Developing Critical Thinkers in Higher Education: 
A Vygotskian Perspective

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Abstract

Despite critical thinking being an avowed aim of higher education, we currently have little understanding of how students develop as critical thinkers.

This qualitative study focused on the in-depth learning experiences of twenty-seven zoology students as they developed as critical thinkers. Data were obtained through annual semi-structured interviews, course documents, my own diary entries, and personal correspondence with the participants. In addition, a technique known as Interpersonal Process Recall (IPR) was used to stimulate the recall and the tacit thinking of four students during a 3rd year tutorial session. The guiding research questions focussed on students, their teachers, the environment, and the zoology curriculum.

In this thesis I take the position that the development of critical thinking does not occur in isolation; it happens within a community of learners. Therefore, I used Vygotsky’s Sociocultural Theory and his Zone of Proximal Development (ZPD) model as a theoretical lens to help me understand these students’ experiences.

Vygotsky claimed that all learning is social in origin and that social interactions potentially transform the way people think. He advocated that rather than concentrating on what an individual can already achieve, we should emphasise their potential in co-operative activity. His ZPD model represents the limits of development, at a moment in time, with the assistance of a more capable peer. Vygotsky died before he was able to explore fully the determinants of his model, and to my knowledge no empirical studies in higher education have used Vygotsky’s theory to examine critical thinking development. In addition, the longitudinal aspect of this study offers something new; other research tends to report on critical thinking development over the course of one semester or a year, rather than an entire undergraduate degree programme.
The development of students as critical thinkers took time and was associated with some key curriculum and social experiences. Main findings from the study were as follows:

- Group project work was reported as challenging and rewarding. These projects facilitated the development of an evaluative judgement necessary for critical thinking.
- Curriculum experiences that involved writing and talking were important for structuring the thought processes required for critical thinking.
- The development of students as critical thinkers was facilitated by students gaining the confidence to ask questions of each other and their teachers.
- Despite students recognising and valuing the social aspect of learning there was little opportunity to do so in the large first year classes. There was also little opportunity to challenge or question information and student learning was largely reported as learning facts.

Vygotsky’s ZPD model can help teachers focus on individual students rather than thinking about students as a homogenous group. It can also help teachers think about the most appropriate activities to create a ZPD for critical thinking and in doing so, develop students as critical thinkers. The challenge is to assist learners to reach their ZPD potential and question whether a curriculum meets this need.
Publications Arising from this Thesis

**REFEREED JOURNAL ARTICLES (APPENDIX F)**


**REFEREED ABSTRACTS OF CONFERENCE PROCEEDINGS (APPENDIX G)**


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Introduction and Overview

Introduction

Why Vygotsky?

This study looks at how zoology students developed as critical thinkers for the three years of their degree programme at the University of Otago. In order to gain insight into these changes, students’ learning experiences were analysed using Vygotsky’s Sociocultural Theory and, in particular, his concept of the Zone of Proximal Development (ZPD). There are four prime reasons for using Vygotsky’s theories in this research.

Firstly, critical thinking development is a complex field to research. Vygotsky’s holistic approach to the development of learning emphasises the importance of individual, cultural-historical, and social factors and appears to offer something new in this regard. Definitions and explanations of how these factors relate to the student development of critical thinking is explained in more detail in the literature review (see p29).

Secondly, I took the position that critical thinking development is likely to be a social activity. Although there are other cognitive theories that stress the importance of the social environment and the mentoring of students by experts, there is limited empirical research in higher education that uses Vygotsky’s theories to examine student development of critical thinking. This research seeks to address this gap.

Thirdly, Vygotsky’s Zone of Proximal Development (or ZPD) model represents key ideas in Vygotsky’s thinking and has been widely accepted, but the parameters of the ZPD are largely uncontested (Schunk, 2004). Wood (1996) asserts that the power from such models comes from their familiar and somewhat intuitive nature, for ‘if they were not familiar and mundane they could not serve the functions that are claimed for them’ (Wood, 1996, p6). To have utility for curriculum designers and teachers in higher education, however, questions need to be addressed, such as; what
does it mean to be a ‘more capable peer’, and does it have to be a teacher (in the traditional sense) to create a ZPD?

A fourth reason to use Vygotsky as a theoretical framework relates to the disparate nature of research on critical thinking. In part, differences reflect the two major traditions and approaches of critical thinking research – cognitive psychology and philosophy. Because of its holistic approach, a Vygotskian perspective on critical thinking might be a useful way of bringing these contrasting lines of research together into a unified theory (Smolucha, 1989).

Why Critical Thinking?

According to Ramsden (1992), the aim of higher education has remained relatively unchanged over the years. He cites (among others) an essay written by A.N. Whitehead in 1929 that purports one purpose is that students in higher education should develop the ability to ‘think critically’. They should do so for a number of reasons. At a societal level, critical thinkers who can reason well and make good judgements are required to improve and contribute to a more rational, civilised society (Barnett, 1997). At a political and economic level, the ability to think critically is seen as an important response to the demands of national governments and employers, who have argued for all sectors of education to prepare individuals to contribute to a successful economy (Barnett, 1997). A third reason, is that the ability to think critically is considered to be an integral part of many occupations and professional fields; it is not enough to accept truth claims at face value as careful consideration of the evidence and alternative explanations are often required. In addition, an emphasis on critical thinking as a life-long skill addresses the issue that much of the factual material that is taught becomes outdated (Ramsden, 1992; Terenzini, Springer, & Pascarella, 1993) and students must leave university with the capacity to be self-directed learners of the highest order.

Because my research uses Vygotsky’s Sociocultural Theory to understand students’ experiences of critical thinking, I will briefly outline the social and cultural context of the study.
Context of the Study

Critical thinking has been central to higher education since at least the beginning of the 20th Century. An emphasis on critical thinking, therefore, is not a recent occurrence. However, teaching in a University today, is very different from, say 30 years ago. In order to understand fully how students develop as critical thinkers and how teachers can support this development, we need to appreciate the context in which critical thinking is experienced.

