 and 4.5.4.2) raised a number of possible explanations for the findings. Integrating the findings in parts 2A and 2B with the findings of part 2C allows a reconsideration of rival explanations and questions raised in the process of drawing meta-inferences from all components of the case study.

Of interest firstly are the results of contrasts 1 (within the same group) and 2 (between groups), that showed lower scores at posttest where students took the test at the start of the program and after completing the first year of the program. In contrast 1, the effect size was -0.026, which would at face value indicate that student critical thinking skills declined during the first year of study. However, it was also found that two scores remained unchanged, and that of remainder, half the scores declined while half the scores improved (the latter by an effect size of +0.78).

This raised the rival explanation that questioned the motivation of some of the students to apply themselves at posttest. Other unknown factors may also have impacted performance, but the reasoning is that such factors would likely have affected all scores. The large effect size for the group of scores that did increase lends support for the rival explanation. The findings in the task and process analysis further support the rival explanation: the projects that students

undertook in the first year of the program have been shown to be conceptually well aligned with the conceptualisation of critical thinking in the expert consensus statement in the Delphi Report (APA, 1990), which is significant since the California Critical Thinking Skills Test is based on the same conceptualisation of critical thinking (Facione et al, 2002, p.1), and the process analysis has shown that students engaged cognitively in the tasks in a process of critical inquiry.

It was speculated that student experience at pretest may account for the variability in student performance at posttest and two potential reasons were raised: students achieved relatively high scores at posttest and did not feel the need to “do their best” at posttest, or students performed poorly at pretest and found the test too hard to make another effortful attempt at posttest. Contrast 2 provided the opportunity to explore these potential explanations further.

Overall a similar decline was found in contrast 2, with an effect size of -0.159. Contrast 2 included the scores of students who took only the pretest or only the posttest and was intended to mitigate against potential test effects. Discrete analysis of the scores of students who had taken only the pretest and those who had taken only the posttest showed the greatest decline with an effect size of -0.354. It was also found that the students who had taken only the pretest had achieved the highest mean of all groups in the study. This supported the explanation that students who had done well at pretest were less motivated to attempt (or put in effort at) the posttest.

The most likely explanation for the decline in performance of testtakers with high scores at pretest in contrasts 1 is therefore that those students were not motivated to do their best at posttest.

Subquestion 2A can therefore best be answered as follows:

(2A) *Overall scores in a standardised critical thinking skills test declined after the first year of studies. Students who achieved relatively low scores at pretest improved their scores at posttest, while students who achieved relatively high scores at pretest either did not complete the posttest or achieved lower scores at posttest.*

Contrast 3 showed a medium effect size of +0.5 and this finding supports the proposition and findings in the task and process analyses of parts 2A and 2B. However, the group in contrast 3 contained the highest percentage of students from non-English-speaking backgrounds, and this, rather than non-participation, may have accounted for the relatively weaker performance of students who had not participated in the first year of the program.

Contrast 4 compared the performance of students from English-speaking backgrounds with those from non-English-speaking backgrounds, and confirmed that students from non-English-speaking backgrounds performed worse in the CCTST. It also found, however, that the test scores of students from non-English-speaking backgrounds improved at posttest while those of students from English-speaking background declined. Moreover, at posttest the students from non-English-speaking backgrounds who had participated in the first year of the program outperformed the students who had not participated in the first year of the program (group B comprising a high percentage of students from non-English-speaking backgrounds) by a standardised mean difference of +0.16 (95% CI: -0.191-0.513). This is a small effect, but it provides support for the initial finding in contrast 3.

Subquestion 2B can therefore be answered as follows:

(2B) *Students who had completed the first year of the program performed better in a standardised critical thinking skills test by an effect size of +0.53 than students at the same year level who had not participated in the program.*

Subquestions 2C and 2D can be answered as follows:

(2C) *Students from English-speaking backgrounds performed better than students from non-English-speaking backgrounds.*

(2D) *Students from non-English-speaking backgrounds performed better in a standardised critical thinking test after completing the first year of the program, while students from English-speaking backgrounds in the contrast groups performed worse at posttest than in the pretest. Students from non-English-speaking backgrounds who completed the first year of the program performed better at posttest than students from non-English-speaking backgrounds who had not participated in the first year of the program.*

Chapter 5 presents the conclusions and implications of the study.

Chapter 5: Conclusions and implications

5.1 Introduction

Chapter 1 set out the aims of the research and provided a rationale for the research that highlighted the central role of critical thinking in developing employability skills (sections 1.2.2 & 1.3). The potential value of adopting a mixed methods approach to evaluating critical thinking skills has been explained in section 3.2.3.1.

The review of the literature in chapter 2 highlighted the malleability of the concept of critical thinking and the different approaches to teaching and assessing critical thinking. This study has adopted a broad conceptualisation of critical thinking in examining the infusion of critical thinking into a program aimed at developing the employability skills of students in undergraduate business education. The program followed an immersion approach to developing employability and targeted a matrix of skills or skillsets: learning management and lifelong learning, ethics, communication, teamwork, and information literacy, critical thinking and reflective practice. Critical thinking is therefore but one aspect of the matrix of skills. It has nevertheless been shown to be an essential component in developing other skills deemed to enhance the employability of graduates (section 2.3.2).

The findings in the study have been interpreted according to the conceptualisation of critical thinking as a process of inquiry or an “essential ... tool of inquiry”, and as defined in the expert consensus statement (Delphi Report, APA, 1990) and reviewed in section 2.2.3.1:

We understand critical thinking to be purposeful, self-regulatory judgment which results in interpretation, analysis, evaluation, and inference, as well as explanation of the evidential, conceptual, methodological, criteriological, or contextual considerations upon which that judgment is based. CT is essential as a tool of inquiry. As such, CT is a liberating force in education and a powerful resource in one's personal and civic life. While not synonymous with good thinking, CT is a pervasive and self-rectifying human phenomenon.

The ideal critical thinker is habitually inquisitive, well-informed, trustful of reason, open-minded, flexible, fairminded in evaluation, honest in facing personal biases, prudent in making judgments, willing to reconsider, clear about issues, orderly in complex matters, diligent in seeking relevant information, reasonable in the selection of criteria, focused in inquiry, and persistent in seeking results which are as precise as the subject and the circumstances of inquiry permit. Thus, educating good

critical thinkers means working toward this ideal. It combines developing CT skills with nurturing those dispositions which consistently yield useful insights and which are the basis of a rational and democratic society.

The research has been situated within the pragmatic paradigm and recognises the existence of multiple perspectives on reality and the intersubjective nature of knowledge (Johnson & Onwuegbuzie, 2004, p.16; Johnson, 2008, p.204). The study followed a mixed methods approach and applied theoretical and conceptual frameworks in a case study using qualitative methods and estimated effect sizes using quantitative data. The purposes of the mixed methods approach in this study were set out in detail in section 3.2.3.1, and included triangulation as a means to corroborating findings across methods, uncovering contradictions in the integration of the findings of different components of the case study, building explanations and generating propositions, and fundamentally as a means to answering the research questions through a case study design.

The case study covered the key areas in relation to critical thinking identified in the review of the literature and comprised:

- (1) a broad conceptualisation of critical thinking and how critical thinking skills have been infused into the employability skills program that provided the context for the case study (part 2A)
- (2) a detailed account of how students in the program engaged in the critical thinking cycle (part 2B)
- (3) measuring improvement in critical thinking based on a standardised critical thinking skills test (CCTST) (part 2C)

In drawing conclusions based on the results obtained, this chapter builds on the interpretations and discussions incorporated into the case study presented in chapter 4.

5.1.2 Overview of the chapter

Section 5.2 will provide an overview of the results obtained in the task, process and performance analyses in the case study, and will draw conclusions on the basis of the integrated findings that have been presented in Part 3 of the case study in chapter 4 (section 4.6). Section 5.2 will moreover present the conclusions that can be drawn from the findings in relation to other research and the research problem, having addressed rival explanations in the case discussions.

Section 5.3 will consider the implications of the study in relation to current practices in critical thinking instruction and assessment as well as approaches to research in critical thinking skills development. It provides a response to the question: What does this study contribute to our understanding of approaches to critical thinking skills instruction and how we measure critical thinking skills development?

Section 5.4 will address limitations in the study by identifying potential threats and the steps that have been taken to increase confidence in the results and interpretations. It therefore adds to the potential limitations identified in considering rival explanations when drawing conclusions in section 5.2.

Given the broad nature of the field of critical thinking skills development, the study necessarily leaves some questions in relation to critical thinking skills instruction unanswered, and section 5.4.1 will look at areas for further research.

5.2 Findings and conclusions

The findings and interpretation for each of the three component parts of the case study have been integrated in section 4.6 which also addressed each of the subquestions. Findings and interpretations have been reported as a concurrent activity (Miles & Huberman, 1994, pp.10-11) accompanying the analyses within the case study in a process of step-wise explanation building (Yin, 2008, p.141) that accommodated the mixed methods approach to the research.

This section therefore addresses the conclusions that can be drawn from the findings in terms of the two main research questions:

RQ1. *How does the immersion approach followed in the program provide opportunities for developing critical thinking skills*

and

RQ2. *How effectively does participation in an employability skills program develop students' critical thinking skills as measured in a standardised test?*

The first question was answered in parts 2A and 2B of the case study, and the main findings were that:

critical thinking skills and subskills were infused into the tasks that students performed in projects undertaken during the first year of the program, and the projects provided substantial opportunities for critical thinking skills development

and that

the projects on which students worked collaboratively over a sustained period of time engaged them noticeably in a cycle of critical thinking.

It can therefore be concluded that

- A1. *the immersion approach provided opportunities for developing critical thinking skills through project tasks aligned with the types of activities that develop critical thinking and through a process of inquiry that engaged students in a critical thinking cycle.*

This conclusion is considered in more detail in section 5.2.1 (The immersion approach) below.

The second question was answered in part 2C of the case study which compared the performance of several groups of students in a standardised critical thinking skills test (CCTST). A series of contrasts included multiple comparison groups (Halpern, 2001, p.274) and results varied across contrasts. The interpretation and discussion sections for each of the contrasts in sections 4.5.4.1-4.5.4.4 and the discussion of integrated findings in part 3 of the case study (section 4.6) considered a number of rival explanations and it can be concluded that

- A2. *participation in the program had a positive effect on student performance in a standardised critical thinking skills test in some contrasts and that comparisons of group means needed to be interpreted with caution as closer inspection can reveal anomalies in scores that may be attributed to student motivation.*

This conclusion and its implications are considered in section 5.2.2 (Standardised testing: Performance and interpretive issues) below.

5.2.1 The immersion approach

As shown in the descriptive component of the case study (part 1, section 4.2), the immersion approach followed in the program is distinctive. The program is a core component of an undergraduate course and is aimed at developing the employability skills of business students in four units of study across the undergraduate curriculum. It addresses a matrix of skills that contribute to the employability of graduates, and critical thinking is one aspect of the skills targeted. It is neither a stand-alone module that deliberately instructs students in generic micro-logical skills (Hatcher, 2006, p. 248), nor does it follow an embedded approach by integrating critical thinking instruction in a subject-specific unit of study (McPeck,, 1981, p.5). It also differs from the type of immersion approach defined by Ennis (1989, p.5) as using “only standard subject-matter content”, and is more aligned with Prawat’s (1991) focus on the value

of “ideas as the most important resource in promoting thought” (p.6), which was also applied by Angeli and Valanides (2008).

Within the context of developing a matrix of employability skills, the employability skills development program (ESDP) followed an immersion approach that was moreover strongly aligned with the recommendation in the expert consensus statement (the Delphi Report, APA, 1990, p.33) in that it is “not restricted to factual matters or academic subjects”. As shown in the projects that the students undertook, the program included “issues which have normative, moral, ethical or public policy dimensions” (APA, 1990, p.33). The projects required students to “reflect on, articulate, share and discuss” (APA, 1990, p.33) such issues (although not specifically in respect of their thought processes as advocated by Resnick, 1991).

Other studies have shown that critical thinking skills were more likely to develop where learning processes were not focused on information transmission and rote learning, but instead made use of class discussions, peer and self-evaluation, and critical self-reflection (Tsui, 2002, discussed in section 2.5.3.1), and where students were engaged in thinking and peer interactions about topics that did not have a definitive answer (Kuhn et al, 1997). Few of the existing studies reported sufficient detail of the particular instructional model to allow for detailed comparisons. One exception is the process workshops model described by Hanson and Wolfskill (2000). The ESDP (as described in part 1 of the case study) employs an approach that has several elements in common with the process workshops model (Hanson & Wolfskill, 2000) reviewed in section 2.5.3.3, including the use of self-managed teams, guided discovery, sharing of information, regular report-backs and reflection on learning (pp.120-121), as well as emphasis on process and not only on product (p.128). There are, however, a number of distinct differences between the process workshops and the approach in the employability skills program:

- The process workshops appeared to be more closely related to discipline-specific learning (general chemistry), and were therefore similar to the immersion model defined by Ennis (1989, p.5).
- Teams in the workshops were self-managing, but members were assigned specific roles – whereas teams in the program here decided roles among team members themselves.
- Teams collaborated during the workshops only – activities assigned were completed within the workshop time (initially 55 minutes then extended to 80 minutes) and teams had to reach “closure to each session” (Hanson & Wolfskill, 2000, p.122), whereas teams in the ESDP were required to engage in extended collaboration over periods of approximately four weeks on each project; the briefs were moreover open-ended and

problems were ill structured, and these elements were not evident in the process workshops, where the aim was to achieve “true understanding” of single concepts.

- Students in the process workshops were required to “acquire information and develop understanding through guided discovery ... [through tasks and] ... models which provide all the information central to the lesson” (p.120), whereas students in the ESDP worked in a connected classroom (described in part 1 of the case study, section 4.2.2) and were required to source information from a variety of online sources (projects 1 and 2) or to generate primary data through surveys (projects 3 and 4).

The main differences therefore relate to the open-ended nature of tasks in the ESDP, the durations of tasks, and the need for students to source some of their own information or collect primary data. Collaboration in the process workshops took place in more controlled environments and tasks had a clear resolution prior to students leaving the workshops, which may have made team dynamics more predictable and less onerous in the workshops than in the sustained projects of the program under investigation.

It is not possible to compare the performance in the ESDP with student performance in the process workshops, as the indicators that Hanson and Wolfskill (2000) used differ from those employed in the current study, and included attendance, enrolments, student evaluations of the workshops and self-reports of their effect on levels confidence, student ratings, exam results, and instructor reports.

In the ESDP case study, the question that arose was how critical thinking skills had been infused within this immersion approach – a question of “how [can] something ... be present but underground or invisible” (Prawat, 1991, p.5)?

Part 2A of the case study provided a task-level analysis of the projects and mapped the component tasks against the critical thinking components, categories and subskills outlined in the Delphi Report (APA, 1990), using a pattern-matching technique, on the basis of similarity between the examples of tasks identified for each critical thinking component (Facione, 1990a) and those undertaken in the projects. The matrices (section 4.3.1.3) confirmed the infusion of tasks that develop critical thinking skills, and showed that the approach followed in the program supplied “conditions that make for ..[the] cultivation ... of methods of inquiry and reasoning appropriate to the various problems that present themselves” (Dewey, 1910, pp.27-28).

The proposition was therefore that the program provided opportunities for critical thinking skills development by infusing critical thinking type tasks. The question then was whether and how students engaged in critical thinking while performing the tasks set in the projects.

Angeli and Valanides (2009) had found that “students were not automatically disposed to think critically even for controversial issues that lend themselves naturally to critical examination of different perspectives” (2009, p.331), and that guided discussions appeared to make the biggest difference to critical thinking performance. They also found that students in an infusion group, who had received a lecture on critical thinking, had a better understanding of critical thinking than students in an immersion group who did not receive the lecture. This finding may be questioned, as the statements that they used to establish imprecise or erroneous understandings of critical thinking – “a critical thinker compromises to reach a decision” and “a critical thinker collaborates and listens to others” (Angeli & Valanides, 2009, p.327) – can also be seen to be characteristic of critical thinking, and in particular of a disposition towards critical thinking. Halpern (1997, pp.11-12) listed six characteristic of a critical thinking disposition which included a consensus-seeking attitude – that is, the need to compromise, collaborate and listen to others: “A critical thinker will need to be disposed to ways in which consensus can be achieved. Consensus seekers will need high-level communication skills, but they will also need to find ways to compromise and to achieve agreement. Without this disposition, even the most brilliant thinkers will find that they cannot convert thoughts to actions.”

The ESDP was designed to facilitate a collaborative learning approach, and in contrast to the study by Angeli and Valanides (2009), a number of components and categories of critical thinking skills development were supported by the very need for consensus, collaboration and listening to others, being open-minded and receptive to multiple perspectives. The deconstruction of projects to task level in part 2A of the case study aligned tasks in the collaborative context to components of critical thinking such as self-regulation (self-examination and self-correction), interpretation (clarifying meanings), analysis (examining ideas) (section 4.3.1).

The findings in the ESDP case study are therefore contrary to those of Angeli and Valanides (2009), and lend a different perspective on the conceptualisation of critical thinking and of the process of critical thinking within the context of collaborative critical inquiry.

Part 2B of the case study examined engagement in critical thinking by analysing student reflections in terms of a conceptual framework or model of inquiry (Garrison, 1991) that represents a critical thinking cycle. The indicators proposed in terms of this model (Garrison &

Anderson, 2003, p.61) were augmented according to the types of activities that were seen as relevant to each phase of the cycle. The descriptive framework and modified indicators have been presented in section 4.3.3. Detailed analysis of student reflections indicated generally strong levels of engagement in all phases of the critical thinking cycle.

The project descriptions in each section of the analysis in part 2B showed that the topics for the projects and the tasks set required students to work with ill-structured problems. King and Kitchener (1994) referred to Dewey's exposition of reflective thinking and highlighted the fact that such thinking is predicated first on the recognition that a real problem exists, and that it is accompanied by controversy or doubt, such that their thinking is not dominated by absolute, preconceived assumptions. A situation is considered truly controversial when "there is no way to apply a formula to derive a correct solution and no way to prove definitively that a proposed solution is correct" (King & Kitchener, 1994, p.6). The nature of the projects in the first year of the ESDP were such that it was not possible for students to identify with certainty that a particular solution was "true" or "correct" (King & Kitchener, 1994, p.10). Students were required to deal with "multilogical" problems, to consider alternative arguments and competing points of view, to seek new evidence, or to evaluate the reliability of data and information sources, and to "learn to construct and defend reasonable solutions" (King & Kitchener, 1994, p.11). Interestingly, one of the examples of an ill-structured problem provided by King and Kitchener (1994, p.11) was "predicting how to dispose of nuclear waste safely" which had also formed a component within project 2 of the ESDP.

Dealing with ill-structured problems requires students to move beyond using their skills in applying the principles of critical thinking. It involves their own understanding of the limits of knowledge and the uncertainty of solutions. King and Kitchener (1994, p.13) contended that neglecting "to engage students meaningfully in addressing ill-structured problems" will mean that teaching of true reflective thinking is also neglected.