This study takes place at the University of Otago, New Zealand, where the central importance of critical thinking to a university education is reflected in both government and university policy. For instance, the Tertiary Education Strategy (2010-2015) produced by the New Zealand Ministry of Education claims that one of the core roles of a University is to act as ‘sources of critical thinking and intellectual talent’. Similarly, the Teaching and Learning Plan (2005-2010) of the University of Otago states that ‘critical thinking is an attribute to be fostered in the Otago graduate’.

Higher education has undergone a rapid expansion in New Zealand, with increasing numbers of students entering University (Scott, 2005). This growth in tertiary enrolments has been aided in New Zealand by the country’s lifelong approach to tertiary learning, its relatively open access to enrolment, and the availability of a student loan scheme (Scott, 2005). As access to higher education has widened, large groups of students from heterogeneous backgrounds have become the norm in most subjects (Buntting, 2006).

In addition to teaching increased numbers of students from diverse backgrounds, there have also been greater demands on teachers for accountability (Scott, 2005). The neoliberal reforms that have occurred over the last thirty years in the New Zealand education sector set out to achieve a competitive environment with a focus on getting better value for the government’s investment by achieving greater efficiencies and redirecting productivity towards economic needs (Harland, Tidswell, Everett, Hale, & Pickering, 2010). Coupled with this, has been an explicit focus on recognising and raising the quality of teaching and learning, and improving outcomes for students.
Another change that has affected academic staff is in the manner in which universities have been funded. Previously, research income was based on student enrolments but in 2003, with the introduction of Performance Based Research Funding (PBRF), funding became based on both student enrolments and research productivity. This change ensured competition between universities and as a result, all academic staff are now held accountable for their research outputs. With more emphasis spent on research and more time spent on the process of being accountable for it, there is a suspicion among academics that other standards, particularly in teaching, have dropped in the past decade.

New Zealand universities face the challenge of balancing a reduction in state funding and a rapidly expanding education sector, with managing affordability and access for students while still maintaining quality and viability. Teachers are faced with larger class sizes, increased workloads and more compliance-driven administration (Brew, 2010). Add to this the fact that academics are not typically formally trained as teachers or engaged with teaching as a professional practice and we have a situation where university teaching, generally, is undervalued and teaching for critical thinking is poorly understood by many academics (Choy & Cheah, 2009).
THESIS AIM AND RESEARCH QUESTIONS

The aim of the study is to investigate how students develop as critical thinkers over three years of a zoology degree programme. To help understand this, Vygotsky’s theory of the Zone of Proximal Development (ZPD) (see p33 for definition) is used in the analysis of empirical data primarily from student experiences. The purpose is to contribute to a theory of teaching and learning critical thinking, and to ascertain if the ZPD can help researchers understand the complex nature of learning to be a critical thinker. Specifically, I was interested in the following research questions:

• What are the key curriculum experiences that facilitated students’ development as critical thinkers?

• How do social interactions affect students’ development as critical thinkers?

• How can the ZPD guide teaching and learning of critical thinking?
OVERVIEW OF THESIS

What follows is a summary of each chapter. After the literature review and methodology, Chapters 3 through to 5 report the key findings of the study. Chapter 6 presents the conclusion of the research.

Chapter 1: Literature Review

It is important to have a clear commonly accepted definition of critical thinking, otherwise we run into the danger of having an uncritical acceptance of the concept (Choy & Cheah, 2009). This first section of Chapter 1, therefore, investigates various conceptions of critical thinking, drawing on the works of scholars from philosophy, cognitive psychology, and Facione’s (1990) publication of a consensus on critical thinking using the Delphi method.

Following on from the various conceptions of critical thinking, the next section reviews the literature on critical thinking in the following four areas:

1. The major approaches to developing critical thinking (generic versus disciplinary)
2. Critical thinking across the curriculum.
3. Student perceptions of how critical thinking changes and develop over time.
4. Critical thinking and epistemological changes.

In this literature review chapter I also discuss some of the major learning theories (behaviourism and the cognitive theories of constructivism and social constructivism) and their basic assumptions are outlined. Although many studies suggest various instructional methods to enhance critical thinking, little is known about how this occurs from a theoretical perspective of learning. Learning theories offer a framework for observing, interpreting, and explaining the development of critical thinking (Meece & Daniels, 2008). Because this study uses Vygotsky’s Sociocultural Theory and his concept of the ZPD as a way to understand students’
experiences of critical thinking development, particular attention is given to this theoretical framework.

Chapter 2: Methodology

A researcher’s beliefs about what can be known (ontology) and how it can be known (epistemology) will influence all subsequent stages of the research, such as the choice of research questions and the method used to answer these (as stated by Grix, 2002). A research methodology should therefore not only describe and analyse the methods used to generate and interpret data, but also present the philosophical framework within which the research project develops (Lather, 1992). Furthermore, good research requires making these assumptions, paradigms and frameworks explicit because it allows the research to be understood in a way that permits constructive dialogue and opens it up to criticism (Grix, 2002).

This chapter, therefore, provides a broad overview of the research methodology beginning with my ontological and epistemological position. I make clear why I have chosen an interpretive methodology for the study and I discuss the limitations of this methodology. I consider what it means to be trustworthy, valid, and ethical within this framework.

Chapter 3: Critical Thinking and Curriculum

Chapter 3 provides an overview of student experiences of critical thinking development within the zoology curriculum at the University of Otago. The curriculum is based on an old assumption that learning to do research will act as a proxy measure for the development of skills and attributes of a scientific researcher (including critical thinking). In order to gain insight into how the curriculum affected students’ learning and development, all of the participants were asked to talk about how they had changed as learners and their best learning experiences. This research strategy enabled a graphical overview that represented students’ ideas about what curriculum experiences they valued and how these changed over time.
It was not until their final year that participants were able to take part in research projects of their own choosing and have freedom in the design of their experiments, gathering of data, data analysis and finally presentation. Up until this point, some students commented on how they found the curriculum prescriptive and limiting. The implications of a fact-first curriculum to enhance critical thinking are discussed.

Chapter 4: Critical Thinking and the Social Environment

In Chapter 4, I take a Vygotskian perspective and look at the importance of social interactions within the existing curriculum and the impact that these have on student development. Six key factors that relate to the social environment in which critical thinking development occurred are identified. These are as follows:

(i) Relationships with peers
(ii) Relationships with demonstrators and lecturers
(iii) Written and spoken ability
(iv) Attitudes to learning
(v) Confidence
(vi) Ideas about knowledge

Students noted that over the course of the degree programme interpersonal relationships changed as they themselves became valued more by other students and their teachers. As students became comfortable with the curriculum content and they grew in confidence, this was reflected in their written and oral ability. Students also reported a change in their ideas about knowledge and their understanding of themselves as zoology researchers. I argue that for critical thinking to occur, as teachers we should not lose sight of the importance of the social environment in which students develop as critical thinkers.
Chapter 5: Critical Thinking and the Zone of Proximal Development

Vygotsky developed various formulations of the ZPD before he died, but the characteristics of the ZPD have not received much attention in the research literature. The aim of my research was to use the ZPD to gain a better understanding of student development, but at the same time determine if data revealed anything that could inform the theory. In this chapter, I consider reciprocal learning, movement through the ZPD and the emotional nature of the zone. I also examine the notion of emotional scaffolding and the temporal and dynamic features of scaffolding for critical thinking. Two different ways of scaffolding for critical thinking are identified. The first - material scaffolds - within the context of the zoology curriculum, are conventional scaffolds and include textbooks, computer simulations, and traditional didactic lecturers. Although these scaffolds were helpful for learning content, it was the informal scaffolds (such as peer and lecturer conversations) that participants reported afforded the best opportunities for scaffolding critical thinking development. These interactions were important because lecturers were seen as role models for structuring the thought processes required for critical thinking especially when they allowed students to generate their own questions (as opposed to students answering questions set by lecturers). I conclude this chapter by considering the implications of using the ZPD model for teaching and learning.

Chapter 6: Summary and Conclusions

This study looked at student experiences of critical thinking development over the course of an entire degree programme, and for this reason, it is novel. It is also different in that is looks at critical thinking development from a sociocultural perspective and questions whether Vygotsky’s Zone of Proximal Development (ZPD) offers new insights.

The study reveals that critical thinking was enhanced by developing positive relationships between peers and with teachers. It was also developed by scaffolding for research (carrying out research activities). It should be noted, however, that it was not until third year that some students realised that they did not want to do research and it was not their primary reason for choosing the course (they simply wanted to
learn more about animals). If critical thinking remains an aim for higher education and critical thinking is enhanced through research activities then it is necessary that both students and educators understand this phenomenon.

Critical thinking is a composite of both generic and discipline specific skills and knowledge. Therefore, it is also suggested that students should be more involved in authentic activities such as using the language and the tools (writing, critique and so forth) of the discipline to expedite critical thinking. It is argued that critical thinking needs to be experienced as an integral part of a complex cultural activity. For instance, it is not enough to introduce report writing into the curriculum and hope that is will enhance critical thinking development; instead, it is necessary to create an environment where students understand writing as a critical activity performed by scientists that requires social interaction, and self-reflection.

Whereas much of the literature focuses on developing skills necessary for critical thinking, this research highlights the important role of the teacher in developing dispositions. There was evidence for a direct and an indirect effect of this, but it remains to be seen what the full impact of this might be on student learning.

In the final section of the last chapter, I consider some of the limitations of the study and consider possibilities for future research. Many studies focus on either the skills required for critical thinking or the dispositions necessary. This study used a more holistic framework for critical thinking and adopted a longitudinal approach. Although it was beyond the scope of this project, it would be possible to involve teachers in a similar study to ascertain what they hope to achieve for an undergraduate education and how they understand critical thinking development.
Chapter 1: Literature Review

INTRODUCTION

In teaching critical thinking, it is important for the teacher to have a clear understanding of the concept (Choy & Chea, 2009) and be able to put this into practice. There is no single shared conception of critical thinking and the first section of this chapter, therefore, investigates various conceptions of critical thinking, drawing on the works of scholars from philosophy, cognitive psychology, and the publication of a consensus on critical thinking using the Delphi method (see Facione, 1990).

To conduct my general review of the status of critical thinking in higher education I review the following four areas of the research literature, as these are particularly relevant for this study:

1. The major approaches to developing critical thinking (generic versus disciplinary)
2. Critical thinking across the curriculum.
3. Student perceptions of how critical thinking changes and develop over time.
4. Critical thinking and epistemological changes.

Although the literature suggests that various instructional methods may enhance critical thinking, little is known about how this occurs from a theoretical and experiential perspective of learning. These learning theories purport to offer a framework for observing, interpreting, and explaining critical thinking development over time (Meece & Daniels, 2008). Some of the major learning theories are discussed within the frameworks of behaviourism and the cognitive theories of constructivism and social constructivism, and their basic assumptions outlined. Because this study uses Vygotsky’s Sociocultural Theory and his concept of the ZPD as a way to understand students’ experiences of critical thinking development, more attention is given to this theoretical framework. We have little idea about the
explanatory power of Vygotsky’s Sociocultural Theory, however, or the ZPD’s relationship to it.
DEFINING CRITICAL THINKING

The critical thinking literature is grounded in at least two traditions – philosophy and psychology (Lai, 2011). Although there are similarities in the way critical thinking is defined (namely, that critical thinking involves two dimensions - skills and dispositions), there is little agreement on what these are or the extent of their relative importance.