The process analysis in part 2B confirmed that students engaged in the critical thinking cycle, both in terms of the presence of indicators and in the way that students moved through the phases of the cycle, sometimes telescoping phases and sometimes doubling back to a previous phase before moving to the next. The reflections for some projects showed that a particular phase dominated, for example the exploration phase in project 2 (Nuclear energy), where reflections expressed the need for more information, which can be seen as indicative of the challenges associated with taking positions on complex issues. The findings also highlighted the specific value of some indicators or tasks, such as mindmapping to define the problem in project 3, and peer assessment and multiple perspectives in project 4. The reflections

furthermore confirmed the presence of dispositional aspects that characterise critical thinking (APA, 1990, p.20), including “a willingness to consider new options, ... reconsider old problems ... to suspend judgment, gather more information, and attempt to clarify difficult issues ... [and] willingness to self-correct” (Halpern, 1997, pp.11-12)

The discussions in section 4.4.3 summarised the findings for this part of the case study, and confirmed the proposition that the nature of the projects that students undertook in the ESDP engaged them in critical thinking, and it can be concluded on the basis of evidence presented in student reflections that students engaged in the critical thinking cycle.

The reasoning would then be, given that the program provided opportunities for critical thinking, and that students engaged in critical thinking, that student performance in a standardised critical thinking skills test should reflect an improvement in scores.

Student scores in the California Critical Thinking Skills Test were analysed in four contrasts reported in part 2C of the case study. Results were interpreted and discussed for each contrast (sections 4.5.4.1-4.5.4.4), the findings were summarised in section 4.5.5, and Part 3 of the case study (section 4.6) presented an integrated discussion of the findings in all three components of the case study.

Before drawing conclusions from the results obtained in the CCTST, section 5.2.2 presents a discussion of the performance analysis in part 2C of the case study and the issues that may arise when assessing critical thinking through standardised testing.

5.2.2 Standardised testing: Performance and interpretive issues

The appropriateness of standardised testing of critical thinking skills, and in particular the use of multiple-choice questionnaires, has become increasingly contentious as research into critical thinking skills development has come to highlight the importance of a critical thinking disposition and more authentic approaches to critical thinking skills instruction and assessment.

One strong response to the notion of testing critical thinking via multiple-choice tests came in Round 2 of the Delphi Project, and was noted in the Delphi Research Letters (APA, 1990, Appendix C, p.67): “I fear the creation of an instrument promising more than it can deliver – an instrument touted not for what it is, an assessment device measuring certain important, but rudimentary, CT activities, but rather as a valid and reliable assessment tool for CT”. The same contributor noted that “the initiation of CT activities, generation of appropriate CT strategies, and defense of a tentative reasoned judgment are not susceptible to the type of assessment legislators are willing to finance or faculty are willing to undertake. The extensive writing or

oral argument required to demonstrate CT, as I understand it, are not practical inclusions in an assessment instrument.”

The demand for accountability in education has increased the need for standardised measurements, in spite of the risk that “our educational goals may start to be driven by our measuring instruments, and many valuable aims [including open-mindedness and critical ability] do not lend themselves to ready measurement” (Hare, 2000, p.106). Commercial standardised tests nevertheless remain in use, both to evaluate the success of institutions (Hagedorn et al, 1999) or programs and the effectiveness of interventions for research purposes (Williams & Stockdale, 2003; Hatcher, 2006).

In the ESDP case study, care has been taken not to assume that student performance in the CCTST necessarily constituted an ecologically valid indicator of critical thinking ability or disposition. The study has examined student performance in the test as a component that should be interpreted in light of the findings in the task and process analyses. In addition to allowing for comparison with other studies, it has therefore also made it possible to corroborate or challenge the findings in the qualitative components of the case study.

When comparing the results obtained in the ESDP case study with other studies, it is necessary to consider also the context in which other studies were conducted, especially the type of learning environment in each study. Studies such as large-scale testing at institutional level by Hagedorn et al (1999), that do not relate to the effect of specific interventions (and which used different instruments and did not report effect sizes) offer limited comparability with the current case study, except to note that overall that study found the main effect of the institutional context to dissipate after the first year of studies.

Hatcher’s study (2006) compared stand-alone and integrated approaches and reported greater gains by students in the integrated than in the stand-alone approach, and provides opportunity for comparison with the current case study, specifically in relation to gains during the freshman year (1996 to 2005) using the CCTST (integrated approach $ES=+0.57$; standard logic class $ES=-0.31$). In addition, effect size gains over one year in other studies ranged from $+0.28$ to $+0.88$. A large effect size ($+0.84$) was obtained in a University of Melbourne study (van Gelder, 2001; Butchart, Forster, Gold et al, 2009) that had used computer-assisted training with questions similar to those in the CCTST (Hatcher, 2006, p.263). Although van Gelder described the gains achieved in that learning context as “dramatic” (2001, p.539), there can be no meaningful comparison between the approach in that study and the immersion approach in the ESDP case study. The Hatcher study (2006) followed an integrated approach, which consisted of instruction in using logic tools (approximately 20%) and writing (approximately

80%) in which students were required to apply formal logic as well as critical thinking skills “to argue for and critique positions in student papers” (p.254). Although Hatcher referred to this as an integrated approach, it included instruction in general skills and can best be regarded as a composite or mixed approach (Abrami, Bernard, Borokhovski, et al, 2008, p.1106). The context of the Hatcher study is therefore also in essence dissimilar to that of the ESDP case study.

Difficulties with “comparable” contexts extend to the selection of appropriate comparison groups when attempting to measure gains within a specific study. Halpern (1993 & 2001, p.274) proposed the use of multiple groups, as has been done in the ESDP case study (section 3.3.4.2 and figure 3.8), as the best solution. The results of such multiple comparisons in the case study showed the value of the strategy.

Calculation of effect sizes (ES) in the ESDP case study showed a decline in performance at cohort level in a posttest (within-group contrast 1, $ES=-0.026$) after students completed the first year of the program. This could have been interpreted, at face value, as evidence either of the program being ineffective, or of the test being inappropriate as a measure in an immersion approach.

Upon further analysis, however, it was also found that half as many students improved their scores as performed weaker after completing the first year of the program and notably that students whose performance had declined had performed better than the average at pretest (with a pretest mean score of 17.19 compared with an overall group pretest mean of 15.52) while students whose pretest performance was below average ($M=14.03$) improved their average scores at posttest with an effect size of $+0.8$, which can be deemed to represent a large effect.

A second contrast showed that students who had completed the first year of the program performed better ($ES=0.5$) than students at the same year level who had not participated in the first year of the program. It was also found that students from non-English-speaking backgrounds (nESB) achieved lower scores in all tests than students from English-speaking backgrounds, but that nESB students improved their performance after participating in the first year of the program and outperformed nESB students who had not participated in the program.

Potential (rival) explanations for each result have been considered in the discussion sections in 4.5.4.1 to 4.5.4.4 and the integrated discussion in Part 3 of the case study. The most plausible explanation appeared to be that lack of motivation was responsible for the poor posttest performance of students who achieved above average scores at pretest. Other studies

(Hitchcock, 2004) have reported similar concerns relating to testtaker motivation at posttest. While lack of motivation may explain poor performance, it is not possible to draw this conclusion on the basis of the evidence to hand, and additional evidence of motivational and attitudinal effects would be required.

The reality is that interventions or programs will affect different participants in different ways. When using student performance in a standardised critical thinking skills test as a measure for the development of critical thinking skills, the results need to be approached circumspectly. The within-subjects design of contrast 1 was intended to overcome some of the uncontrollable and often unidentifiable factors that could cause differences in the performance of unrelated groups. As has been seen here, the within-group performance can nevertheless vary considerably, and the data obtained may not necessarily be a reliable reflection of testtakers' critical thinking ability.

The conclusion drawn from the findings in part 2C is therefore that participation in the first year of an employability skills development program following an immersion approach can improve the performance of students in a standardised critical thinking skills test, including the performance of groups of students from non-English-speaking backgrounds. It is also concluded that analysis of performance should be interpreted with caution, since group means can conceal considerable differences in student performance.

5.3 Implications of the research

Section 5.3 considers the implications of the study in relation to current practices in critical thinking instruction and assessment as well as approaches to research in critical thinking skills development.

The need to develop the critical thinking skills of students is not contentious. In spite of the growth of research into how best to go about such development, and how to measure the success of different approaches, questions surrounding the research problem remain pertinent in the areas of curriculum development and approaches to learning and teaching.

In a comprehensive review of thinking skills instruction in post-16 education, Livingston et al (2004) noted that "there were few studies that explored the relationship between curriculum design and content and the successful development of thinking interventions" and that "there is little evidence that curriculum designers generally start from the premise that the development of thinking skills should be central to all student study" (p.61).

5.3.1 A place for thinking skills instruction

This study contributes to our understanding of approaches to critical thinking skills instruction and how we measure critical thinking skills development by making explicit how critical thinking skills can be infused in an immersion model and how students engage in a process of critical thinking. The rationale for the research stemmed from a view that saw critical thinking as central to the development of a matrix of employability skills (section 1.2.2).

As institutions respond to the demand for work-ready graduates, learning outcomes are increasingly targeted at the development of employability skills within the context of subject-specific studies, where the demands of “content-to-be-covered” and readiness of staff can present significant barriers.

Livingston et al (2004) recommended “a shift away from a curriculum context ... that is too prescriptive to allow scope for students to express their thinking” (Executive summary, p.70). They identified a number of key principles for thinking skills instruction in higher education, including:

- encouraging learners to change their understanding
- promoting learning with others
- encouraging learners to regulate their behaviour
- challenging students
- establishing personal meaning for learners
- setting authentic tasks in varied contexts that facilitate the use of a range of thinking skills

The ESDP case study has shown that adopting an immersion model can comply with these principles. Infusing critical thinking skills into an employability skills program can moreover provide the necessary “critical demand” to promote adoption of such a model as a core component in undergraduate studies.

Livingston et al (2004) also noted the need for carefully noting how thinking skills are infused into programs that serve a different primary purpose, and the ESDP case study has shown that it is possible to map thinking skills development onto “discrete elements of the curriculum” (2004, Executive summary) by employing a fine-grained task-level analysis.

The ESDP case study has therefore shown both where and how critical thinking can be infused into an employability skills program.

5.3.2 Mixed methods: integrating components of the case study

The mixed methods approach adopted in the study provided the means to make explicit how critical thinking skills were infused into elements of the curriculum (Livingston et al, 2004) and to explain how students engaged in critical thinking in an immersion model of instruction.

The detailed description of the context for the case study, the types of projects in which students engaged and the transparent analysis and the rigour applied in drawing inferences will facilitate analytic generalisation of the mixed methods approach followed in this study.

The qualitative components made it possible to build an explanation of the immersion approach through a process of abductive reasoning (Morgan, 2007, p.71). In recognising the intersubjective nature of research, latent meanings identified in the content analyses have been made explicit through transparent interpretations, and the use of clear and detailed conceptual and theoretical frameworks in the qualitative components of the case study served as a safeguard against drawing unwarranted conclusions.

The presence of tasks that develop critical thinking skills has been interpreted as opportunities and not as evidence that students did indeed engage in critical thinking. Identification of engagement in the critical thinking cycle through content analysis of student reflections should similarly not be seen as a claim that all students engaged in the critical thinking cycle. The study has shown that standardised testing can confirm the effectiveness of immersion approaches to thinking skills instruction, but that standardised testing using multiple-choice formats should not be the only measure, and that group means may conceal important differences in performance.

It is unlikely that any particular intervention or program would impact all students in the same way. The effect of an intervention is most likely to be affected by the characteristics and attributes of individual students, and “limiting one’s vision to general effects can frequently be misleading and mask dramatic differences in the impact of an intervention or experience for different kinds of students” (Pascarella, 2006, p.512). For example, even where overall group effects on the standardised test were negative, as in contrast 1 in this study, closer examination revealed a positive effect for a subgroup of students, a situation that has been noted in several studies (Pascarella, 2006, p.512). Test results should therefore be viewed as performance in the test, and not necessarily be interpreted at face value as an indicator of student critical thinking ability or disposition in authentic contexts.

The study has shown that barriers such as finding room in the curriculum to engage students in critical thinking and preparing staff for teaching in a way that encourages critical thinking skills development can be overcome.

5.4 Limitations

Within pragmatism as paradigm, this study has been focused on answering the research questions. Nevertheless, the field of critical thinking development, approaches to instruction and assessment of critical thinking skills is vast, and in delimiting the study some questions that are relevant within the field were of necessity not asked. It is acknowledged that “there is an endless list of questions that can be asked about the relationship among learning experiences, individual abilities, and the development of critical-thinking skills” (Halpern, 2001, p.285), for example, questions relating to the transfer of skills to other areas of study and beyond (Halpern, 2001, p.284) and a wide range of conditional effects (Pascarella, 2006, p.512).

The difficult nature of assessing critical thinking is moreover widely acknowledged, both because changes in thinking abilities may be subtle and because it is logistically difficult to establish research situations that are likely to allow for generalisation. In situating this study within the pragmatic approach, it is acknowledged that no claim of generalisability can be made beyond analytic generalisation. In answering the research questions, the knowledge of the particular immersion approach and infusion of critical thinking into authentic learning tasks and new insights into how students engage in the process of critical thinking can nevertheless be appropriately used in other settings (Morgan, 2007 p.72).

5.4.1 Areas for further research

As approaches to teaching and learning in general evolve towards meeting the needs of the 21st century workplace, what kinds of knowledge about critical thinking will facilitate the development of critical thinkers?

Areas for further study that are closely related to the ESDP case study include an examination of the motivational and affective elements of disposition and the effect of specific aspects of collaborative learning environments on student engagement in the critical thinking cycle (Livingston et al, 2004, p.31).

The case study design presented an approach to explanatory case analysis and the use of unobtrusive measures that may be transferable to other contexts, including examination of motivational aspects, which have not been explored in-depth in the context of instructional

models (Mayer, 1998, p.56). In this study a conceptual framework of inquiry that is typically used to analyse online discussion transcripts has been applied to student reflections on their learning experiences, and the analyses expanded the indicators for the phases of critical thinking so that they allow for a more detailed analysis of student reflections. This approach can be meaningfully adopted to explore student engagement in critical thinking within other collaborative contexts.

5.5 Conclusion

The rationale for this study has been based on the need to enhance the critical thinking ability of students in order to equip them as participants in an increasingly complex and information-rich world. Chapter 1 set out the context of the research against the background of the skills agenda, provided an overview of the research problem and provided justification for the research in view of the centrality of critical thinking in the development of employability skills.

The review of the literature in chapter 2 has been aligned with the key questions in relation to critical thinking skills in higher education: what it is, where and how it should be taught, and how it can be measured. It presented a range of perspectives on critical thinking and critical thinking skills instruction and assessment, and reviewed other studies to present research most relevant to the current study.

The methodology adopted in this study was set out in chapter 3 and paid particular attention to both the paradigm and epistemology within which the research has been situated. The pragmatic paradigm which accommodates multiple perspectives on reality underscores the tentative and provisional nature of our knowledge about critical thinking ability, and the case study approach provided a framework for the study that allowed an in-depth investigation of the infusion of critical thinking skills at conceptual, operational and performance levels.

Chapter 4 presented the case study following step-wise explanation building that ensured interpretive and theoretical consistency and presenting credible inferences to ensure agreement between the data to hand and the findings (as set out in section 3.4.2.2). Explicit consideration of rival explanations enabled interpretive distinctiveness and efficacy in drawing conclusions by integrating the findings of qualitative and quantitative components of the research.

In conclusion, the ESDP case study has contributed to our understanding of alternative options for enhancing critical thinking skills in higher education. It has shown that an immersion approach can accommodate thinking skills development within a matrix of employability skills,

and that facilitative approaches (in contrast to direct instruction) can enhance critical thinking ability by engaging students in a process of inquiry. It has shown that gains in critical thinking within this context may be reflected also in standardised testing, but that standardised testing as sole measure is likely to add little to our understanding of critical thinking skills development.

The more we commit ourselves to the measurable, the less we are likely to be concerned with educational aims such as open-mindedness and critical thinking ... These virtues will probably appear as vague, uncertain, rhetorical, and impossibly idealistic. Open-mindedness, however, is important because it is the disposition that indicates an individual's willingness to go on learning and to acknowledge her or his mistakes; and critical thinking is important if the judgments we make are to be something more than the mere consequences of prejudice and unexamined opinion. These qualities suggest something very closely tied to the idea of being educated itself. We should not lose sight of the importance of making useful, informal judgments about the development of open-mindedness and critical ability in students in the absence of measurable data, and we should retain our confidence that these qualities are among the most valuable traits a teacher can possess. (Hare, 2000, p.106)

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Appendix 3.1: Participant information and consent

Evaluation of thinking skills development in undergraduate business education

Participant information statement

You are invited to participate in a study of student development of critical thinking skills by taking the California Critical Thinking Skills Test. The aim of the study is to evaluate the effectiveness of skills components in units by measuring performance over the course of study.

This study has been approved by the ECU Human Research Ethics Committee.

The Critical Thinking Skills Test consists of 34 multiple-choice questions. There is no time limit on completing the questionnaire. The test should take approximately 40 minutes.

Participation and confidentiality

Participation in the study is voluntary.

Individual results will not be made available to your lecturers. The results will not be taken into account in any of your units of study and will have no effect on your assignment or examination results.

Any information that is obtained in connection with this study and that can be identified with you will remain confidential. Identification of individual questionnaires is required only to match the results of subsequent tests in order to measure improvements. All information will be kept securely and will be de-identified before being processed. In any discussion, report or publication, information obtained in this study will be used in such a way that you cannot be identified.

If you decide to participate, you remain free to withdraw your consent and to discontinue participation at any time without prejudice.

If you have any questions, please feel free to ask us:

Contact information:

Assoc/Prof Sue Stoney, phone 6304 5260, email: s.stoney@ecu.edu.au

Sophie Kennedy, phone 6304 5348, email: sophie.kennedy@ecu.edu.au

If you have any concerns or complaints about the study and wish to talk to an independent person, you may contact the Research Ethics Officer, phone 6304 2170, email research.ethics@ecu.edu.au.

Evaluation of thinking skills development in undergraduate business education

[keep this form for later use, if required]

REVOCAION OF CONSENT

I hereby wish to **withdraw** my consent to participate in the research proposal described above and understand that such withdrawal will be without prejudice.

.....

Student number

.....

...../2007

Signature of Research Participant

Date

Evaluation of thinking skills development in undergraduate business education

CONSENT FORM

I have read the Participant Information Statement, and have decided to take part in the study.

I understand that my participation is completely voluntary, and that I am free to withdraw from the study at any time I choose, without penalty.

.....

Student number

.....

...../2007

Signature of Research Participant

Date

Participant information statement

Dear student

Reflective learning by way of written reflections forms an integral part of the Business Edge program. This is a request for consent to use the reflective journal entries, that you made in Business Edge units, as part of my PhD research.

The aim of my research is to evaluate critical thinking skills as indicator of employability skills developed by students in the Business Edge program as an experiential learning model. As reflective learning is one of the techniques for developing critical thinking skills through analysis, interpretation and evaluation of the learning experience, an analysis of student reflections will provide useful indicators of critical thinking skill development.

You are under no obligation to provide your consent. The analysis of reflections will be confidential and will not be related in any way to or taken into consideration in any of your units of study and will have no effect on your assignment or examination results.

Any information that is obtained in connection with this study and that can be identified with you will remain confidential. All information will be kept securely and will be de-identified before being processed. No information obtained in this study or analyses will be reported or published in a manner whereby you could be identified.

If you have any questions, please feel free to ask me. You may also address any questions or concerns to my Supervisor.

To give your consent, just sign the attached form and return to your lecturer or to:

Sophie Kennedy
Room 2.448
Faculty of Business and Law
Edith Cowan University
sophie.kennedy@ecu.edu.au

Tel: 6304 5348

Supervisor:

Associate Professor Susan Stoney

Tel: 6304 5260

Analysis of reflective learning as contributor to critical thinking skills development in an experiential model

CONSENT FORM

I have read the Participant Information Statement, and have decided to grant permission for analysis of my reflective journal entries.

I understand that my participation is completely voluntary.

.....

Student number

.....

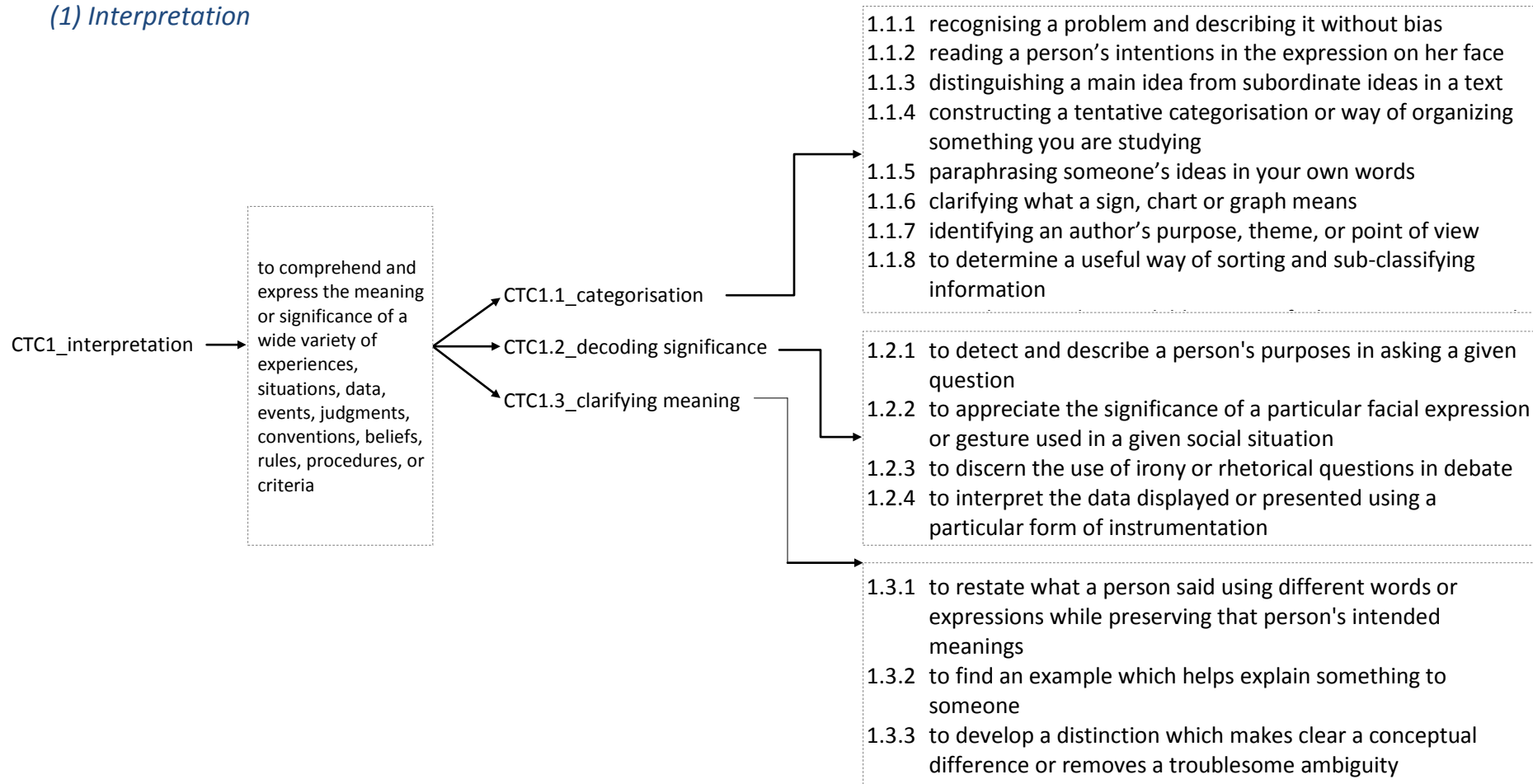
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Signature of Research Participant

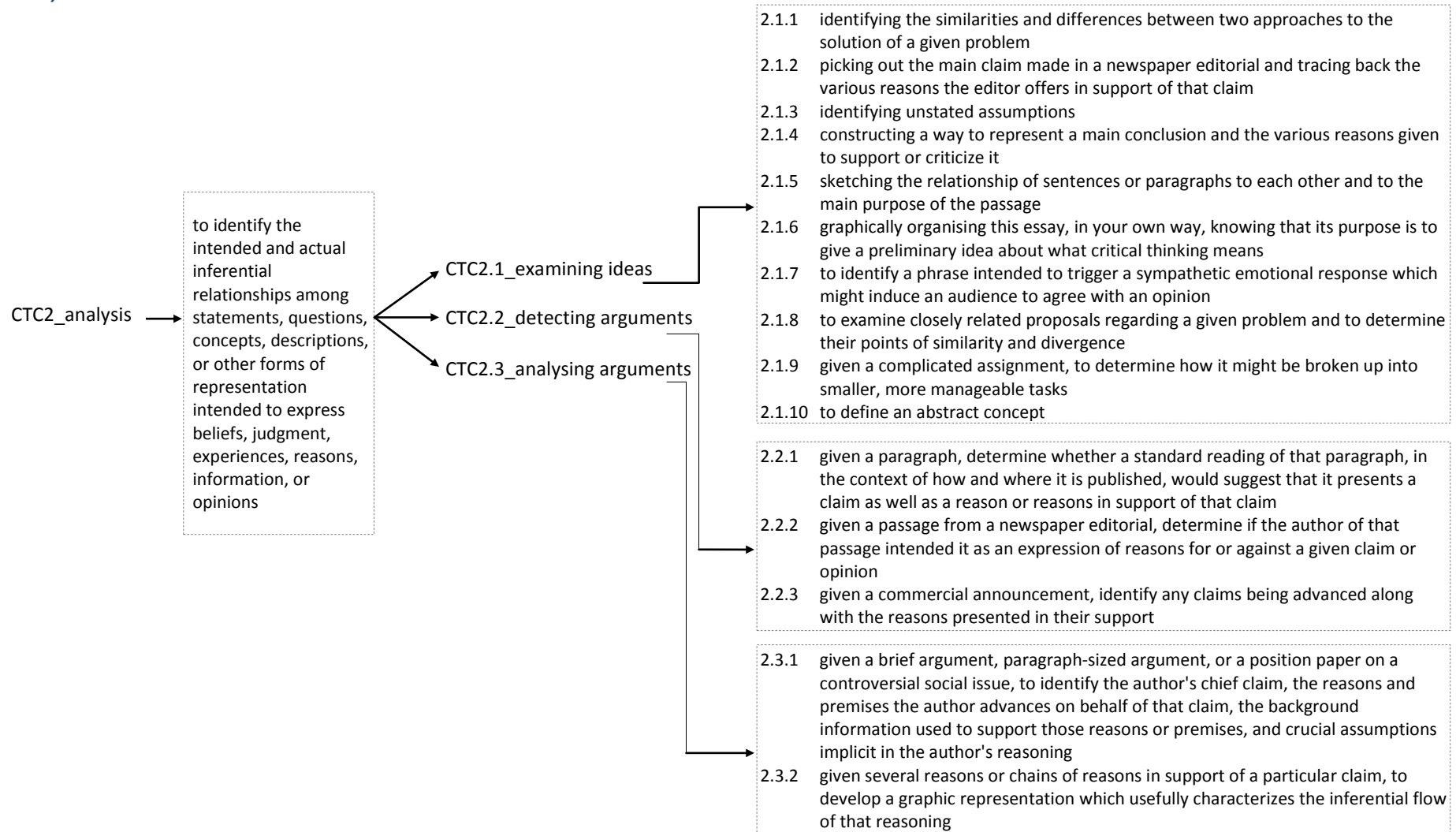
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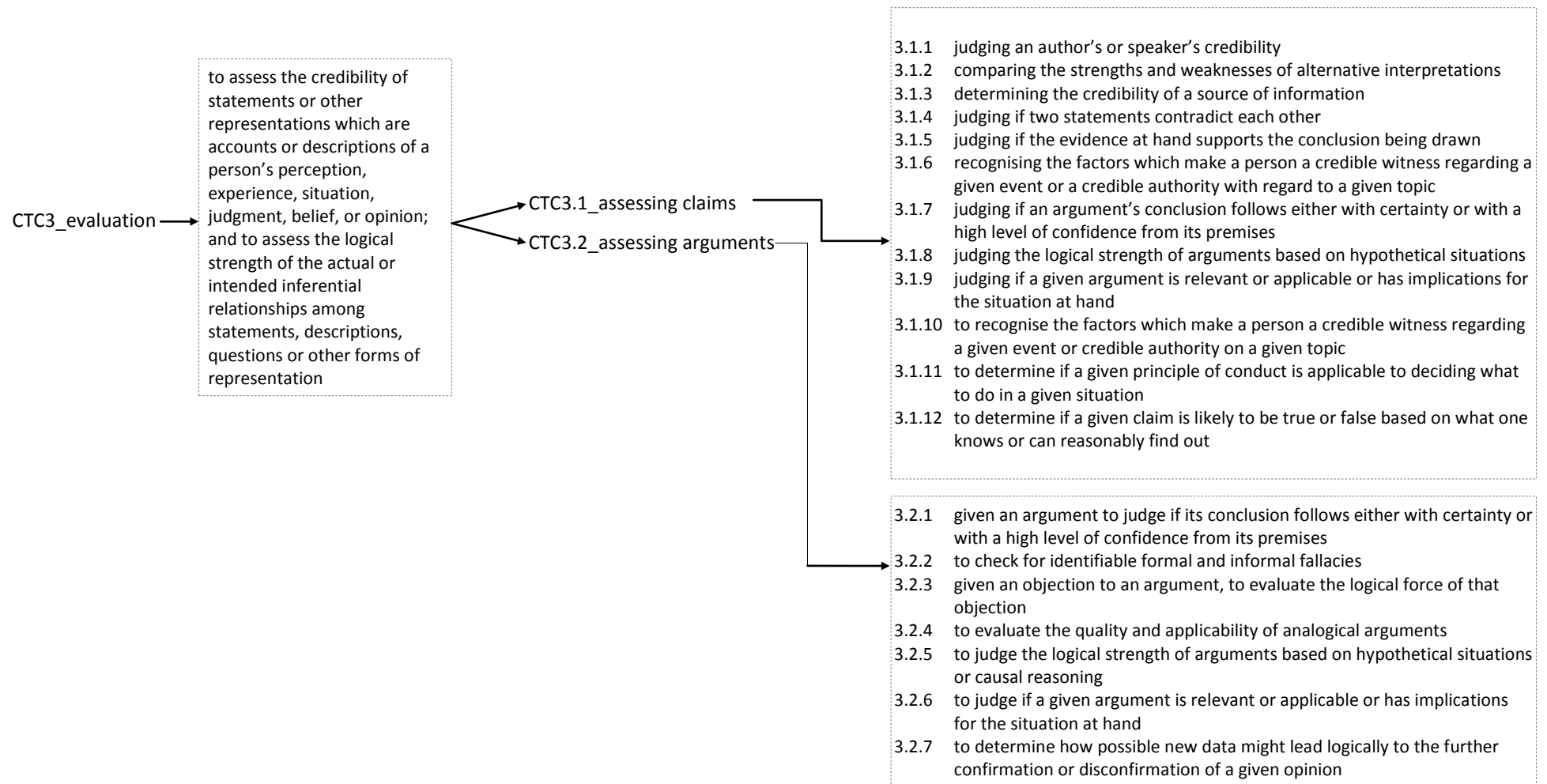
Appendix 4.1: Critical thinking skills deconstruction: Components and task examples