Possibly one of the most significant developments in the literature on critical thinking was the publication of a consensus on critical thinking using the Delphi method (see Facione, 1990). Delphi is a technique used to gauge the degree of agreement or disagreement among experts on any topic using an iterative, multistage, group facilitation technique designed to transform opinion into consensus (Hasson, Keeney, & McKenna, 2000). In this case, the expert group consisted of 46 authorities on critical thinking that represented many different scholarly disciplines (humanities, sciences, social sciences, and education) whose main purpose was to identify and clarify the elements of critical thinking that are appropriate to a student in higher education.

After a period of almost two years and six cycles of consultation and feedback with the panel, the group came up with the following definition of critical thinking:

*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.*

*Facione (1990, p2)*

In addition, this Delphi exercise identified 19 affective dispositions as being important for critical thinking. These dispositions, both general and specific, were agreed by a 61% majority to constitute part of the meaning of critical thinking. The reason for this is that critical thinking skills require a correlated disposition in order
to execute that skill. It is possible to be adept at critical thinking skills, but by not using them habitually disqualifies one from being called a critical thinker.

The Delphi exercise concluded with the following description of critical thinking dispositions:

*The ideal critical thinking is habitually inquisitive, well-informed, trustful of reason, open minded, flexible, fair minded in evaluation, honest in facing personal biases, prudent in making judgments, willing to reconsider, clear about issues, orderly in complex matters, diligent in seeking information, reasonable in the selection of criteria, focussed in inquiry, and persistent in seeking results which are as precise as the subject and the circumstances of inquiry permit.*

*Facione (1990, p2)*

The experts agreed that this was an ideal. It was not suggested that to be a critical thinker it was necessary to possess all of the skills and dispositions all of the time. It was also acknowledged that because of the way people compartmentalise their lives, it may be that critical thinking is more active and evident in some areas than others.

In order to avoid the situation where every useful cognitive process or every affective disposition could be thought of as contributing to critical thinking, it is useful to identify what critical thinking is not. According to Facione (1990), critical thinking is one among a family of closely related forms of higher-order thinking, along with, for example, problem-solving, decision making and creative thinking, but it is not synonymous with these terms. Taking problem solving as an example, Beyer (1985) draws attention to the distinction between the two - problem solving begins with a perceived problem and seeks out how it might be resolved, whereas critical thinking begins with a claim, conclusion or product and needs to consider its truth or worth.

Barnett (1997) re-conceptualised critical thinking in higher education into the much broader context of the ‘critical being’. The critical being is seen as the integration of three forms of criticality: critical reason, critical self-reflection, and critical action. In this view, critical thinkers not only reflect critically on knowledge, but they also
develop powers of critical self-reflection and take critical action. Thus, critical thinking is seen as a life-long practice that results in improvements in the quality of thought and values. When values are enacted, a person may be said to be ‘living their values’ (McNiff, 1992). That is, it is not enough for the critical being to engage critically with themselves, they must also critically engage with the world. The critical being is collaborative in character and must be sustained through collective activity and discourse around collective standards within a community (Barnett, 1997).

Because of its relevance to a scientific context (see Chapter 3, p66), for the purpose of the present study critical thinking is viewed as an evaluative process that involves an interdependent array of abilities and dispositions. These include; judging the quality of evidence and the credibility of sources, asking appropriate questions, being open minded, being aware of assumptions and seeing things from other’s points of view. The social element is relevant as critical thinking involves continuously developing standards and criteria for judgement, and this evaluation occurs within a community of learners (Barnett, 1997).
WHAT DO WE KNOW ABOUT TEACHING STUDENTS TO THINK CRITICALLY?

Universities are making a point of emphasising the importance of critical thinking as a ‘generic skill’ that is central to most, of not all, subjects (Davies, 2011) and recent years have also seen the emergence of a significant number of stand-alone critical thinking courses in institutions (Moore, 2011). There is evidence to suggest that students increase their critical thinking skills because of instruction (see reviews by McMillan (1987), Kennedy et al. (1991) and more recently Abrami et al., (2008)). Little is known, however, about what education experiences contribute to this (Renaud & Murray, 2007). Norris (1985) claims that while the conclusion of each study is usually that instruction leads to better critical thinkers, we do not learn what specifically makes these students better thinkers and in what specific ways that they can still improve.

In this section of the literature review I examine four areas of the critical thinking literature to provide an understanding on what is known, and what is unknown, about student development of critical thinking. This will provide the rationale for this study’s contribution to the field.

1. The Major Approaches to Developing Critical Thinking (generic versus disciplinary).

In addition to the difficulties of precisely defining what critical thinking is, lies a fundamental question of whether critical thinking should be considered a finite set of skills that can be learned in a systematic way and is applicable across all disciplines, or is critical thinking specific to a particular context and discipline. The former approach is known in the critical thinking literature as the ‘generalist’ position adopted by Ennis (1992) and Facione (1990), and the latter, the disciplinary or specifist position, of which McPeck (1992) is an example. Whether critical thinking skills and abilities are generic or domain specific has been a long-standing controversy that continues today. Those that advocate for the generalist position suggest that critical thinking should be taught as a universal, general skill and a
subject in itself, whereas the specifists argue that critical thinking is best taught by prolonged immersion in a particular discipline because what constitutes valid evidence, arguments, and standards tends to vary across disciplines (Bailin, 2002).