(1) Interpretation



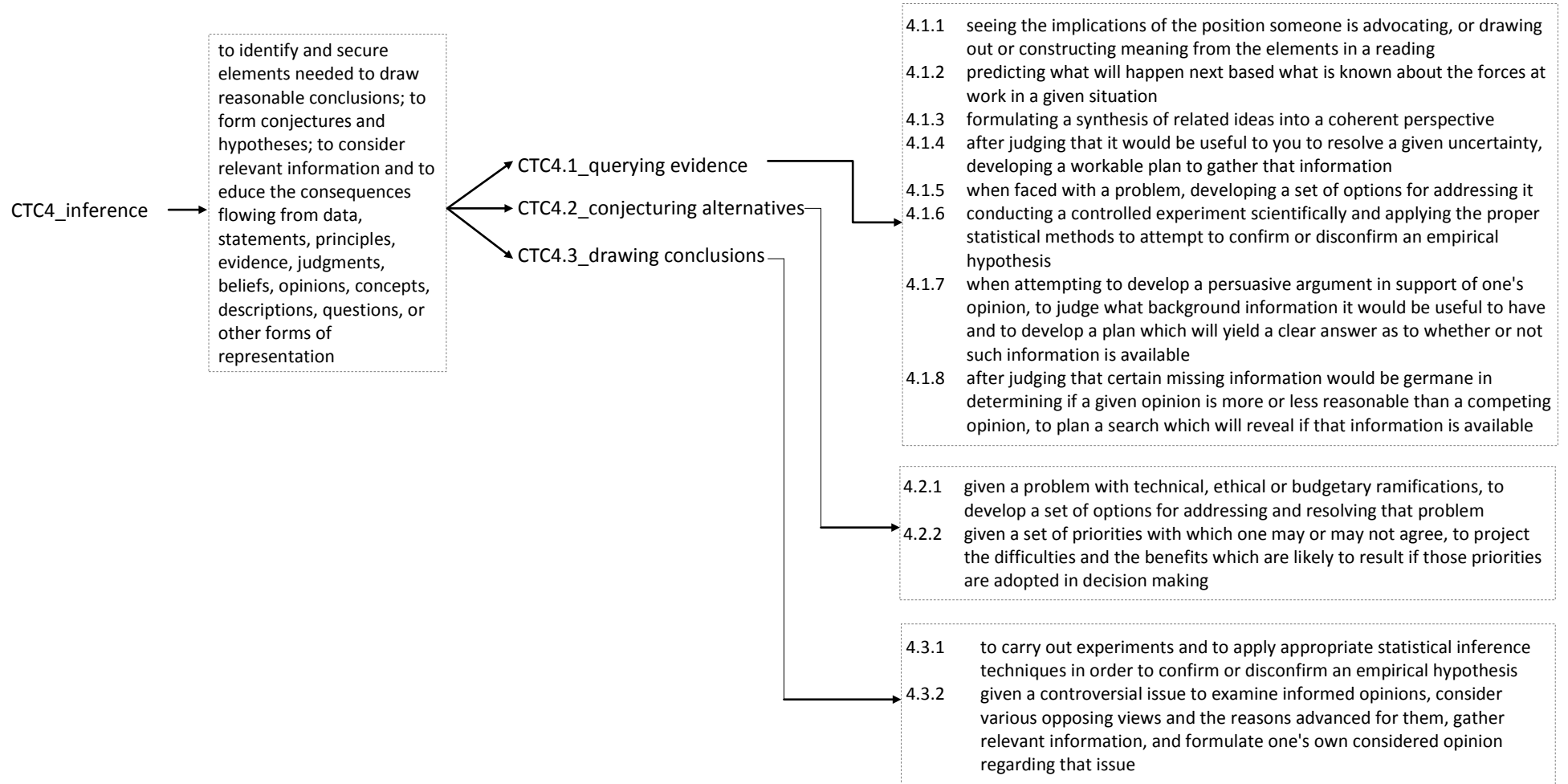
(2) Analysis



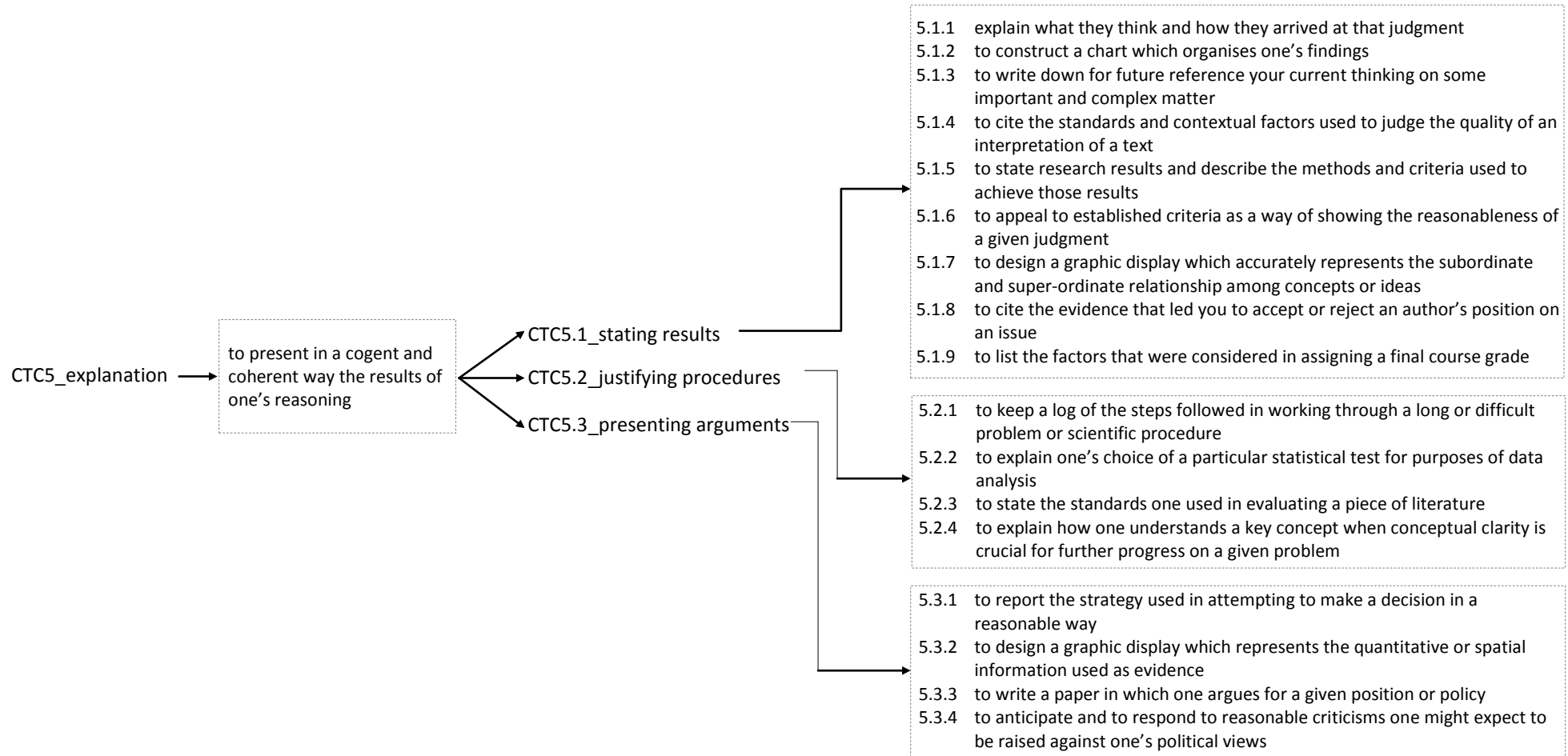


(3) Evaluation

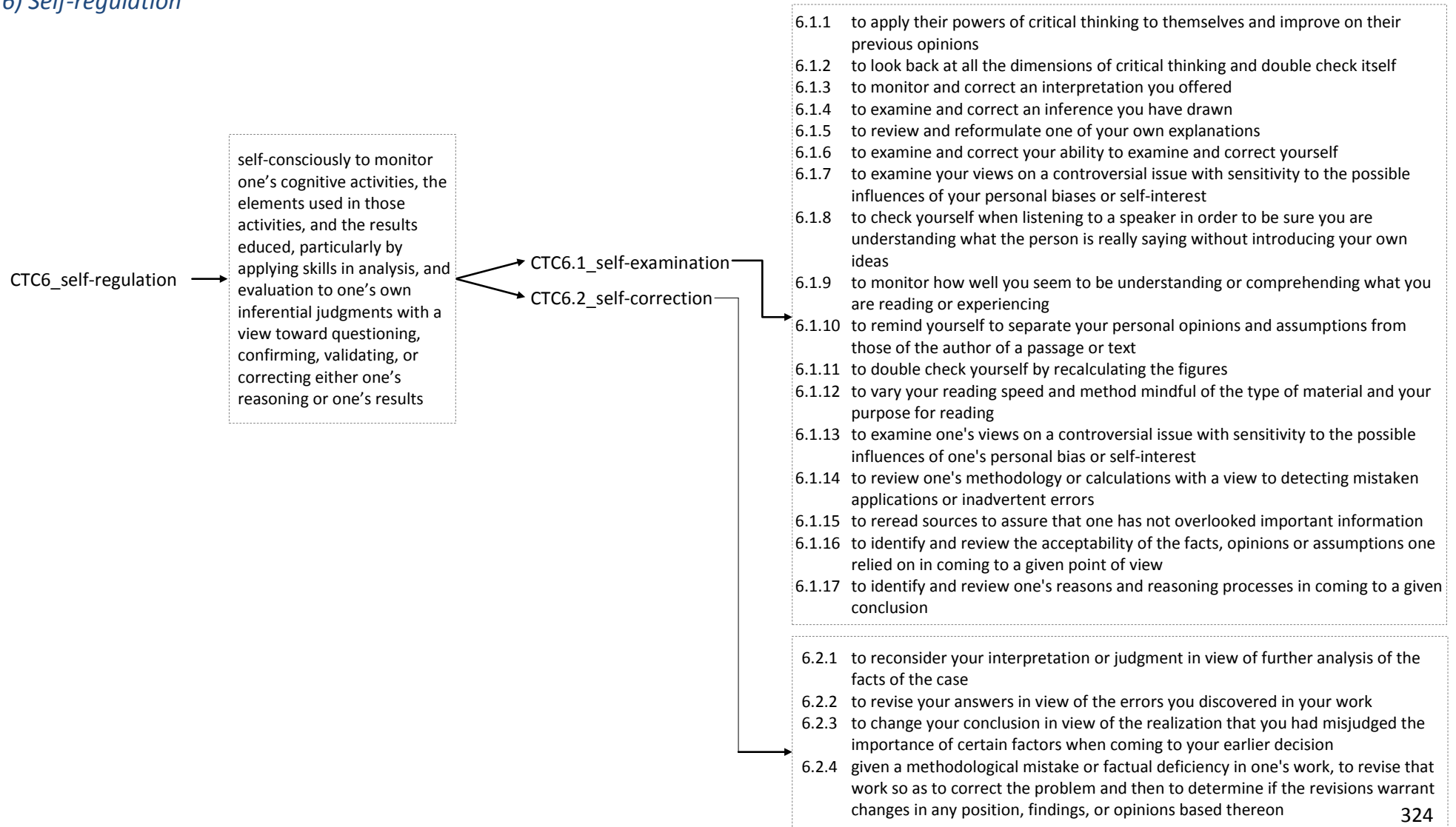
(4) Inference



(5) Explanation



(6) Self-regulation



Appendix 4.2: Project instructions (coded)

Project 1: New drivers

Learning outcomes

This activity will help you achieve the following learning outcomes:

1. analysing and commenting on ethical issues in society [P1-TA3; P1-TA4]
2. applying the fundamental principles of effective interpersonal communication [P1-TA1]
3. researching, writing and producing a professional business report [P1-TA2; P1-TA3; P1-TA4]
4. making an effective oral presentation, delivering results supported by relevant descriptive statistics and using appropriate presentation tools [P1-TA4]
5. participating constructively in groups and teams, using groupwork techniques to critically analyse problems and identify alternative solutions [P1-TA1; P1-TA3]
6. applying descriptive statistics to analyse data sets using appropriate software and graphing techniques [P1-TA4]

Activity

This activity includes both teamwork and an individual report. The team works together to explore the topic [P1-TA1; P1-TA2;] and make weekly oral reports on their analysis and progress [P1-TA3]. The final submission is an individual report. [P1-TA4]

The activity will run from week 4 to week 7 and is made up of a series of tasks, which are aligned with lab sessions during which you will gain the technical skills you need to complete the activity.

There are three assessment points in this activity. Your reflections during this activity [P1-TA5] also feed into Proficiency test 4 (Teamwork self-report).

Instructions

You are partners in a pizza business located 8 km from a large residential university campus. You are dependent on the student population as a source of casual employees as well as relying on them as customers.

To keep your business costs down, all the students you employ are under 19, and are therefore new drivers on P plates. You employ the students to make pizza deliveries, and have been concerned because several have been involved in traffic accidents, one of them a fatal accident. As a partnership, you take pride in the fact that your business is concerned with corporate social responsibility, and the attached article in The West Australian (21st June, 2007) has captured your interest.

Team task

You have been invited to speak to the local chapter of your Small Enterprise group about restrictions that could be put in place for new drivers [P1-TA3.2; P1-TA3.5], and the implications [P1-TA3.5] these restrictions could have for small and medium sized businesses.

In order to prepare properly for this presentation, your group is to:

- research the issues in Australia [P1-TA2]
- identify and evaluate some of the proposed solutions in Australia [P1-TA3]

- research the solutions or policies of one other country of your choosing [P1-TA2; P1-TA3]
- make a weekly oral report on team progress.[P1-TA4]

Your individual task is to produce a written report [P1-TA4] in which you make appropriate recommendations [P1-TA3], properly formatted and referenced.

Class sessions

Activities during class sessions focus on working together as a team [P1-TA1], analysing and evaluating information[P1-TA3]. When working in teams, each team member is expected to make contributions by sharing their own views [P1-TA1.1]and working towards a consensus opinion [P1-TA1.3] for the team.

Teams should take into account alternative points of view[P1-TA1.2], investigate the evidence critically[P1-TA3.4], weigh the various options [P1-TA3.2; P1-TA3.5]and consider the validity of all arguments [P1-TA3.5], in order to arrive at a position that the team can justify and present to the class in a convincing manner[P1-TA1.4].

Skills

During this activity you should acquire the skills to

- search an online database [P1-TA2.1]
- identify variables and export data [P1-TA2.1]
- use Word and Excel to present data in graphs and diagrams [P1-TA4.3]
- conduct information searches targeting specific countries [P1-TA2.2]
- create a PowerPoint presentation [P1-TA4.1]

Week	Tasks	Reflective journal
4	<p>Make sure you understand the skills requirements.</p> <p>Analyse the newspaper report [P1-TA3.1] reproduced on page 3. Work with your team members to identify the real issues at stake [P1-TA3.2]. What is the real problem? What has been done about it? Are there other things that can be done? [P1-TA3.5] Create a “picture” (mind map or flowchart) of the facts in the situation [P1-TA3.3].</p> <p>The team will present the mindmap in a report-back in week 5.</p>	<p>Reflect on your contribution to the team effort. [P1-TA5.1]</p>
<p>The newspaper report has been removed for copyright reasons.</p>		
5	<p>Report back on your week 4 analysis. Present the outcomes visually. Include one new piece of information that your team has found during the week [P1-TA2.3].</p> <p>Find another country to include in your analysis. Collect as much information as you can about the situation in that country [P1-TA2.2]. Highlight what is being done in that country with what is being done in Australia and Western Australia [P1-TA3.5]..</p>	<p>Reflect on the contributions that you anticipate from the members of your team[P1-TA5.2]. Do they have specific strengths and weaknesses?</p>

Assessment preparation: Start drafting your individual report. The individual written report forms Assignment 2, Part 1. You will be able to continue working on your report during the

semester break. The report is due at the end of Week 7. A link will be placed in the Assessment area of the unit site on Blackboard for you to submit the report using the Assignment manager.

- 6 Report back on your week 5 analysis.

Work together to arrive at team consensus on the recommendations you will make [P1-TA1.3]. Although the report is an individual piece of work, it should result from a teamwork process. *Please note: collaboration is acceptable, but collusion is not. Your report should be your own work.*

Start preparing your team report-back presentation [P1-TA4.1; P1-TA4.2] for week 7.

Most of this session will be spent on team report-back presentations.

- 7 Each presentation should consist of a title slide and no more than 5 additional slides. Each team member is to present the information on one slide. Each team will get 10 minutes for their presentation.

Assignment 3, Part 1 concludes with in-class team presentation [P1-TA4.1; P1-TA4.2; P1-TA4.3; P1-TA1.4]

Submit Assignment 2, Part 1

- 9 Your reflective journal entries over the past four weeks [P1-TA5]. provide a basis for your teamwork self-report which forms Proficiency test 4, to be submitted by the end of week 9.

Assessment preparation: Teamwork self-report: This is your Proficiency test 4 and is based on your reflective journal entries. Make sure you use Turnitin and attach your report.

Midsemester break

Reflect on the team-building process [P1-TA5.3]. Are there specific dynamics that you think will hamper or facilitate a good outcome in the project.

Project 2: Alternative energy

Learning outcomes

This activity will help you achieve the following learning outcomes:

1. analysing and commenting on ethical issues in society
2. communicating online using correct electronic etiquette
3. making an effective oral presentation, delivering results supported by relevant descriptive statistics and using appropriate presentation tools
4. participating constructively in groups and teams, [\[P2-TA1\]](#) using groupwork techniques to critically analyse problems [\[P2-TA1.3\]](#) and identify alternative solutions [\[P2-TA3\]](#)
5. developing an understanding of the nature of business by critically evaluating a range of business scenarios

Activity

This activity includes both teamwork and an individual oral presentation. You will work together as a team to explore the topic of nuclear energy and the uranium trading debate [\[P2-TA1; P2-TA2; P2-TA3\]](#), and will provide weekly team progress updates in various formats. The final assessment is an individual oral presentation [\[P2-TA4\]](#).

The activity will run from weeks 8 to 12. You will be using the skills that you acquired and the feedback provided during the previous activity to guide you in this project.

Assessment

There are two assessments linked to this project.

Assignment 2, Part 2: Individual presentations in weeks 11 and 12. The presentations comprise 25% of the total mark for this unit. [\[P2-TA4\]](#)

Assignment 3, Part 2: Weekly written group progress updates, submitted online in weeks 8, 9, and 10. The weekly group progress reports [\[P2-TA1\]](#) will take the format of

- (1) an email update to the Chief Executive Officer of the company in week 8
- (2) a memorandum to the Board in week 9, and
- (3) a brief contribution to the company newsletter in week 10

The progress updates comprise 10% of the total mark for this unit.

Instructions

You have been working as a member of the Policy Advisory Group for the Kindling Investment Group in Perth, Western Australia, for some five years. You have received a request from the Chief Executive Officer to conduct research into nuclear energy [\[P2-TA2\]](#) and to recommend a company position to the Board [\[P2-TA3.5\]](#).

The company needs to take a position on aspects of the issue of the use of nuclear energy as an alternative to energy derived from fossil fuels from a West Australian and Australian perspective.

While the group has large amounts of capital to invest, its investment portfolio currently does not include any uranium holdings. You are not required to make an investment decision as such, but you are required to advise the board on a position for the company to take for or against nuclear energy and uranium trading. The Kindling Investment Group is proud of its

reputation as a good corporate citizen, and has requested that you consider the triple bottom line in your deliberations.

Consider aspects such as [P2-TA2.1; P2-TA3.4]

- environmental concerns (nuclear energy as an option cuts out harmful emissions, but storage of nuclear waste may pose a challenge) versus
- ethical concerns (can Australia justify selling uranium to other countries, given its potential use in weapons?),
- the economic imperative of trading in uranium, the counter-demands of the coal lobby, and so forth.

The nuclear debate had been silent in Australia for several years. However, in the face of environmental considerations and rising concerns over global warming, it has become a hot topic in both political and business forums. The extract below is from the report [P2-TA3.1] following the *Uranium mining, processing and nuclear energy review*.

Your team is to

- research the literature [P2-TA2.1] on nuclear energy and uranium trading, including ethical and environmental considerations [P2-TA2.1]
- investigate the pros and cons [P2-TA3.1; P2-TA3.2; P2-TA3.3] of uranium mining and trading from an economic perspective [P2-TA3.4] within the context of the nuclear energy review in Australia
- submit weekly written progress updates in the formats [P2-TA1.4] outlined in the Assessment section above.

Your individual task is to prepare and deliver an individual oral presentation [P2-TA4.1] to the Board in which you recommend a company position [P2-TA3.5; P2-TA4.2] on uranium mining and trading for the purpose of nuclear energy as an alternative energy source.

from: **Uranium mining, processing and nuclear energy: Opportunities for Australia?**
(available online at http://www.aussmc.org/Nuclear_Energy_Review.php)

On 6 June 2006, the Prime Minister announced the appointment of a taskforce to undertake an objective, scientific and comprehensive review of uranium mining, value-added processing and the contribution of nuclear energy in Australia in the longer term. This is known as the Review of Uranium Mining Processing and Nuclear Energy in Australia, referred to in this report as the Review.

The Prime Minister asked the Review to report by the end of 2006. A draft report was released for public comment on 21 November 2006 and was also reviewed by an expert panel chaired by the Chief Scientist (see Appendix F). The Review is grateful for comments provided on the draft report by members of the public. The report has been modified in the light of those comments.

In response to its initial call for public comment in August 2006 the Review received over 230 submissions from interested parties. It also conducted a wide range of consultations with organisations and individuals in Australia and overseas, and commissioned specialist studies on various aspects of the nuclear industry.

Participating in the nuclear fuel cycle is a difficult issue for many Australians and can elicit strong views. This report is intended to provide a factual base and an analytical framework to encourage informed community discussion.

Australia's demand for electricity will more than double before 2050. Over this period, more than two-thirds of existing electricity generation will need to be substantially upgraded or replaced and new capacity added. The additional capacity will need to be

near-zero greenhouse gas emitting technology if Australia is just to keep greenhouse gas emissions at today's levels.

Many countries confront similar circumstances and have therefore considered the use of nuclear power for some of the following reasons:

- the relative cost competitiveness of nuclear power versus the alternatives
- security of supply and independence from fossil fuel energy imports
- diversity of domestic electricity production and reduction in volatility arising from input fossil fuel costs; and
- reduction in greenhouse gas emissions and subsequent effects on global climate.

The world's first civilian nuclear reactor commenced operation in 1955. According to the International Energy Agency (IEA), today there are 443 nuclear reactors operating in 31 countries, producing 15 per cent of the world's electricity.

As a substantial holder of recoverable reserves (38 per cent of known low cost global reserves) and producer of uranium (23 per cent of global production), Australia is well positioned to increase production and export of uranium oxide to meet market demand. There is an opportunity for Australia to be a participant in the wider nuclear fuel cycle given international confidence in the quality of our production processes, our sophisticated technology community (although no longer with a significant presence in the nuclear fuel cycle) and the strength of our commitment to nuclear non-proliferation.

Nuclear power has a much lower greenhouse signature than Australia's current major energy sources for electricity; namely brown and black coal, and gas. Although the priority for Australia will continue to be to reduce carbon dioxide emissions from coal and gas, the Review sees nuclear power as a practical option for part of Australia's electricity production.

Resources

For this activity, you are required to find your own resources [P2-TA2.1]. You may share appropriate resources via the discussion forum for this activity on MyECU.

Class sessions

Activities during class sessions focus on researching the literature and discussing issues in teams [P2-TA1.1]. You should spend the final half hour of each session putting together your progress update in the required format and posting it on MyECU.

Teams should take into account alternative points of view [P2-TA1.2], investigate the evidence critically [P2-TA3.2], weigh the various options [P2-TA3.3] and consider the validity of all arguments [P2-TA1.3].

You are also required to post a reflective journal entry each week [P2-TA5.1]. Your reflections should express your own experience of the activity as a learning experience.

Skills

During this activity you should acquire the skills to

- locate, access and search online information sources [P2-TA2.1]
 - evaluate information [P2-TA2.2]
 - use PowerPoint to create a presentation [P2-TA4.1]
 - deliver an oral presentation [P2-TA4.2].
-

Project 3: The Ribena debacle

Learning outcomes

This activity will help you achieve the following learning outcomes:

1. discussing the consequences of ethical behaviour in an organisational context
2. demonstrating effective interpersonal communication and working effectively within a team
3. summarising and synthesising information
4. interpreting and evaluating data using a range of tools and technologies
5. using accepted techniques for managing electronic documents

Activity

Description

Inkling Inc is a marketing consultancy who have been commissioned by JoosEd, a health drink distributor who sells a variety of health drinks via vending machines on campuses and at schools. Following the Ribena debacle, JoosEd anticipates a possible drop-off in demand for health drinks and needs timely market information to manage supplies. You are a member of the Inkling team assigned to the JoosEd account.

Your team is required to develop and conduct a survey, analyse the data and report the results [P3-TA1]. You are required to read the news item **Ribena Vitamin C claims false and misleading** (handout Ribena_Scoop_news_Vit_C_claims_false.pdf in the activities area on [Blackboard] [P3-TA2], and also available at <http://www.scoop.co.nz/stories/BU0703/S00478.htm>), and analyse the sequence of events [P3-TA2.2] using concept mapping [P3-TA2.1]. You should then prepare a questionnaire [P3-TA3] and conduct a survey [P3-TA4] to test consumer sentiment relating to the health benefits of fruit drinks. In week 6 your team will report its findings [P3-TA5; P3-TA6] to a JoosEd strategic planning representative. You are required to conduct some online research of organisational structures to find out what an appropriate title for this person would be.

Tasks

You will be working in a team on this activity. Each member of the team must make a contribution.