There are others (and I am one) that do not accept the ‘either-or’ dichotomous positions that the generalist or specifists advocate, and instead see critical thinking as involving both general and domain specific elements. In this thesis I preserve the generalist’s position, that there are commonalities between, for example, the interpretation and evaluation of arguments in different disciplines. However, I also believe that it is important to recognise that understanding discipline specific methodological principles and competencies is at the core of making reasonable judgments (Facione, 1990).

One thing that does seems to be agreed upon by many of the critical thinking researchers is that background knowledge within a given subject, is a necessary, although perhaps not a sufficient condition for enabling critical thought. As McPeck (1990) has noted, to think critically, students need something to think critically about. Interestingly, it has been postulated that it is this lack of background knowledge that may explain some of the misleading conclusions regarding the critical thinking abilities of young children – they simply did not have the background or content knowledge needed to engage in the task (Kennedy, et al., 1991).

2. **Critical Thinking across the Curriculum.**

In this section, I review the literature on critical thinking across the curriculum and curriculum construction in general. This is particularly relevant given that this study is premised on the assumption that the zoology curriculum develops critical thinking and is situated within the critical thinking across the curriculum/discipline perspective.

The general consensus across the literature is that critical thinking skills and abilities can be taught (Lai, 2011). Whether it should be taught as a general or specific set of skills and abilities is up for contention. However, in their meta-analysis of 117
empirical studies on the effects of instructional approaches, Abrami et al. (2008) found that the most gains on critical thinking skills and abilities was when critical thinking instruction was both integrated into regular academic content and, general critical thinking skills were taught as a stand-alone component. The authors also found that interventions in which educators received special training in teaching critical thinking had the largest effect-sizes, compared to studies in which course curricula were simply aligned to critical thinking standards or critical thinking was simply included as an instructional objective (Abrami et al., 2008).

3. Critical Thinking and Epistemological Changes.

Based on a wealth of empirical research, the psychologist Deanna Kuhn proposed a developmental model of critical thinking that consisted of three forms of metaknowing (metacognitive, metastrategic, and epistemological), which represent successively more sophisticated ways of thinking (Kuhn, 1999). She argues that individuals need to develop each of these forms in order to make critical thinking possible.

Metacognitive knowing is concerned with declarative knowledge (knowing that), whereas metastrategic knowing is to do with procedural knowing (knowing how). According to Kuhn, the development of an epistemological understanding, however, may be the most fundamental underpinning for critical thinking (Kuhn, 1999).

Epistemological knowing has to do with an individual’s broader understanding of knowledge and knowing. That is, reflecting on what is known and how that knowledge is justified. For critical thinking to occur Khun argues that individuals need to develop an evaluative epistemology, in which all opinions are not equal, and knowing is understood as a process that entails judgement, evaluation and argument.

Epistemological understanding is posited as the most sophisticated level of critical thought and is characterised by three distinct stages. The first stage, called the ‘Absolutist’ position, is the norm during childhood and is common during adolescence. Kuhn argues that it can even persist into adulthood for some individuals (Kuhn, 1999). People in the absolutist stage believe that absolute truth is either
‘known or potentially knowable, either through direct apprehension or the opinion of experts’ (Kuhn, 1999, p22).

The second stage in epistemological understanding - the ‘Multiplist Epistemological’ position, tends to be prevalent during adolescence. During this stage, the individual acknowledges that experts can disagree, however, instead of viewing the world as inherently and objectively knowable, individuals in this stage perceive the world as a completely subjective place. In other words, “because all people have a right to their opinions, all opinions are equally right” (p22). Kuhn points out that many people become permanently stuck in this phase.

Finally, Kuhn (1999) argues that the last stage in epistemological understanding (and critical thinking), to which only a minority of people will ever progress, is known as ‘Epistemological Metaknowing’. At this stage the individual uses judgment, evaluation, and argumentation to sift through opinions and arrive at those that are most valid. Not all opinions are valued equally; rather, reason, logic, and empirical evidence can be used to privilege certain positions over others (Kuhn, 1999).


This body of literature is particularly relevant given the longitudinal interview data on student perceptions over the 3-year degree programme.

In a recent review of critical thinking, Brookfield (2012) emphasises that there is a plethora of books to help students understand what critical thinking is, how to get students to ask questions, and how to get students to think logically. Like my own research, he is more interested in how students 'experience' critical thinking, that is, how it ‘actually takes place in students' heads and bodies’ (p53). His findings are based on completed student surveys from courses and workshops on critical thinking, gathered over a period of thirty years.
Five themes emerged from Brookfield’s (2012) observations of how students learn critical thinking. These are:

1. Critical thinking is a social learning process
2. Students like it when teachers model the critical thinking process (and draw students’ attention to it)
3. It is helpful to ground critical thinking with concrete examples;
4. Significant moments in critical thinking are often associated with some kind of unexpected event or idea
5. Learning critical thinking is a developmental process (students prefer to practice critical thinking in relatively non-threatening situations before applying it to their own)

Brookfield (2012) claims that the way we teach critical thinking is often at odds with how students experience it. In the study by Pascarella (2001), for instance, experiences of diversity (such as making friends with students of a different race) were seen as having a positive effect on critical thinking outcomes. Similarly, Terenzini et al. (1995) reported the positive effects of ‘out of class’ experiences such as socialising with other students, interacting with teachers and so forth. In a meta-analysis of eight studies, Gellin (2003) concluded that college students who engaged in activities such as interacting with faculty and peers, living on campus, and participating in college clubs or organizations also increased their critical thinking skills. In other studies the importance of instructor-influenced classroom interactions on critical thinking is revealed (Smith, 1977; cited in Terenzini 1995). These and other studies suggest holistic and longitudinal studies are necessary for understanding critical thinking development.