- (1) You have to read the article for homework after your first class session before you come to class in Week 2. Consider the following questions as you read the article:
 - What are the facts of the case? [P3-TA2.2]
 - What are the ethical considerations in the case? [P3-TA2.3]
 - Is the case likely to have any long-term effects on the product? [P3-TA2.4; P3-TA4.3]
 - Is this likely to have an impact on the company and/or the industry? [P3-TA2.4; P3-TA4.3]
- (2) Throughout this activity you also have to complete a series of proficiency tests that will enable you to analyse and interpret data.
- (3) You must make weekly entries in your reflective journal [P3-TA7]. Three entries will be selected at random for marking.
- (4) You are required to contribute to all your team tasks during and between classes, including preparation and delivery of the team presentation [P3-TA6.1] to the CEO of JoosEd during week 6.

As a team, your group is required to:

- (2) Analyse the article [P3-TA2.2] and develop a mind map [P3-TA2.1] during class in week 2. This exercise should help you identify the issues in the case [P3-TA2.2], which will in turn help you to identify the information that will be useful [P3-TA3.1]. You will gather that information by means of a survey, so you should get some idea of the questions you should ask [P3-TA3.2].
- (3) Develop a survey questionnaire. You should start working on this outside of class and will finalise your team's survey during class in week 3. Keep track of the process by making detailed notes throughout [P3-TA3.2]. This will help you when you to write up the briefing report [P3-TA6.2]. In developing the survey, consider the following questions:
 - Exactly what are we trying to learn as an outcome of the survey? [P3-TA3.3]
 - How much time can we expect someone to spend answering our questions? [P3-TA3.4]
 - Do we need to simplify and/or alter our objectives from their ideal to ensure that the survey can be answered in the expected time? [P3-TA3.4]
 - Will the survey questions we have developed enable us to meet our objectives? [P3-TA3.3]

Your team will then survey members of the public [P3-TA4.1] in week 4. The venues for conducting the survey will be discussed in class, and are likely to include shopping malls as well as train and bus stations.

- (4) By week 5 you should have analysed your data [P3-TA5.1] so you can prepare your team presentation [P3-TA6.1]. You should also finalise your briefing paper [P3-TA6.2] now. The briefing paper should provide a summary of the procedures followed in developing and conducting the survey and the results that underpin the presentation [P3-TA6.3].
- (5) In week 6, teams will present their findings [P3-TA6.1]. This is a team presentation and should be no longer than 7 minutes. You should use PowerPoint to support your presentation. You should have no more than 7 slides, of which one has to be a title slide and one has to contain references and/or acknowledgements. Your team will have to work out how you will present [P3-TA1.1], for example each team member may speak to one slide.
- (6) You must submit the briefing paper by the end of week 6 by following the link in the Assessment area of the unit's online site on Blackboard. Failure to submit on time will result in penalties of 5% of the total mark per day.

Preparation

After reading and analysing the article [P3-TA2], and before you start drafting your questionnaire, you need to have some plan of where you will collect your data and from whom. In other words, you need to select your sample. To learn more about sampling access the Open Learning Initiative Statistics course and **read module 3 attentively**. Make sure you complete all the interactive tasks (**Did I get this?** and **Learn by doing**).

Resources

Other resources for this activity are posted in the unit's online site on Blackboard. You will also be required to find some of your own resources and add these to the forum for this activity on Blackboard.

Assessment

This activity relates to the following assessment items. More information is provided in the assignment descriptions in your unit plan:

Group assignments	Due	Weighting
Briefing paper	Week 6	10%
Oral presentation 1	Week 6	10%

Each team has to present the results of their survey to the class. The briefing paper is to provide a summary of the procedures followed in developing and conducting the survey and the results that underpin the presentation [\[P3-TA6.3\]](#).

Other assessment items that you need to work on individually:

Individual assignments	Due	Weighting
Reflective journal entries	Weekly throughout semester	15% total/semester
Proficiency tests	Weekly throughout semester	25% total/semester

Project 4: Internet censorship

Learning outcomes

This activity will help you achieve the following learning outcomes:

1. developing skills in self and peer assessment
2. discussing the consequences of ethical behaviour in an organisational context
3. demonstrating effective interpersonal communication and working effectively within a team
4. summarising and synthesising information
5. using accepted techniques for managing electronic documents
6. producing business documentation to a professional standard
7. interpret, evaluate and use business data to support oral and written argument
8. apply critical thinking in analysing different scenarios and issues

Activity

Description

This is a team activity [P4-TA1] in which you will be conducting an online survey [P4-TA2; P4-TA3] on internet censorship. As part of the activity you are required to identify the key issues in this topic [P4-TA1], conduct an online survey [P4-TA1], analyse the survey data you collect and present your results [P4-TA4]. You are also required to draft a report as a team [P4-TA4.2], and to write an individual executive summary [P4-TA4.3] for the report.

Tasks

There are three main components to this activity:

1. analysing the topic and identifying the main issues and questions to explore [P4-TA1.2; P4-TA1.3]
2. developing an online survey instrument and conducting an online survey [P4-TA2; P4-TA3]
3. analysing and reporting the data [P4-TA4]

You are also required to document the survey process following a report format [P4-TA4.2]. You will write the executive summary [P4-TA4.3] to your report in class in week 11. More information appears in the Assessment section of your unit plan.

Task 1: The issues

You should read the article [P4-TA1.2] [smh_news_int_censorship_grows_worldwide.pdf](#) posted on Blackboard before coming to class in week 7. You should also explore some of the online resources [P4-TA2.2] provided and conduct your own online search [P4-TA2.2] to find out more about the topic. In week 7 you will work with your team members to analyse the topic using **brainstorming** and concept mapping (or **mind mapping**) techniques [P4-TA1.3].

In analysing the information, try to identify the main issues and questions to explore [P4-TA1]. Consider your own views on the topic [P4-TA1.4]. Do you think some people might share your views? Are there some people who will have different views? [P4-TA1.4]

Remember to share your resources and insights in the online discussion forum [P4-TA1.5] on Blackboard.

Task 2: The questions and your survey

During your analysis, start writing down the questions that you might include in a survey [P4-TA2.3]. Why do you think some people might be in favour of censoring information on the internet? Why would some people oppose this? Do people feel differently about different types of information? Is ownership of information an issue?

Also consider who would be your target population and how you will reach them. [P4-TA3.2]

You will have to complete the first draft of your survey instrument (questionnaire) [P4-TA2.3] before coming to class in week 8. During the class session in week 8 you will swap your team's questionnaire with another team and critique each other's questionnaires [P4-TA2.4]. Once you have received feedback, you may revise your questionnaire [P4-TA2.4] before posting it online [P4-TA3.1].

You will then draft an email to send to prospective respondents, inviting them to participate in the survey [P4-TA3.2].

During the semester break you will be preparing and outline of your survey development report [P4-TA4.2]. You should work on this as a team, and each team must submit their outline for feedback in week 9. Your report should cover aspects such as the objectives of your survey, preparing and conducting the survey, data collection including issues such as data formats and storage, bottlenecks and difficulties, and your main findings. [P4-TA3.3]

Task 3: Your findings

Once you have collected your raw results, you will need to analyse the results and summarise your findings [P4-TA4.1]. The format of your raw results will depend on the online facility you used, but you should be able to convert or import your data into an Excel spreadsheet for processing. If the format is incompatible, you will need to enter the data manually.

Your lecturer will provide support on the kinds of analyses that are expected.

Remember to work on your report [P4-TA4.2] as a team. You will write the executive summary [P4-TA4.3] individually in class, using a copy of the team report.

You are required to present your survey results to an audience report [P4-TA4.4] using Powerpoint slides.

Resources

You will be required to find some of your own resources and add these to the forum for this activity on MyECU.

First Monday

http://www.firstmonday.org/issues/issue11_9/

Internet censorship grows worldwide: study May 19, 2007

<http://www.smh.com.au/news/Technology/Internet-censorship-grows-worldwide-study/2007/05/19/1179497293880.html>

World Politics Review. As battle for internet control continues, state censors play an increasing part

<http://www.worldpoliticsreview.com/article.aspx?id=817#>

The OpenNet Initiative

<http://opennet.net/>

EFA: Internet Censorship Laws in Australia

<http://www.efa.org.au/Issues/Censor/cens1.html>

Internet Censorship: A discussion

http://gslis.simmons.edu/blogs/lis48802fall06/2006/10/internet_censorship_i_think_no.html

Regulation of objectionable material on the internet

<http://www.waikato.ac.nz/law/lawlinks/RegulationofObjectionableMaterialontheInternet.shtml>

Families against internet censorship

<http://www.netfamilies.org/>

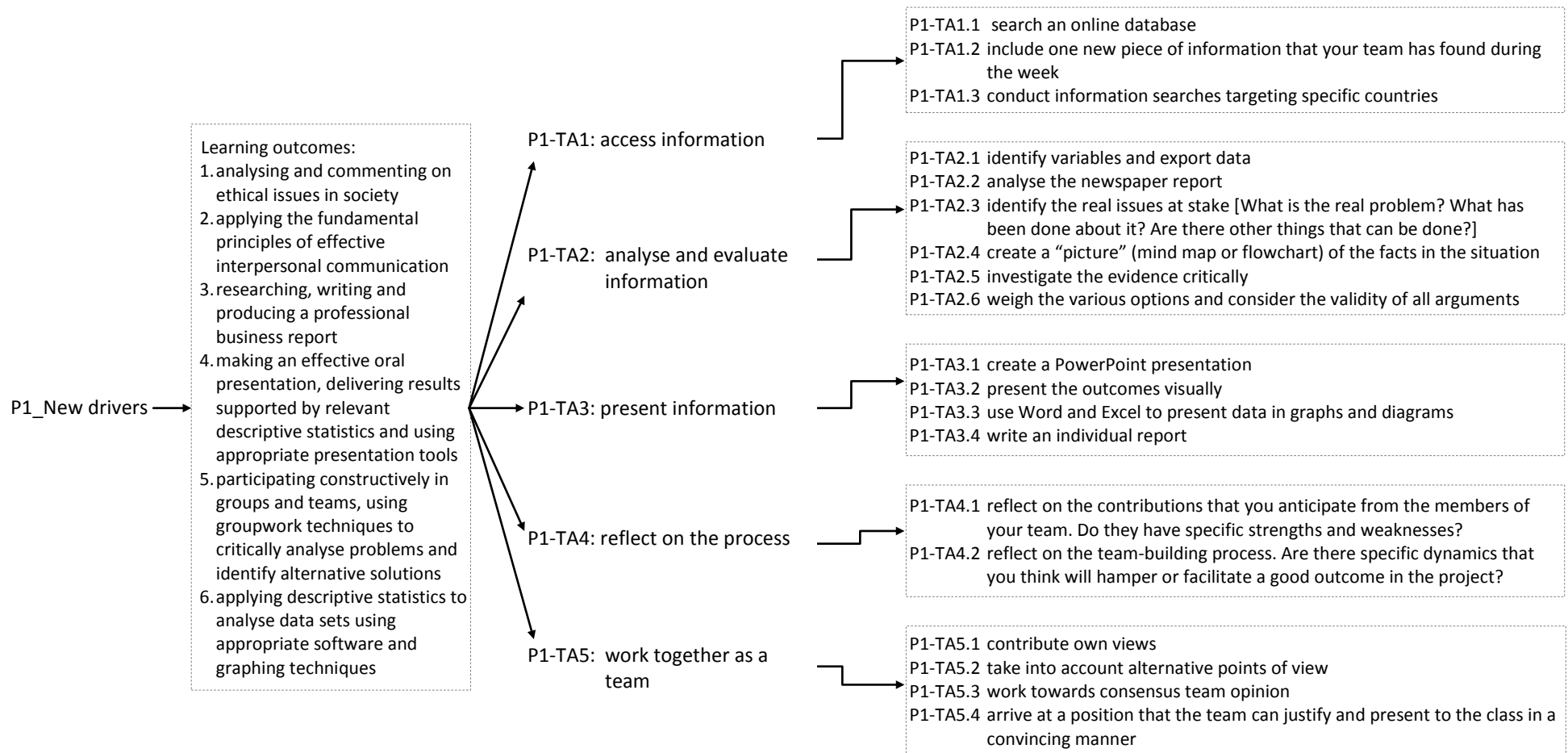
Related assessment items

Assessment item	Due	Weighting
Group survey instrument critique (in-class assessment)	Week 8	5%
Survey development report: Executive summary (in-class assessment)	Week 11	15%
Oral presentation 2	Weeks 11 & 12	20%

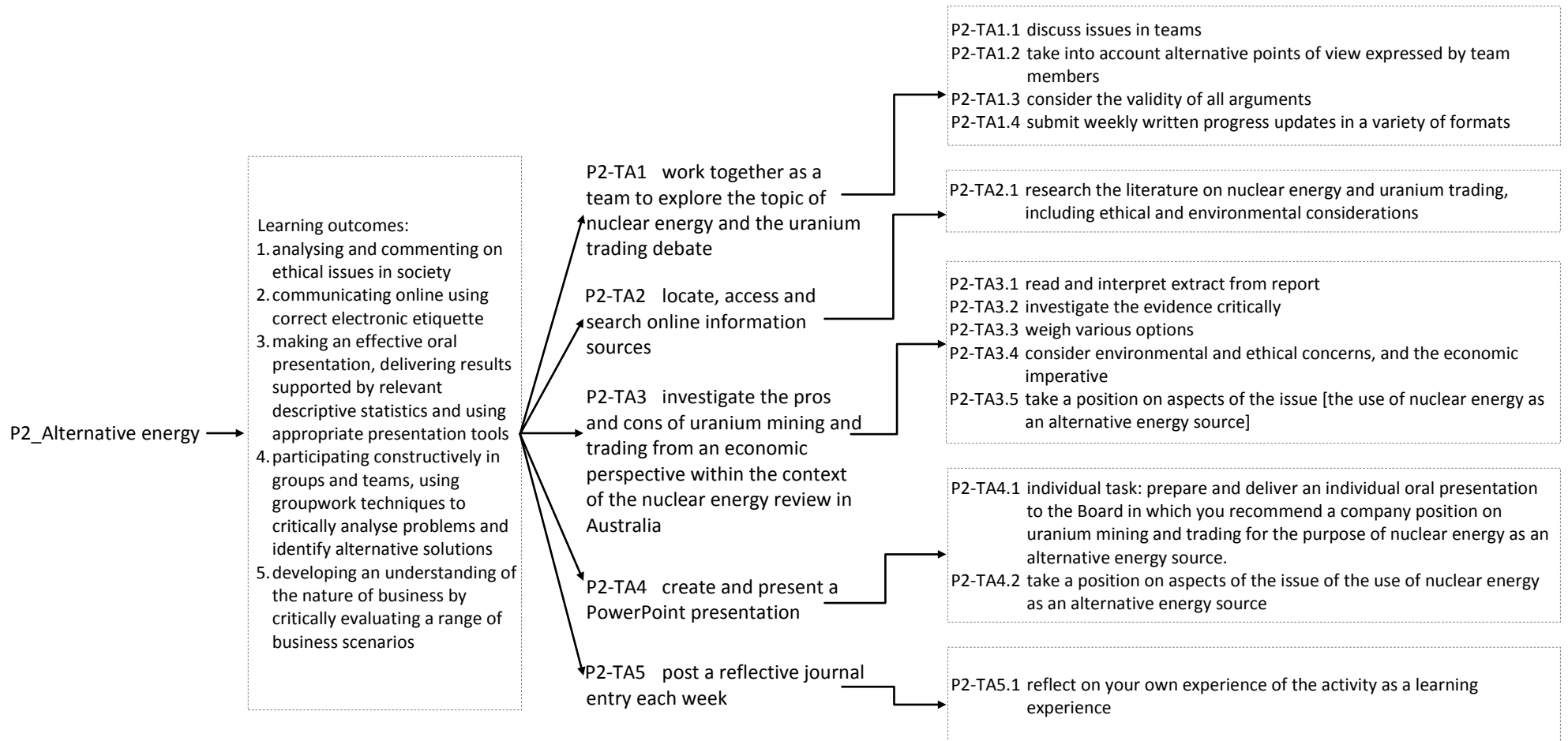
Note that you will also be working on your reflective journals [\[P4-TA5\]](#) and proficiency tests during this time.