A Vygotskian approach gives us a theoretical model for understanding how students develop as critical thinkers. It also gives teachers ways to think about facilitating student development, by placing the emphasis on students, what they learn, and by providing appropriate activities. Other researchers who have emphasised the importance of social interactions for promoting cognitive development and are therefore rooted in Vygotskian traditions are: Abrami et al., 2008; Bailin et al., 1991;

**Critical Thinking in Zoology Programmes**

There is a lack of information that looks at critical thinking development in zoology programmes. Historically, Bailey (1979) reported significant gains in the critical thinking skills of students who completed zoology and botany courses, designed to emphasise problem solving, compared with students who completed regular classes (in Borg & Stranahan, 2010).

Another study (cited in Abrami et al, 2009) looked at critical thinking development within a general biology programme. Zohar, Weinberger, & Tamir (1994) reported highly favourable results of seventh-grade biology students when they were made to think critically about their subject matter, in addition to, having the general principles of critical thinking skills and dispositions made explicit.

An example of how to successfully integrate critical thinking and research into an entire curriculum was presented by Spronken-Smith et al. (2010). Their focus for this case study research was on how the teaching team initiated this change, rather than the effects of the changes on the students within this redesigned undergraduate ecology programme.

**Summary**

In summary, there seems to be some evidence that instruction leads to improved abilities in critical thinking skills and abilities. It was not, however, until recent studies such as Abrami et al. (2009) possible to link the outcome with the instruction method. There have also been some gains in our understanding of how students develop as critical thinkers, and the psychologist Deanna Kuhn has been instrumental in this. We now have a better understanding of students’ perceptions of critical thinking development and what had come from this research is the importance of
social factors and interactions. There is very little information on the development of students as critical thinkers in zoology, or biology programmes generally.
DOMINANT THEORIES OF LEARNING

In this section, I provide an historical background on the dominant theories of learning in order to understand some perspectives on critical thinking development.

Learning theories offer a framework for observing, interpreting, and explaining critical thinking development over time (Meece & Daniels, 2008). In this section, some of the major learning theories are discussed and their basic assumptions outlined. It is important to remember that the various learning theories provide multiple frameworks for understanding and interpreting behaviour. The intention is not to categorically state that all learning, in any given context, occurs in a certain way - learning is much more complex than that. In adopting a certain view as to how people learn, however, we need to be aware of the assumptions underlying that particular position.

It should also be noted that what is presented here is not an exhaustive list of all learning theories, as this is beyond the scope of this thesis. Instead, the focus will be on those relevant to this study (see Figure 1.1, p24). For a more comprehensive overview, see the Learning Theories Knowledgebase (Learning-Theories, 2009).
Figure 1.1 The interrelationship between the various learning theories discussed in this chapter
Behaviourism

The behaviourists’ perspective of learning stems from the work of Pavlov and Skinner, and according to Jarvis et al. (1998) is perhaps the best known.

In the behaviourist perspective, learning is seen as ‘a change in the rate, frequency of occurrence, or form of behaviour or response, which occurs primarily as a function of environmental factors’ (Schunk, 2004, p17).

According to behaviourist theory, learning involves the formation of associations between stimuli and response. Thus, a reinforcing consequence makes the response more likely to occur, whereas punishing consequences make it less likely. We see examples of behaviourist theories, translated into practice, with the use of star charts for young children to reinforce good behaviours. Desired behaviours are reinforced with a sticker that symbolises a reward (or the sticker itself can be the reward). With time, the desired behaviour is learnt and the charts are no longer necessary. Putting a child in ‘time-out’ is the antithesis, as the unwelcome behaviour is associated with physical removal from what they were doing. This negative consequence makes the undesired behaviour less likely to continue.

Behaviourists, therefore, focus on measurable behavioural outcomes of learning that occur primarily because of the environment. Behaviourists postulate that learning takes place by shaping the responses of the learner through using instructional procedures such as modelling, demonstration, and reinforcement (Palincsar, 1998). The hallmark of this instructional model that reflects the tenets of behaviourism is known as direct instruction. It is characterised by the active and directive role of the teacher who is in command of the learning situation and leads the pace, sequence, and content of the lesson (Palincsar, 1998). According to Jarvis et al. (1998), behaviourism became a well-known approach in education because it assumes that we can measure learning and intelligence by tests and examinations, and that this gives us a clear understanding of what has been learnt. In addition, Jarvis contends it has also been successful because we live in an age in which the product has always been more important than the means.

Despite the acceptance of behaviourism as a learning theory, it has been argued that behaviourism seems best suited to explain simpler forms of learning that involve
associations; multiplication facts, foreign language word meanings, and so forth (Schunk, 2004). While direct instruction is an effective means of teaching factual content, according to Palincsar (1998) there is less evidence that this type of instruction transfers to higher order cognitive skills (such as critical thinking). Palincsar (1998) also notes that behaviourism offers no satisfactory explanation of the mechanisms that account for learning; this is left to the cognitive revolution.

Cognitivists’ Theories

Beginning in the 1950’s, behaviourism was challenged on many fronts (Schunk, 2004). It seemed that reinforcement was not necessary for learning to occur - behaviourists were not able to explain children imitating behaviour days or weeks after observing the initial behaviour with no reinforcement – and this disputed the central assumption of behaviourist theories (Schunk, 2004). Behaviourists’ explanations for learning also did not account for an individual’s thoughts, feelings, and beliefs: the focus was on the environment and the measurable behavioural outcomes of learning. Cognitive theories, on the other hand, stressed the acquisition of knowledge and skills, the formation of mental structures, and the processing of information and beliefs (Schunk, 2004) and in the 1960s replaced behaviourism as the dominant paradigm for understanding learning (Learning-Theories, 2009).

There are many different cognitive theories (see Figure 1.1, p24) and they differ in where the focus of attention lies; whether it is the individual, the social or the sociocultural context in which an individual lives. The various cognitive theories, however, share a shift towards human factors as explanations for learning.