Appendix 4.3: Projects deconstruction: Tasks

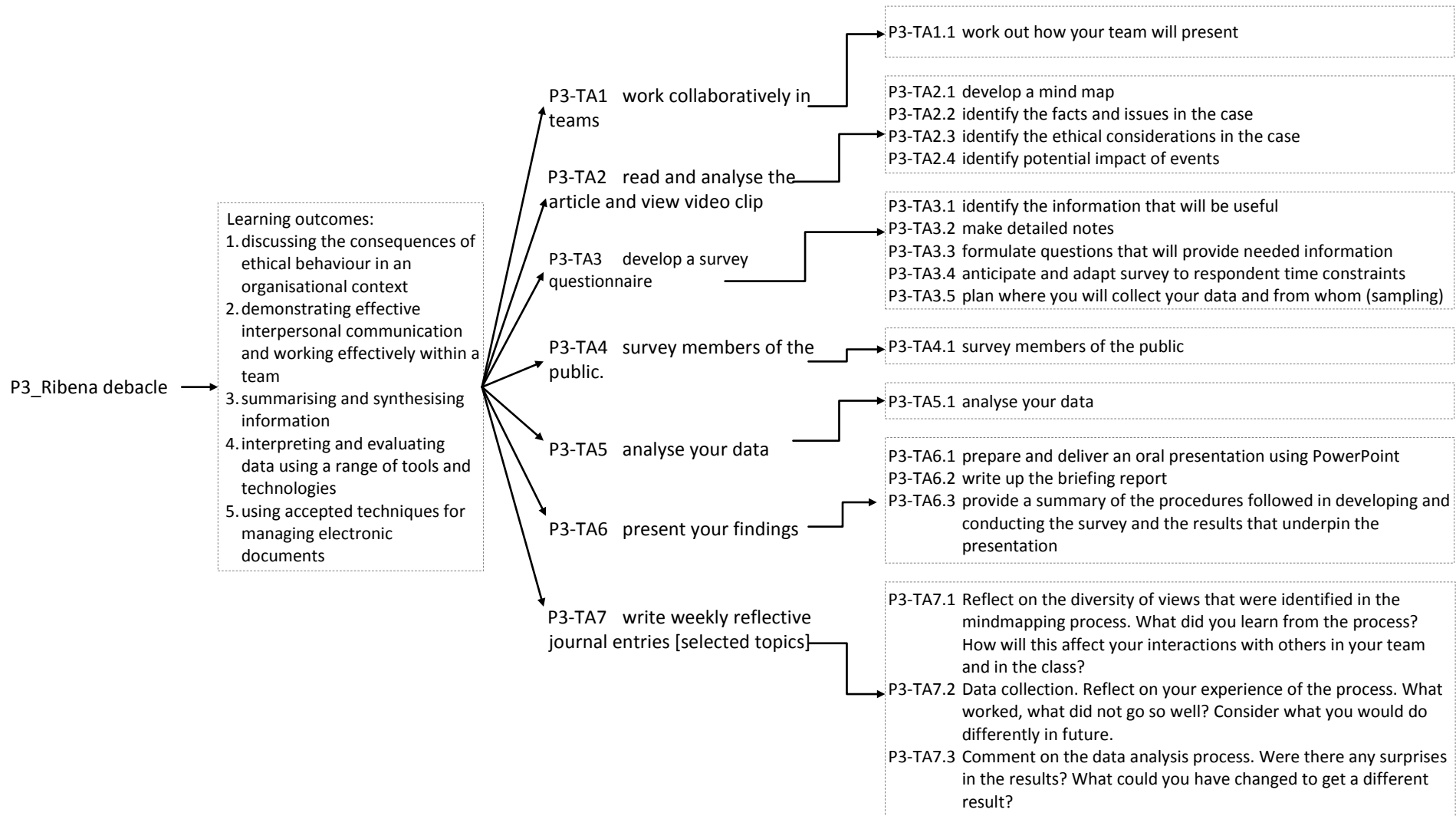
Project 1: New drivers



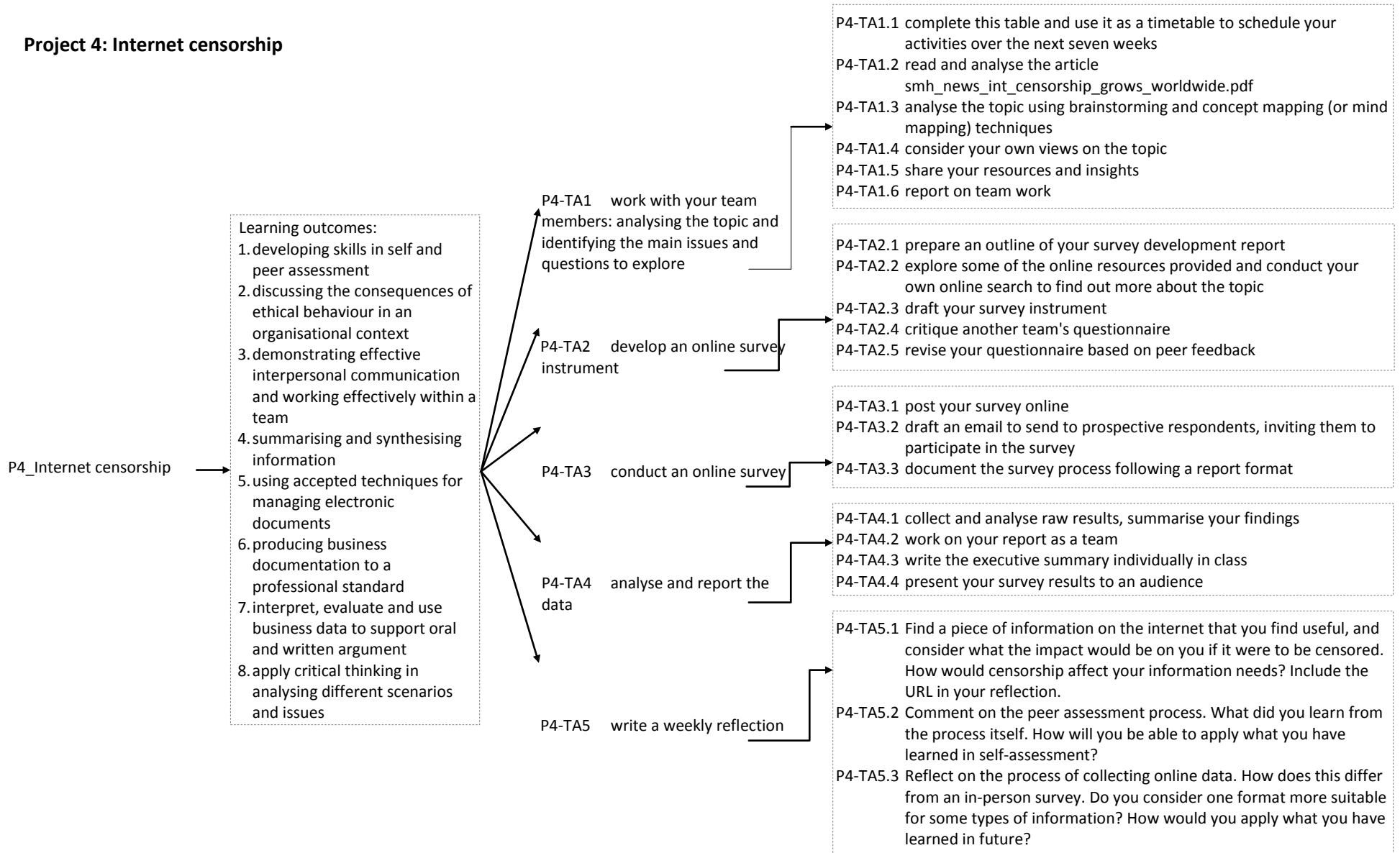
Project 2: Alternative energy



Project 3: Ribena



Project 4: Internet censorship



Appendix 4.4: Project tasks and CT analysis

Project 1: New drivers

Project 1	Project task	Consensus statement example		Subskill	CT Component
P1-TA1.1	[in working together as a team] contribute your own views	CTC5.1.1 CTC1.3.2	* explain what they think and how they arrived at that judgment * to find an example which helps explain something to someone	stating results clarifying meanings	interpretation analysis
P1-TA1.2	take into account alternative points of view	CTC2.1.1 CTC4.1.5 CTC6.1.8	* identifying the similarities and differences between two approaches to the solution of a given problem * when faced with a problem, developing a set of options for addressing it * to check yourself when listening to a speaker in order to be sure you are understanding what the person is really saying without introducing your own ideas	examining ideas querying evidence self-examination	analysis inference self-regulation
P1-TA1.3	work towards consensus team opinion	CTC1.3.1 CTC6.1.3 CTC6.1.5 CTC6.1.1 CTC6.2.3	* to restate what a person said using different words or expressions while preserving that person's intended meanings * to monitor and correct an interpretation you offered * to review and reformulate one of your own explanations * to apply their powers of critical thinking to themselves and improve on their previous opinions * to change your conclusion in view of the realization that you had misjudged the importance of certain factors when coming to your earlier decision	clarifying meanings self-examination self-examination self-examination self-correction	interpretation self-regulation self-regulation self-regulation self-regulation
P1-TA1.4	arrive at a position that the team can justify and present to the class in a convincing manner	CTC1.1.5 CTC4.2.1 CTC6.1.7	* paraphrasing someone's ideas in your own words * given a problem with technical, ethical or budgetary ramifications, to develop a set of options for addressing and resolving that problem	categorisation conjecturing alternatives self-examination	Interpretation inference self-regulation

Project 1	Project task		Consensus statement example	Subskill	CT Component
			* to examine your views on a controversial issue with sensitivity to the possible influences of your personal biases or self-interest		
P1-TA2.1	search an online database, identify variables and export data	CTC1.1.10 CTC1.1.4 CTC1.2.4	* to classify data, findings or opinions using a given classification schema * constructing a tentative categorisation or way of organizing something you are studying * to interpret the data displayed or presented using a particular form of instrumentation	categorisation categorisation decoding significance	interpretation interpretation interpretation
P1-TA2.2	conduct information searches targeting specific countries	CTC1.1.8	* to determine a useful way of sorting and sub-classifying information	categorisation	interpretation
P1-TA2.3	include one new piece of information that your team has found during the week	CTC1.3.2	* to find an example which helps explain something to someone	clarifying meaning	interpretation
P1-TA3.1	analyse the newspaper report	CTC2.2.1 CTC2.1.2	* given a passage from a newspaper editorial, determine if the author of that passage intended it as an expression of reasons for or against a given claim or opinion * picking out the main claim made in a newspaper editorial and tracing back the various reasons the editor offers in support of that claim	examining ideas	analysis
P1-TA3.2	identify the real issues at stake [What is the real problem? What has been done about it? Are there other things that can be done?]	CTC2.1.5 CTC2.1.3 CTC2.1.7 CTC2.2.2	* sketching the relationship of sentences or paragraphs to each other and to the main purpose of the passage * identifying unstated assumptions * to identify a phrase intended to trigger a sympathetic emotional response which might induce an audience to agree with an opinion * given a passage from a newspaper editorial, determine if the author of that passage intended it as an expression of reasons for or against a given claim or opinion	examining ideas examining ideas examining ideas identifying arguments	analysis
P1-TA3.3	Create a "picture" (mind map or	CTC2.3.2	* given several reasons or chains of reasons in support of	analysing arguments	analysis

Project 1	Project task	Consensus statement example		Subskill	CT Component
	flowchart) of the facts in the situation		a particular claim, to develop a graphic representation which usefully characterizes the inferential flow of that reasoning		
P1-TA3.4	investigate the evidence critically	CTC3.1.4	* judging if two statements contradict each other	assessing claims	evaluation
P1-TA3.5	weigh the various options and consider the validity of all arguments	CTC3.1.2 CTC3.1.5 CTC3.1.8 CTC3.1.12 CTC3.2.1	* comparing the strengths and weaknesses of alternative interpretations * judging if the evidence at hand supports the conclusion being drawn * judging the logical strength of arguments based on hypothetical situations * to determine if a given claim is likely to be true or false based on what one knows or can reasonably find out * given an argument to judge if its conclusion follows either with certainty or with a high level of confidence from its premises	assessing claims assessing arguments	evaluation
P1-TA3.6	identify and evaluate some of the proposed solutions in Australia	CTC4.2.2	* given a set of priorities with which one may or may not agree, to project the difficulties and the benefits which are likely to result if those priorities are adopted in decision making	conjecturing alternatives	inference
P1-TA4.1	create a PowerPoint presentation	CTC5.1.8	* to cite the evidence that led you to accept or reject an author's position on an issue	stating results	explanation
P4-TA4.2	write the executive summary individually in class	CTC1.3.1 CTC4.1.3	* to restate what a person said using different words or expressions while preserving that person's intended meanings * formulating a synthesis of related ideas into a coherent perspective	clarifying meaning querying evidence	interpretation inference
P1-TA4.3	use Word and Excel to present data in graphs and diagrams	CTC5.1.7	* to design a graphic display which accurately represents the subordinate and super-ordinate relationship among concepts or ideas	stating results	explanation
P1-TA4.4	write an individual report making	CTC4.3.2	* given a controversial issue to examine informed	drawing conclusions	inference

Project 1	Project task		Consensus statement example	Subskill	CT Component
	recommendations	CTC5.3.3	opinions, consider various opposing views and the reasons advanced for them, gather relevant information, and formulate one's own considered opinion regarding that issue * to write a paper in which one argues for a given position or policy	presenting arguments	explanation
P1-TA5.1	Reflect on the contributions that you anticipate from the members of your team. Do they have specific strengths and weaknesses?	CTC6.1.9	* to monitor how well you seem to be understanding or comprehending what you are reading or experiencing	self-examination	self-regulation
P1-TA5.2	Reflect on the team-building process. Are there specific dynamics that you think will hamper or facilitate a good outcome in the project?	CTC6.1.9	* to monitor how well you seem to be understanding or comprehending what you are reading or experiencing	self-examination	self-regulation

Project 2: Alternative energy

Project 2	Project task		Consensus statement example	Subskill	CT Component
P2-TA1.1	discuss issues in teams	CTC1.1.2 CTC1.2.2 CTC1.1.5 CTC1.2.1	* reading a person's intentions in the expression on her face * to appreciate the significance of a particular facial expression or gesture used in a given social situation * paraphrasing someone's ideas in your own words * to detect and describe a person's purposes in asking a given question	categorisation decoding significance categorisation decoding significance	interpretation interpretation interpretation interpretation
P2-TA1.2	take into account alternative points of view expressed by team members	CTC1.3.1 CTC5.3.4	* to restate what a person said using different words or expressions while preserving that person's intended meanings * to anticipate and to respond to reasonable criticisms	clarifying meaning presenting arguments	interpretation explanation

Project 2	Project task		Consensus statement example	Subskill	CT Component
			one might expect to be raised against one's political views		
P2-TA1.3	consider the validity of all arguments	CTC2.1.3 CTC2.1.8	* identifying unstated assumptions * to examine closely related proposals regarding a given problem and to determine their points of similarity and divergence	examining ideas	analysis
P2-TA1.4	submit weekly written progress updates in a variety of formats	CTC5.2.1	* to keep a log of the steps followed in working through a long or difficult problem or scientific procedure	justifying procedures	explanation
P2-TA2.1	locate, access and search online information sources	CTC4.1.8 CTC3.1.3	* after judging that certain missing information would be germane in determining if a given opinion is more or less reasonable than a competing opinion, to plan a search which will reveal if that information is available * determining the credibility of a source of information	querying evidence assessing claims	inference evaluation
P2-TA3.1	read and interpret extract from report	CTC2.2.1 CTC4.1.1 CTC2.3.1	* given a paragraph, determine whether a standard reading of that paragraph, in the context of how and where it is published, would suggest that it presents a claim as well as a reason or reasons in support of that claim * seeing the implications of the position someone is advocating, or drawing out or constructing meaning from the elements in a reading * given a brief argument, paragraph-sized argument, or a position paper on a controversial social issue, to identify the author's chief claim, the reasons and premises the author advances on behalf of that claim, the background information used to support those reasons or premises, and crucial assumptions implicit in the author's reasoning	identifying arguments querying evidence analysing arguments	analysis inference analysis
P2-TA3.2	investigate the evidence critically	CTC2.1.7 CTC6.1.10 CTC3.2.6	* to identify a phrase intended to trigger a sympathetic emotional response which might induce an audience to agree with an opinion * to remind yourself to separate your personal opinions	examining ideas self-examination assessing arguments	analysis self-regulation evaluation

Project 2	Project task		Consensus statement example	Subskill	CT Component
			and assumptions from those of the author of a passage or text * to judge if a given argument is relevant or applicable or has implications for the situation at hand		
P2-TA3.3	weigh various options	CTC3.1.8 CTC3.2.1	* judging the logical strength of arguments based on hypothetical situations * given an argument to judge if its conclusion follows either with certainty or with a high level of confidence from its premises	assessing claims assessing arguments	evaluation evaluation
P2-TA3.4	consider environmental and ethical concerns, and the economic imperative	CTC3.1.9 CTC3.2.3 CTC4.1.2 CTC4.2.1 CTC4.3.2	* judging if a given argument is relevant or applicable or has implications for the situation at hand * given an objection to an argument , to evaluate the logical force of that objection * predicting what will happen next based what is known about the forces at work in a given situation * given a problem with technical, ethical or budgetary ramifications, to develop a set of options for addressing and resolving that problem * given a controversial issue to examine informed opinions, consider various opposing views and the reasons advanced for them, gather relevant information, and formulate one's own considered opinion regarding that issue	assessing claims assessing arguments querying evidence conjecturing alternatives drawing conclusions	evaluation evaluation inference inference inference
P2-TA3.5	take a position on aspects of the issue of the use of nuclear energy as an alternative energy source	CTC3.1.11 CTC3.2.5 CTC5.3.3	* to determine if a given principle of conduct is applicable to deciding what to do in a given situation * to judge the logical strength of arguments based on hypothetical situations or causal reasoning * to write a paper in which one argues for a given position or policy	assessing claims assessing arguments presenting arguments	evaluation evaluation inference
P2-TA4.1	use PowerPoint to create a	CTC5.1.1	* explain what they think and how they arrived at that	stating results	explanation

Project 2	Project task	Consensus statement example		Subskill	CT Component
	presentation	CTC5.1.2	judgment	stating results	explanation
P2-TA4.2	recommend a company position on uranium mining and trading for the purpose of nuclear energy as an alternative energy source	CTC5.3.1	* to construct a chart which organises one's findings * to report the strategy used in attempting to make a decision in a reasonable way	presenting arguments	explanation
P2-TA5.1	reflect on your own experience of the activity as a learning experience	CTC6.1.5 CTC6.1.7	* to review and reformulate one of your own explanations * to examine your views on a controversial issue with sensitivity to the possible influences of your personal biases or self-interest	self-examination	self-regulation

Project 3: Ribena

Project 3	Project task	Consensus statement example		Subskill	CT Component
P3-TA1.1	decide team roles and contributions, coordinate data collection, work out how your team will present	CTC1.2.2 CTC2.1.9	* to appreciate the significance of a particular facial expression or gesture used in a given social situation * given a complicated assignment, to determine how it might be broken up into smaller, more manageable tasks	decoding significance examining ideas	interpretation analysis
P3-TA2.1	develop a mind map	CTC1.1.4 CTC5.1.7	* constructing a tentative categorisation or way of organizing something you are studying * to design a graphic display which accurately represents the subordinate and super-ordinate relationship among concepts or ideas	categorisation stating results	interpretation explanation
P3-TA2.2	identify the facts and issues in the case	CTC1.1.1 CTC1.1.3 CTC1.1.6 CTC1.2.4	* recognising a problem and describing it without bias * distinguishing a main idea from subordinate ideas in a text * clarifying what a sign, chart or graph means	categorisation categorisation categorisation decoding significance	interpretation interpretation interpretation interpretation

Project 3	Project task	Consensus statement example		Subskill	CT Component
		CTC2.2.3	* to interpret the data displayed or presented using a particular form of instrumentation * given a commercial announcement, identify any claims being advanced along with the reasons presented in their support	identifying arguments	analysis
P3-TA2.3	identify the ethical considerations in the case	CTC2.1.10 CTC1.3.3 CTC3.1.1 CTC3.1.6 CTC3.1.11	* to define an abstract concept * to develop a distinction which makes clear a conceptual difference or removes a troublesome ambiguity * judging an author's or speaker's credibility * recognising the factors which make a person a credible witness regarding a given event or a credible authority with regard to a given topic * to determine if a given principle of conduct is applicable to deciding what to do in a given situation	examining ideas clarifying meanings assessing claims assessing claims assessing claims	analysis interpretation evaluation evaluation evaluation
P3-TA2.4	identify potential impact of events	CTC3.1.7 CTC3.2.6	* judging if an argument's conclusion follows either with certainty or with a high level of confidence from its premises * to judge if a given argument is relevant or applicable or has implications for the situation at hand	assessing claims assessing arguments	evaluation evaluation
P3-TA3.1	identify the information that will be useful	CTC4.1.7	* when attempting to develop a persuasive argument in support of one's opinion, to judge what background information it would be useful to have and to develop a plan which will yield a clear answer as to whether or not such information is available	conjecturing alternatives	inference
P3-TA3.2	make detailed notes	CTC5.1.3	* to write down for future reference your current thinking on some important and complex matter	stating results	explanation
P3-TA3.3	formulate questions that will provide needed information	CTC4.1.4 CTC4.2.2	* after judging that it would be useful to you to resolve a given uncertainty, developing a workable plan to gather that information * when attempting to develop a persuasive argument in	querying evidence conjecturing alternatives	inference inference

Project 3	Project task		Consensus statement example	Subskill	CT Component
			support of one's opinion, to judge what background information it would be useful to have and to develop a plan which will yield a clear answer as to whether or not such information is available		
P3-TA3.4	anticipate and adapt survey to respondent time constraints	CTC4.1.7	* given a set of priorities with which one may or may not agree, to project the difficulties and the benefits which are likely to result if those priorities are adopted in decision making	querying evidence conjecturing alternatives	inference inference
P3-TA3.5	plan where you will collect your data and from whom (sampling)	CTC4.1.4	* after judging that it would be useful to you to resolve a given uncertainty, developing a workable plan to gather that information	querying evidence	inference
P3-TA4.1	survey members of the public	CTC4.1.8	* after judging that certain missing information would be germane in determining if a given opinion is more or less reasonable than a competing opinion, to plan a search which will reveal if that information is available	querying evidence	inference
P3-TA5.1	analyse your data	CTC1.1.10	* to classify data, findings or opinions using a given classification schema	categorisation	interpretation
P3-TA6.1	prepare and deliver an oral presentation using PowerPoint	CTC5.1.5 CTC5.3.2	* to state research results and describe the methods and criteria used to achieve those results * to design a graphic display which represents the quantitative or spatial information used as evidence	stating results presenting arguments	explanation explanation
P3-TA6.2	write up the briefing report	CTC4.3.2 CTC5.3.2	* given a controversial issue to examine informed opinions, consider various opposing views and the reasons advanced for them, gather relevant information, and formulate one's own considered opinion regarding that issue * to design a graphic display which represents the quantitative or spatial information used as evidence	drawing conclusions presenting arguments	inference explanation
P3-TA6.3	provide a summary of the procedures followed in developing	CTC5.2.2	* to explain one's choice of a particular statistical test for purposes of data analysis	justifying procedures	explanation

Project 3	Project task	Consensus statement example		Subskill	CT Component
	and conducting the survey and the results that underpin the presentation				
P3-TA7.1	Reflect on the diversity of views that were identified in the mindmapping process. What did you learn from the process? How will this affect your interactions with others in your team and in the class?	CTC6.1.1 CTC6.1.8	* to apply their powers of critical thinking to themselves and improve on their previous opinions * to check yourself when listening to a speaker in order to be sure you are understanding what the person is really saying without introducing your own ideas	self-examination self-examination	self-regulation self-regulation
P3-TA7.2	Data collection. Reflect on your experience of the process. What worked, what did not go so well? Consider what you would do differently in future.	CTC4.2.1 CTC6.2.4 CTC6.2.1	* given a problem with technical, ethical or budgetary ramifications, to develop a set of options for addressing and resolving that problem * given a methodological mistake or factual deficiency in one's work, to revise that work so as to correct the problem and then to determine if the revisions warrant changes in any position, findings, or opinions based thereon * to reconsider your interpretation or judgment in view of further analysis of the facts of the case	conjecturing alternatives self-correction self-correction	inference self-regulation self-regulation
P3-TA7.3	Comment on the data analysis process. Were there any surprises in the results? What could you have changed to get a different result?	CTC5.1.6 CTC6.1.3 CTC6.1.4 CTC6.1.14	* to appeal to established criteria as a way of showing the reasonableness of a given judgment * to monitor and correct an interpretation you offered to review one's methodology or calculations with a view to detecting mistaken applications or inadvertent errors	stating results self-examination self-examination self-examination	explanation self-regulation self-regulation self-regulation

Project 4: Internet censorship

Project 4	Project task		Consensus statement example	Subskill	CT Component
P4-TA1.1	schedule your activities over the next seven weeks	CTC1.1.4 CTC2.1.9 CTC6.1.15	* constructing a tentative categorisation or way of organizing something you are studying * given a complicated assignment, to determine how it might be broken up into smaller, more manageable tasks * to reread sources to assure that one has not overlooked important information	categorisation examining ideas self-examination	interpretation analysis self-regulation
P4-TA1.2	read and analyse the article smh.news.int.censorship.grows.worldwide.pdf	CTC3.1.3 CTC2.1.3 CTC3.1.5 CTC6.1.12	* determining the credibility of a source of information * identifying unstated assumptions * judging if the evidence at hand supports the conclusion being drawn * to vary your reading speed and method mindful of the type of material and your purpose for reading	assessing claims examining ideas assessing claims self-examination	evaluation analysis evaluation self-regulation
P4-TA1.3	analyse the topic using brainstorming and concept mapping (or mind mapping) techniques	CTC2.3.2 CTC3.1.2	* given several reasons or chains of reasons in support of a particular claim, to develop a graphic representation which usefully characterizes the inferential flow of that reasoning * comparing the strengths and weaknesses of alternative interpretations	analysing arguments assessing claims	analysis evaluation
P4-TA1.4	consider your own views on the topic and those of others	CTC3.1.12 CTC4.1.1 CTC4.3.2	* to determine if a given claim is likely to be true or false based on what one knows or can reasonably find out * seeing the implications of the position someone is advocating, or drawing out or constructing meaning from the elements in a reading * given a controversial issue to examine informed opinions, consider various opposing views and the reasons advanced for them, gather relevant information, and formulate one's own considered opinion regarding that issue	assessing claims querying claims drawing conclusions	evaluation inference inference
P4-TA1.5	share your resources and insights in an online forum	CTC5.2.4 CTC2.1.1	* to explain how one understands a key concept when conceptual clarity is crucial for further progress on a given	justifying procedures examining ideas	explanation analysis

Project 4	Project task	Consensus statement example		Subskill	CT Component
		CTC5.3.5	problem * identifying the similarities and differences between two approaches to the solution of a given problem * to identify and express evidence and counter-evidence intended as a dialectical contribution to one's own or another person's thinking on a matter of deep personal concern	presenting arguments	evaluation
P4-TA1.6	report on team work	CTC4.2.2	* given a set of priorities with which one may or may not agree, to project the difficulties and the benefits which are likely to result if those priorities are adopted in decision making	conjecturing alternatives	inference
P4-TA2.1	prepare an outline of your survey development report	CTC5.2.1	* to keep a log of the steps followed in working through a long or difficult problem or scientific procedure	justifying procedures	explanation
P4-TA2.2	explore some of the online resources provided and conduct your own online search to find out more about the topic	CTC4.1.7 CTC4.1.4	* when attempting to develop a persuasive argument in support of one's opinion, to judge what background information it would be useful to have and to develop a plan which will yield a clear answer as to whether or not such information is available * after judging that it would be useful to you to resolve a given uncertainty, developing a workable plan to gather that information	querying evidence querying evidence	inference inference
P4-TA2.3	draft your survey instrument	CTC4.1.4 CTC4.1.8	* after judging that it would be useful to you to resolve a given uncertainty, developing a workable plan to gather that information * after judging that certain missing information would be germane in determining if a given opinion is more or less reasonable than a competing opinion, to plan a search which will reveal if that information is available	querying evidence querying evidence	inference inference
P4-TA2.4	critique another team's questionnaire	CTC4.1.2 CTC5.1.4	* predicting what will happen next based what is known about the forces at work in a given situation	querying evidence stating results	inference explanation

Project 4	Project task	Consensus statement example		Subskill	CT Component
		CTC5.1.6	* to cite the standards and contextual factors used to judge the quality of an interpretation of a text * to appeal to established criteria as a way of showing the reasonableness of a given judgment	stating results	explanation
P4-TA2.5	revise your questionnaire based on peer feedback	CTC6.1.14 CTC6.2.4	* to review one's methodology or calculations with a view to detecting mistaken applications or inadvertent errors * given a methodological mistake or factual deficiency in one's work, to revise that work so as to correct the problem and then to determine if the revisions warrant changes in any position, findings, or opinions based thereon	self-examination self-correction	self-regulation self-regulation
P4-TA3.1	post your survey online	CTC4.1.4	* after judging that it would be useful to you to resolve a given uncertainty, developing a workable plan to gather that information	querying evidence	inference
P4-TA3.2	consider your target population (invite respondents)	CTC4.1.4	* after judging that it would be useful to you to resolve a given uncertainty, developing a workable plan to gather that information	querying evidence	inference
P4-TA3.3	document the survey process following a report format	CTC5.2.1	* to keep a log of the steps followed in working through a long or difficult problem or scientific procedure	justifying procedures	explanation
P4-TA4.1	collect and analyse raw results, analyse the results and summarise your findings	CTC4.3.1 CTC5.1.5	* to carry out experiments and to apply appropriate statistical inference techniques in order to confirm or disconfirm an empirical hypothesis * to state research results and describe the methods and criteria used to achieve those results	drawing conclusions drawing conclusions stating results	inference inference explanation
P4-TA4.2	write the executive summary individually in class	CTC4.1.3	* formulating a synthesis of related ideas into a coherent perspective	querying evidence	inference
P4-TA4.3	present your survey results to an audience	CTC5.1.2 CTC2.1.4 CTC5.3.2 CTC5.2.2	* to construct a chart which organises one's findings * constructing a way to represent a main conclusion and the various reasons given to support or criticize it * to design a graphic display which represents the	stating results examining ideas presenting arguments justifying procedures	explanation analysis explanation explanation

Project 4	Project task		Consensus statement example	Subskill	CT Component
			quantitative or spatial information used as evidence * to explain one's choice of a particular statistical test for purposes of data analysis		
P4-TA5.1	Find a piece of information on the internet that you find useful, and consider what the impact would be on you if it were to be censored. How would censorship affect your information needs? Include the URL in your reflection.	CTC6.1.13	* to examine one's views on a controversial issue with sensitivity to the possible influences of one's personal bias or self-interest	self-examination	self-regulation
P4-TA5.2	Comment on the peer assessment process. What did you learn from the process itself. How will you be able to apply what you have learned in self-assessment?	CTC6.1.6	* to examine and correct your ability to examine and correct yourself	self-examination	self-regulation
P4-TA5.3	Reflect on the process of collecting online data. How does this differ from an in-person survey. Do you consider one format more suitable for some types of information? How would you apply what you have learned in future?	CTC5.3.1 CTC6.1.17	* to report the strategy used in attempting to make a decision in a reasonable way * to identify and review one's reasons and reasoning processes in coming to a given conclusion	presenting arguments self-examination	explanation self-regulation

Appendix 4.6: Visual inspection of distributional aspects of data

1. Meeting the assumptions

The main considerations for selecting an effect size measure appropriate to the data in the study were set out in section 3.3.4.2(c), and include the nature of the research design, whether assumptions of normality and equality of variance (homoscedasticity) are satisfied, and the approaches adopted in similar studies in the field of critical thinking instruction. Section 2.5.2 reviewed three studies using standardised critical thinking skills tests (the critical thinking module of the *Collegiate Assessment of Academic Proficiency* (CAAP) in Hagedorn et al, 1999; the CCTST and the Watson-Glaser Critical Thinking Appraisal – Form 3 in Williams and Stockdale, 2003; and the *Ennis-Weir Critical Thinking Essay Test* (E-W) and CCTST in Hatcher, 2006), and four studies using other measures. The Hatcher (2006) study was the only one that specifically reported effect sizes (standardised mean differences), and reported using the same standardiser (SD=4.52) as in the CCTST validation study. None of the studies reported detail on the nature of the data in terms of assumptions. This analysis will consider the nature of the data in determining the appropriate standardiser as set out in figure 3.10 (Procedures for analysis).

Sections (a) to (d) below examines graphic representations of the data to confirm or elucidate the statistics provided in section 4.5.3.1 and 4.5.3.2. The assumption that the data are independent is relevant when comparing independent groups, but in this case testtaker performance does not depend of the performance of any other testtakers, and so is not relevant to this analysis.

Statistics appearing in the summary tables in Part 2C of the case study (sections 4.5.3.1 & 4.5.3.2) will be referred to as relevant, and the main focus will be on graphical analyses by way of histograms, boxplots and stem-and-leaf plots. Of interest in data representations in the histograms and stem-and-leaf plots are the general location, spread and shape of the test results for each of the data groupings. The boxplots provide a further indication of overall data distribution.

Applying graphical analysis of assumptions to identify threats to data integrity is recommended by Wilkinson and the Task Force, for the simple reason that “graphics broadcast; statistics narrowcast”. They note that summary statistics are often too sensitive to be practical, and that skewness and kurtosis statistics frequently do not detect distributional irregularities (Wilkinson & TFSI, 1999, p. 599).

(a) Distributional aspects of contrast 1 data

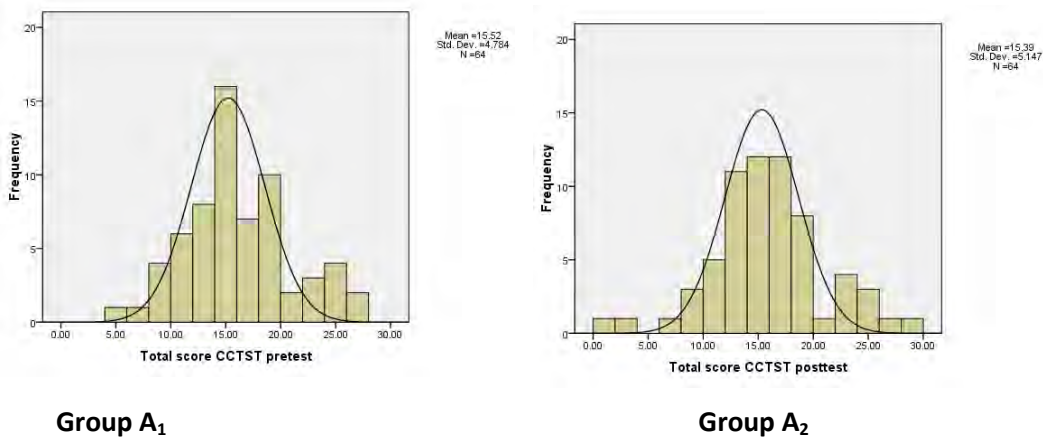


Figure 1(a): Contrast 1 histograms

The histogram of pretest scores confirms the statistics reported in section 4.5.3, showing additionally that the right tail is fatter (rather than longer). The high peak at the mode and median score of 15 explains the minor negative kurtosis in that the concentration of scores at the midpoint will reduce clustering at other points.

The distribution for group A₂ shows that scores are clustered between the mean (M=15) and the mode score of 17, confirming the positive kurtosis value of .721. The histogram also shows that the very minor negative skewness value (-.008) is caused by scores <5, which may be anomalous.

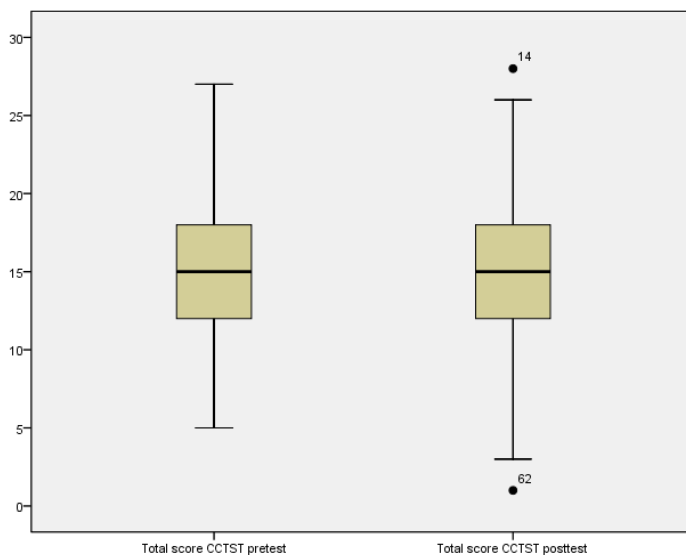
The difference in spread with variance values of 22.9 for group A₁ and 26.5 for group A₂ is also clearly visible.

Group A ₁ pretest	Group A ₂ posttest
Total score CCTST pretest Stem-and-Leaf Plot Frequency Stem & Leaf	Total score CCTST posttest Stem-and-Leaf Plot Frequency Stem & Leaf
.00 0 .	1.00 Extremes (= <1)
6.00 0 . 578999	1.00 0 . 3
21.00 1 . 000011222222334444444	4.00 0 . 7889
26.00 1 . 5555555556666667888888999	22.00 1 . 0001122222233333444444
8.00 2 . 01222444	26.00 1 .
3.00 2 . 567	55555566667777777788888999
	6.00 2 . 022334
	3.00 2 . 556
	1.00 Extremes (>=28)
Stem width: 10.00	
Each leaf: 1 case(s)	

Figure 1(b): Group A₁ stem-and-leaf

The stem-and-leaf plot for group A_1 shows that there are no scores <5 and only six scores <10 (in other words, fewer than 10% of testtakers scored below 10/34 in the pretest). The stem-and-leaf plot for group A_2 similarly shows only six scores <10 , but also indicates one score at 1/34 and one at 3/34. It is notable that for both pretest and posttest, 26 of the 64 testtakers (40.6%) recorded scores of between 15 and 19, and that one more testtaker recorded a score >19 in the pretest than in the posttest group, while one more testtaker recorded a score <10 in the posttest group.

The graphic displays therefore provide some additional insight into the small decline in the mean scores from pretest to posttest ($\delta = M_1 - M_2 = 15.52 - 15.39 = 0.13$). The analysis shows that in the group of 64 testtakers, six scores (9.4%) in the posttest fell below the lowest score recorded in the pretest.



The boxplots of pretest and posttest scores for group A_1 - A_2 show the equal midspreads and equal medians. The longer lower whisker on the posttest boxplot represents a greater spread of scores in the first quartile than for the pretest scores, with one outlier (respondent 62). At the upper extreme there is also one outlier (respondent 14), although

the score is not significantly above the maximum pretest score.

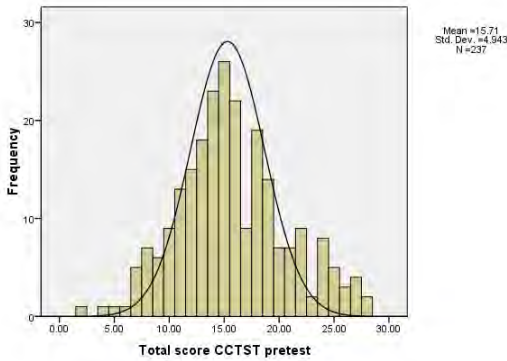
Figure 1(c): Group A_1 - A_2 boxplots

The above analysis and examination of the location, spread and shape of the data for groups A_1 and A_2 show that inequality in variance between the two groups is caused by a small number of cases and is not sufficiently large to impact selection of an effect size measure.

(b) Distributional aspects of contrast 2 data

This section examines the distributional aspects of contrast 2 data. The standardised mean difference for contrast 2 is reported in section 4.5.4.

Group A₁D pretest



Group A₂C posttest

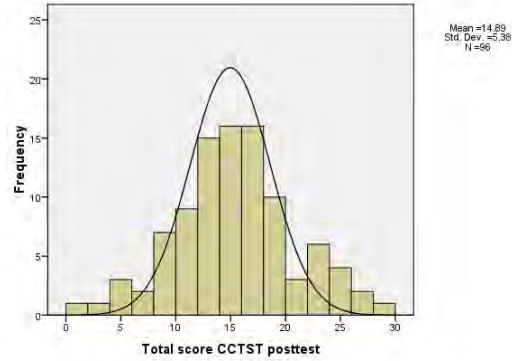


Figure2(a): Contrast 2 histograms

Both distributions appear relatively normal, with slightly fatter right tails. The distribution for group A₁D shows a secondary peak between the midpoint and 75th percentile, and the stem-and-leaf plot in figure 2(b) below identifies the peak at a score of 18. The histogram reflects the low skewness (= .271; SE = .158) and kurtosis (= -.048, SE= .315) values for group A₁D. The histogram for group A₂C shows a flatter spread around the midpoint with no single peak and reflects the low skewness (= .018; SE= .246) and kurtosis (= .090; SE= .488) values.