Cognitive theories are constructivist because they postulate that learning is not automatic. Information is not conveyed and simply processed by rote; rather individuals take in information and formulate their own knowledge. Because cognition is largely a function of experiences in situations, for constructivists, the context that learning takes place in is important. Learners, therefore, create their own understandings, based upon the interaction between what they already know and believe, and the phenomena of ideas with which they come into contact (Richardson, 1997). Thus, knowledge is not transmitted directly into the minds of the learner but
rather knowledge is constructed by relating it to previous knowledge (Jones & Bradeer-Araje, 2002).
**Vygotsky’s Sociocultural Theory of Learning**

As the name suggests, Vygotsky’s Sociocultural Theory describes, from a social and cultural perspective, the development of higher-order thinking or conscious intellectual activity such as reasoning. It was first introduced by Vygotsky and his collaborators in Russia in the 1920s and 1930s. Because of the political climate at the time, however, his published works were suppressed and it is only since the late 1950s and early 1960s that they were translated and made available to the Western world (John-Steiner & Mahn, 1996). His sociocultural approaches have since gained increased recognition, and his ideas have been developed further by scholars in over a dozen countries and in just about any discipline in which it is important to understand human development (John-Steiner & Mahn, 1996; Smagorinsky, 2007). The Zone of Proximal Development (ZPD), in particular, is considered one of Vygotsky’s most important contributions to psychology and education (Meece & Daniels, 2008).

When discussing Vygotsky’s theory it is useful to distinguish the terms ‘development’ and ‘learning’ for these are often used interchangeably in the literature (Packer & Goicoechea, 2000) but for Vygotsky they were not the same. Vygotsky developed his Sociocultural Theory at a time when these words were seen as dichotomies. Development referred to internal individual processes, whereas learning was attributed to external processes. Vygotsky criticised this dichotomy and rejected the Piagetian notion that development is a prerequisite for learning (but never the result of it). Instead, Vygotsky proposed that learning and development are a unity (Vygotsky, 1978). They are not the same, but they are interdependent. Further, he claimed that learning awakens internal processes. Learning is not the same as development, but it sets in motion developmental processes that would otherwise not be possible (John-Steiner & Mahn, 1996).
Summary of Vygotsky’s Ideas

The profound contribution that Vygotsky made to understanding learning and development was to draw attention to the fact that individuals, with assistance from more capable others, can complete tasks that they will not otherwise be able to do on their own. Therefore, classroom instruction should focus on activities that promote these ‘buds of development’ or ‘maturing processes’, rather than those that have already developed. In Vygotsky’s theory, the development of individuals occurs through the interaction of individual, cultural-historical, and interpersonal (social) factors (Tudge & Scrimsher, 2003). Each of these factors will be examined in turn and, will be linked the teaching and learning of critical thinking.

Individual Factors

Like Piaget, Vygotsky insisted on the role of the active individual in the construction of knowledge (Cole & Wertsch, 1996). His theory originated with his interest in children with inherited mental and physical disabilities, and in particular, Vygotsky was interested in the different learning trajectories that were produced in these children compared with children without such challenges (Schunk, 2004).

Whilst acknowledging individual differences, according to Vygotsky, development in most children was the mastering of culture and maturational processes. These cultural and natural spheres intertwine and merge, forming a single social-biological sphere of development (van der Veer & Valsiner, 1991). Vygotsky defended the view that blind and deaf subjects have a potential for normal mental development by creating alternative but equivalent roads for cultural development. He argued that a handicap affects children’s social relations, rather than their direct interactions with the physical surroundings. The social problems resulting from a physical handicap therefore should be seen as the principal problem – blindness is only realised as a social fact, a secondary, mediated result of social experience (van der Veer & Valsiner, 1991).

Vygotsky claimed that the potential for development for these children should be sought in the area of higher psychological function. Because the higher functions develop in social interactions through the use of cultural means, Vygotsky argued
that efforts should concentrate on adjusting these means to the different needs of
defective (sic) children.

What came out of this period were several ideas that were to become of primary
importance in later years. Vygotsky mentioned the idea of the eye and speech as
‘tools’ for carrying out some activity (reading or thinking, respectively). In
connection with this, we can see the first formulation of the idea of mediation.
According to Vygotsky, language was the primary mediator. Language was not only
a means of communication, but also an object of study where teachers directed
students to meanings and definitions that are specific for that discipline. When
students learn language that is specific to zoology, for example, this is a tool in the
sense that it allows students to communicate and understand one another, but it also
is a sign in that it identifies them as zoologists.

The idea of mixed-level groups as a condition promoting cognitive development also
came out during the time when Vygotsky was working with children with mental and
physical disabilities. Vygotsky concluded, ‘the feeble-minded find their ‘living
source of development’ in social interaction with others who are on a higher level
than themselves’ (van der Veer, 1991, p75). This idea foresees the concept of the
Zone of Proximal Development, which I explain more fully on p27. Concerning
critical thinking, Vygotsky was saying that, rather than concentrating on what a
student can already achieve, critical thinking development should emphasise the
potential of an individual in co-operative activity.

Moll noted that for Vygotsky the educational setting was the ‘quintessential
sociocultural activity’ (Moll, 1990, p1) - a social setting specifically designed to
modify thinking. The zoology teacher has an important role in this respect because
the teacher needs to help students learn what it means to think critically in a zoology
context. Teachers who teach from a Vygotskian perspective advocate that ‘learning
leads development’ and will, therefore, select relevant tools for developing critical
thinking (such as computers, textbooks, personal modelling) and then design
classroom activities for students to use these tools in pursuit of relevant goals.
Cultural-Historical Factors

In Vygotsky’s theory, interactions with the minds of others in an educational setting are crucial for individual development. This interaction, however, represented more than just the development of an individual’s potential, for Vygotsky recognised that the mind is shaped by culture (the shared beliefs and practices of a particular social, age, or ethnic group), and by the history of that culture, and that this is essentially a human characteristic (Plotkin, 2003).