Group A₁D pretest

Frequency Stem & Leaf

1.00 Extremes (= <2)

```
.00 0 .
2.00 0 . 45
6.00 0 . 677777
13.00 0 . 8888888999999
22.00 1 . 00000000111111111111
33.00 1 . 22222222222222333333333333333333
49.00 1 . 4444444444444444444444444455555555555555555555555
31.00 1 . 6666666666666666666666667777777777
33.00 1 . 88888888888888888888888899999999999999999999999999
14.00 2 . 00000011111111
11.00 2 . 2222222233
13.00 2 . 44444444555555
7.00 2 . 6667777
2.00 2 . 88
```

Stem width: 10
Each leaf: 1 case(s)

Group A₂C posttest

Frequency Stem & Leaf

```

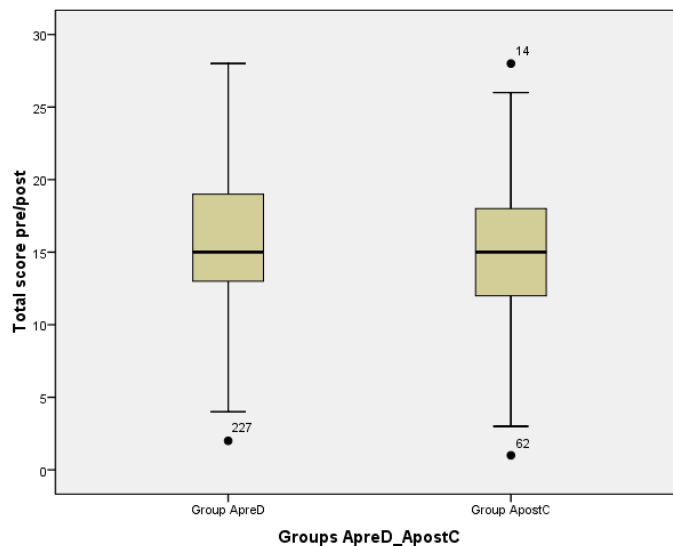
1.00 Extremes  (= <1)
3.00  0 . 344
10.00  0 . 5678889999
32.00  1 . 0001111112222222233333344444444
34.00  1 . 55555556666677777777778888899999
11.00  2 . 00022223344
4.00  2 . 5566
1.00 Extremes  (>=28)
    
```

Stem width: 10
Each leaf: 1 case(s)

Figure 2(b): Stem-and-leaf plots: contrast 2

The stem-and-leaf plot for group A₁D shows the majority of scores at 14 and 15, with a second longer leaf at scores of 18 and 19 (median = 15; mode = 15). One extreme score is identified at the lower extreme (≤ 2). For group A₂C the majority of scores lie between 15 and 19 (median = 15, mode 17), with one score at the lower extreme (≤ 1) and one at the upper extreme (≥ 28). Examination of specific frequencies for scores would not be appropriate, as the two groups are not equal in size.

The boxplots for the two groups in contrast 3 show a greater number of scores within the third quartile of the midspread for group A₁D and identifies one outlier below the minimum score.



As in contrast 1, the extreme low and high scores appear in group A₂C. The outlying score at the high end (respondent 14) is equal to the maximum pretest score of 28, so still falls within the range of pretest scores, but is atypical for the posttest scores in group A₂C, and was also identified as outlier in contrast 1.

Figure 2(c): Boxplots contrast 2

The distributions for the two groups in contrast 2 therefore meet the assumption of normality and equality of variance.

(c) Distributional aspects of contrast 3 data

The histogram for group A₂ is repeated below for purposes of visual comparison.

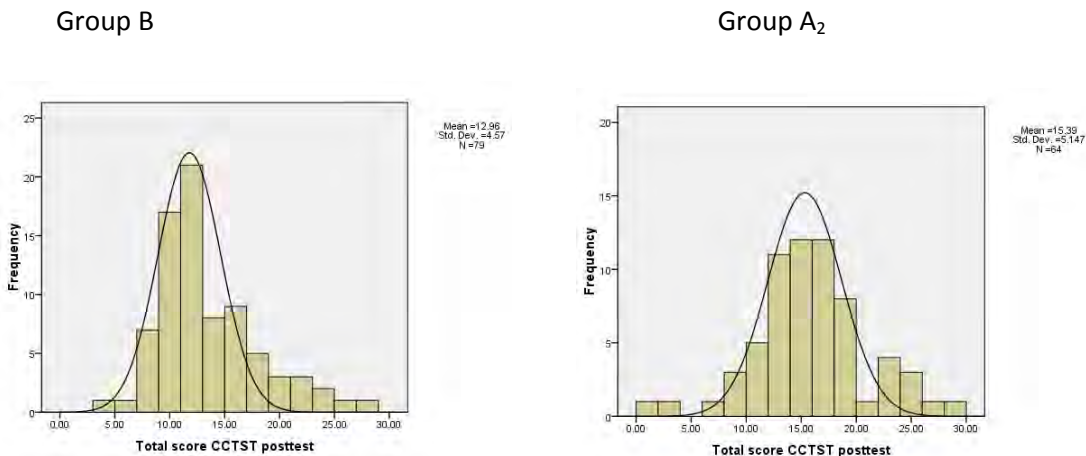


Figure 3(a): Group B histogram

In contrast to the posttest Group A₂, data in the Group B posttest results show less variance ($s=20.883$ compared with 26.496 for group A₂). The higher kurtosis value (.728) and the skewness (.899) are visible in the long right tail of the histogram for group B.

The stem-and-leaf plot below shows that the distribution is clustered around scores between 10 and 14, while the largest cluster, $n=26$, for group A₂ is on scores between 15 and 19. The lowest score in group B is 4, compared with a low score of 1 in group A₂. Extreme values (representing single scores at or above a particular value) at the upper end in the group B distribution lie ≥ 23 , whereas upper extreme values for group A₂ ≥ 28 (figure 1(b)).

Total score CCTST posttest Stem-and-Leaf Plot Group B	
Frequency	Stem & Leaf
1.00	0 . 4
18.00	0 . 5778888899999999999
36.00	1 . 0000000111112222222222222233344444
17.00	1 . 55555666677888999
3.00	2 . 112
4.00	Extremes (>=23)
Stem width: 10.00	
Each leaf: 1 case(s)	

Figure 3(b): Group B stem-and-leaf plot

The boxplots for group A₂ and group B in [figure3\(c\)](#) below clearly show the lower median score for group B ($M_B=12.96$, compared with $M_{A_2}=15.39$), the shorter cluster and the long right tail with outliers extending above a total score of 22/34. While group A₂ shows only one atypically

high score (respondent 14), the boxplot shows four outliers at the upper end for group B. Examination of specific score frequencies would not be appropriate, as the two groups are not equal in size.

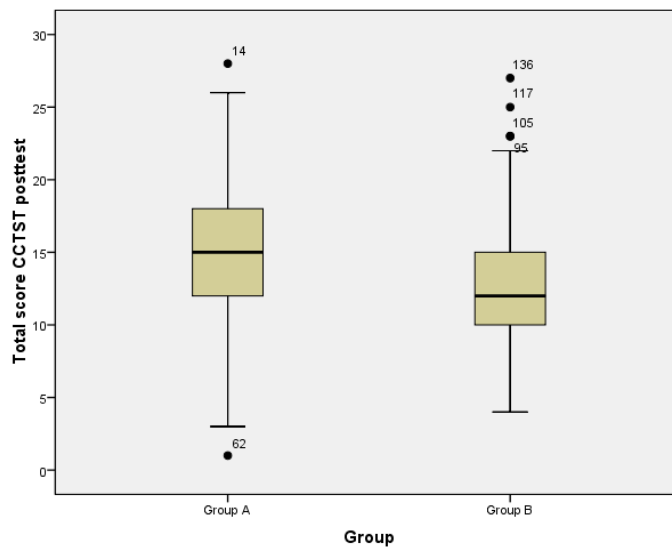


Figure 3(c): Group A₂ and B boxplots

The four scores ≥ 23 account for the positive skewness of group B data and are shown as outliers in the boxplot.

Olejnik and Algina (2000, p.245) recommend against using the pooled standard deviation (even if assumptions are met) in instances where there is reason to suspect that the populations from which the two groups were taken are “systematically different” in some way.

Given the skewness of the distribution of group B data and the difference in the population from which group B has been drawn, the effect size for contrast 3 will be calculated using the standard deviation of group B (the “control” group).

(d) Distributional aspects of contrast 4 data

The distributional aspects of the data in groups A₁D and A₂C which are used in contrast 4 have been examined in contrast 2 above.

Having examined the data for each group visually to determine the appropriate standardiser to apply in calculating the effect size for each contrast, section 4.5.4 addresses each of the contrasts of interest. The standardised difference between the means (effect size) is reported for each contrast, and the findings are summarised in section 4.5.5.

Appendix 4.6: Effect size calculations

Effect Size Estimates

Study Identifier: Sophie Kennedy 2010

Assessment Details: Contrast 1

Measurement Device: CCTST

Mean Group 1: 15.39

Standard Deviation 1: 5.15

Subject Numbers 1: 64

Mean Group 2: 15.52

Standard Deviation 2: 4.78

Subject Numbers 2: 64

Standard deviation used to compute Cohen's d: 4.96845

Cohen's d effect size: -0.02617

Which lies between -0.37266 and 0.32032 with 95% confidence.

Cohen's d effect size with Hedges Adjustment: -0.02601

Which lies between -0.3725 and 0.32048 with 95% confidence.

Hedges' Pooled Standard Deviation: 4.96845

Hedges' g effect size: -0.02601

Which lies between -0.3725 and 0.32048 with 95% confidence.

Statistical Significance Estimates

Total Number Of Subjects: 128

Mean Difference: -0.12999999999999999

Standard Error Of The Difference: 0.87831

Degrees of Freedom: 126

t-test Statistic: -0.14801; 2 tailed p = 0.88257; 1 tailed p = 0.44128

z-test Statistic: -0.14801; 2 tailed p = 0.88233; 1 tailed p = 0.44117

A Priori Power Analysis

Effect Size Entered Into Equation: -0.02617

Number of subjects required PER GROUP:

One Tailed Analysis - Power = 0.8

95% Confidence: 18062

99% Confidence: 29310

One Tailed Analysis - Power = 0.9

95% Confidence: 24983

99% Confidence: 37974

Two Tailed Analysis - Power = 0.8

95% Confidence: 22928

99% Confidence: 34117

Two Tailed Analysis - Power = 0.9

95% Confidence: 30656

99% Confidence: 43421

The Effect Size Generator - ClinTools. <http://www.ClinTools.com>

Effect Size Estimates

Study Identifier: Sophie Kennedy 2010

Assessment Details: Contrast 2

Measurement Device: CCTST

Mean Group 1: 15.39

Standard Deviation 1: 5.15

Subject Numbers 1: 64

Mean Group 2: 12.96

Standard Deviation 2: 4.57

Subject Numbers 2: 79

Standard deviation used to compute Cohen's d: 4.83775

Cohen's d effect size: 0.5023

Which lies between 0.16758 and 0.83702 with 95% confidence.

Cohen's d effect size with Hedges Adjustment: 0.49962

Which lies between 0.16496 and 0.83429 with 95% confidence.

Hedges' Pooled Standard Deviation: 4.83775

Hedges' g effect size: 0.49962

Which lies between 0.16496 and 0.83429 with 95% confidence.

Statistical Significance Estimates

Total Number Of Subjects: 143

Mean Difference: 2.43

Standard Error Of The Difference: 0.81359

Degrees of Freedom: 141

t-test Statistic: 2.98675; 2 tailed p = 0.00333; 1 tailed p = 0.00166

z-test Statistic: 2.94946; 2 tailed p = 0.00318; 1 tailed p = 0.00159

A Priori Power Analysis

Effect Size Entered Into Equation: 0.5023

Number of subjects required PER GROUP:

One Tailed Analysis - Power = 0.8

95% Confidence: 50

99% Confidence: 80

One Tailed Analysis - Power = 0.9

95% Confidence: 68

99% Confidence: 104

Two Tailed Analysis - Power = 0.8

95% Confidence: 63

99% Confidence: 93

Two Tailed Analysis - Power = 0.9

95% Confidence: 84

99% Confidence: 118

The Effect Size Generator - ClinTools. <http://www.ClinTools.com>

Effect Size Estimates

Study Identifier: Sophie Kennedy 2010
Assessment Details: Contrast 3 Grp B mean
Measurement Device: CCTST

Mean Group 1: 15.39
Standard Deviation 1: 5.15
Subject Numbers 1: 64

Mean Group 2: 12.96
Standard Deviation 2: 4.57
Subject Numbers 2: 79

Standard deviation used to compute Cohen's d: 4.57
Cohen's d effect size: 0.53173
Which lies between 0.1964 and 0.86706 with 95% confidence.

Cohen's d effect size with Hedges Adjustment: 0.5289
Which lies between 0.19363 and 0.86416 with 95% confidence.

Hedges' Pooled Standard Deviation: 4.83775
Hedges' g effect size: 0.49962
Which lies between 0.16496 and 0.83429 with 95% confidence.

Statistical Significance Estimates

Total Number Of Subjects: 143
Mean Difference: 2.43
Standard Error Of The Difference: 0.81359
Degrees of Freedom: 141
t-test Statistic: 2.98675; 2 tailed p = 0.00333; 1 tailed p = 0.00166
z-test Statistic: 2.94946; 2 tailed p = 0.00318; 1 tailed p = 0.00159

A Priori Power Analysis

Effect Size Entered Into Equation: 0.53173

Number of subjects required PER GROUP:

One Tailed Analysis - Power = 0.8

95% Confidence: 44

99% Confidence: 71

One Tailed Analysis - Power = 0.9

95% Confidence: 61

99% Confidence: 92

Two Tailed Analysis - Power = 0.8

95% Confidence: 56

99% Confidence: 83

Two Tailed Analysis - Power = 0.9

95% Confidence: 75

99% Confidence: 106

The Effect Size Generator - ClinTools. <http://www.ClinTools.com>

Effect Size Estimates

Study Identifier: Sophie Kennedy 2010

Assessment Details: Contrast 4 ESB: English-speaking background

Measurement Device: CCTST

Mean Group 1: 16.24

Standard Deviation 1: 6.04

Subject Numbers 1: 45

Mean Group 2: 16.75

Standard Deviation 2: 4.95

Subject Numbers 2: 169

Standard deviation used to compute Cohen's d: 5.19507

Cohen's d effect size: -0.09817

Which lies between -0.42708 and 0.23074 with 95% confidence.

Cohen's d effect size with Hedges Adjustment: -0.09782

Which lies between -0.42673 and 0.23109 with 95% confidence.

Hedges' Pooled Standard Deviation: 5.19507

Hedges' g effect size: -0.09782

Which lies between -0.42673 and 0.23109 with 95% confidence.

Statistical Significance Estimates

Total Number Of Subjects: 214

Mean Difference: -0.510000000000002

Standard Error Of The Difference: 0.87146

Degrees of Freedom: 212

t-test Statistic: -0.58522; 2 tailed p = 0.55902; 1 tailed p = 0.27951

z-test Statistic: -0.52169; 2 tailed p = 0.60189; 1 tailed p = 0.30094

A Priori Power Analysis

Effect Size Entered Into Equation: -0.09817

Number of subjects required PER GROUP:

One Tailed Analysis - Power = 0.8

95% Confidence: 1284

99% Confidence: 2083

One Tailed Analysis - Power = 0.9

95% Confidence: 1776

99% Confidence: 2699

Two Tailed Analysis - Power = 0.8

95% Confidence: 1630

99% Confidence: 2425

Two Tailed Analysis - Power = 0.9

95% Confidence: 2179

99% Confidence: 3086

The Effect Size Generator - ClinTools. <http://www.ClinTools.com>

Effect Size Estimates

Study Identifier: Sophie Kennedy 2010

Assessment Details: Contrast 4 nESB (non-English-speaking background)

Measurement Device: CCTST

Mean Group 1: 13.69

Standard Deviation 1: 4.44

Subject Numbers 1: 51

Mean Group 2: 13.13

Standard Deviation 2: 3.89

Subject Numbers 2: 68

Standard deviation used to compute Cohen's d: 4.13401

Cohen's d effect size: 0.13546

Which lies between -0.22801 and 0.49893 with 95% confidence.

Cohen's d effect size with Hedges Adjustment: 0.13459

Which lies between -0.22887 and 0.49806 with 95% confidence.

Hedges' Pooled Standard Deviation: 4.13401

Hedges' g effect size: 0.13459

Which lies between -0.22887 and 0.49806 with 95% confidence.

Statistical Significance Estimates

Total Number Of Subjects: 119

Mean Difference: 0.5599999999999999

Standard Error Of The Difference: 0.76578

Degrees of Freedom: 117

t-test Statistic: 0.73128; 2 tailed p = 0.46607; 1 tailed p = 0.23304

z-test Statistic: 0.71755; 2 tailed p = 0.47303; 1 tailed p = 0.23652

A Priori Power Analysis

Effect Size Entered Into Equation: 0.13546

Number of subjects required PER GROUP:

One Tailed Analysis - Power = 0.8

95% Confidence: 675

99% Confidence: 1094

One Tailed Analysis - Power = 0.9

95% Confidence: 933

99% Confidence: 1418

Two Tailed Analysis - Power = 0.8

95% Confidence: 856

99% Confidence: 1274

Two Tailed Analysis - Power = 0.9

95% Confidence: 1145

99% Confidence: 1621

The Effect Size Generator - ClinTools. <http://www.ClinTools.com>

Effect Size Estimates

Study Identifier: Sophie Kennedy

Assessment Details: Contrast 4 extra: nESB_A2C x B

Measurement Device: CCTST

Mean Group 1: 13.69

Standard Deviation 1: 4.44

Subject Numbers 1: 51

Mean Group 2: 12.96

Standard Deviation 2: 4.57

Subject Numbers 2: 79

Standard deviation used to compute Cohen's d: 4.51966

Cohen's d effect size: 0.16152

Which lies between -0.19109 and 0.51413 with 95% confidence.

Cohen's d effect size with Hedges Adjustment: 0.16057

Which lies between -0.19204 and 0.51317 with 95% confidence.

Hedges' Pooled Standard Deviation: 4.51966

Hedges' g effect size: 0.16057

Which lies between -0.19204 and 0.51317 with 95% confidence.

Statistical Significance Estimates

Total Number Of Subjects: 130

Mean Difference: 0.7299999999999999

Standard Error Of The Difference: 0.81186

Degrees of Freedom: 128

t-test Statistic: 0.89917; 2 tailed p = 0.37025; 1 tailed p = 0.18512

z-test Statistic: 0.90482; 2 tailed p = 0.36556; 1 tailed p = 0.18278

A Priori Power Analysis

Effect Size Entered Into Equation: 0.16152

Number of subjects required PER GROUP:

One Tailed Analysis - Power = 0.8

95% Confidence: 475

99% Confidence: 770

One Tailed Analysis - Power = 0.9

95% Confidence: 656

99% Confidence: 997

Two Tailed Analysis - Power = 0.8

95% Confidence: 602

99% Confidence: 896

Two Tailed Analysis - Power = 0.9

95% Confidence: 805

99% Confidence: 1140

The Effect Size Generator - ClinTools. <http://www.ClinTools.com>