These cultural-historical aspects of Vygotsky’s theory illuminate the point that learning and development cannot be dissociated from their context (Schunk, 2004). The way that learners interact with their worlds - with the persons, objects, and institutions in it - transforms their thinking. In true dialectical unity, the meanings of objects change as they are linked with the world. In terms of critical thinking, Vygotsky’s theory suggests that critical thinking is shaped by, and at the same time will help shape, what it means to be a critical thinker in zoology. It recognises that zoology departments will have a culture that is shaped by their history, for instance valuing field trips and dissections might be part of that culture. It also recognises that, here in Otago, the culture of the zoology department will probably be quite different to elsewhere and the development of students as critical thinkers needs to be understood within this cultural-historical context.

Interpersonal (Social) Factors

According to Vygotsky social interactions with others is crucial for individual development. That is, cognitive development takes place when individuals learn socially relevant tools (hands, hammers, computers) and culturally relevant signs (language, writing, number systems) when they interact with others who socialise them into their culture (Doolittle, 1997; Palincsar, 1998). With respect to child development, Vygotsky argued that children initially use these signs and tools to serve solely as social functions - ways to communicate needs. Through the process of internalisation, these experiences (ideas, behaviours, or attitudes) first encountered in the social setting become part of the child’s mental functioning. Thus, Vygotsky believed that the internalisation of signs and tools led to higher thinking skills.
Cognitive change was, therefore, the result of internalising and mentally transforming these interactions.

Vygotsky argued that development is not simply facilitated by social interactions; he believed that social interactions fundamentally shape and transform the way we think (Cole & Wertsch, 1996). That is, the learner is fundamentally changed by experience. Vygotsky did not see development as a process of transmission. He argued that higher psychological functions develop through a process of enculturation; through the practices of that society mediated with tools and signs (John-Steiner & Mahn, 1996; Moll, 1990). Internalisation represents the complex process of transmission, transformation, and synthesis in the co-construction of knowledge.

Vygotsky also wrote about the interdependent and interconnected relationship between scientific and everyday concepts. He argued that the development of abstract, scientific concepts (such as concepts about the moon and the sun, and about day and night), taught in the classroom would relate to and become part of an individual’s thinking about everyday examples. Similarly, concrete, everyday examples would help make sense of the schooled concepts; that is, the everyday examples help mediate the acquisition of scientific concepts (Howe, 1996).

In Vygotsky’s thinking, the ideas and experiences of critical thinking that students have as a taught concept will grow down into the everyday, into the domain of personal experience, acquiring meaning and significance. At the same time, the perception and use of everyday concepts will also be transformed by interacting with critical thinking as a schooled concept. Thus, Sociocultural Theory would suggest that for the development of critical thinking it is important to go beyond the classroom walls so that classroom knowledge grows into the analysis of the everyday. On p67, I provide an example of a student who was taught critical thinking in a scientific context and then applied this to an everyday example.
ZONE OF PROXIMAL DEVELOPMENT

Vygotsky’s model of the Zone of Proximal Development (ZPD) describes the mechanism for the development of higher-order thinking. The ZPD is defined by Vygotsky as:

\[ \text{the distance between the actual developmental level, as determined by independent problem solving, and the level of potential development, as determined through problem solving under adult guidance or in collaboration with a more capable peer} \]

(Vygotsky, 1978, p86).

If the Zone of Current Development (ZCD) (Harland, 2003) represents what a learner can already achieve independently, then the ZPD represents the theoretical limits of learning, at a moment in time, with assistance from a more capable peer. In the ZPD, the more capable peer and the learner share cultural tools to work on a task that the learner could not perform on their own because of the difficulty level. At a later stage, if the learner is able to perform this same task without assistance, the outer edge of the ZPD (dashed line in Figure 1.2) now defines the limits of the new ZCD.

Figure 1.2 The relationship between Vygotsky’s Zone of Proximal Development (ZPD) and a learner’s Zone of Current Development (ZCD) (adapted from Harland, 2003)
Vygotsky believed that development occurs when the knowledge gained from culturally mediated interactions becomes internalised by the learner (Schunk, 2004). What happens in the ZPD, therefore, potentially leads to development, and this has implications for how individuals should be taught. In the ZPD (see Figure 1.3) the learner is stretched beyond their own knowledge, but only within a range that is within their grasp, given what knowledge and skills they bring to the task (Hein, 1991). If the task asked of learners is too great, then the ZPD does not form at all. If the task is not challenging enough, then development is not stimulated and learning is less than the theoretical potential.

![Figure 1.3: Three different learning experiences](image)

**Figure 1.3 Three different learning experiences when (a) tasks are suited to the knowledge and skills of individuals and (b) when tasks are too challenging or (c) not challenging enough**

In order to help a teacher assist the learner to reach their ZPD potential, the metaphor of scaffolding has been proposed to guide teacher thinking and practice (Bruner, 1975a). Scaffolding represents the support a learner is given to attain a goal or engage in a task otherwise out of reach (Davis & Miyake, 2004). For example, as the learner masters each element of the task, the teacher may ‘remove’ the scaffold support and gradually pass more control to the learner.
Scaffolding within the ZPD normally refers to the assistance received on a particular task. In this longitudinal study, I was interested in development over the course of a three-year undergraduate degree programme and scaffolding was also seen in this light. Therefore, I did not look at students' abilities to complete a specific task *per se*, but rather I investigated the experiences of students and their perceptions of how they had developed as critical thinkers across the entire curriculum. However, one of the problems of the ZPD is that it appears to be intuitive and as something that ‘seems right’. We have little idea about the explanatory power of the theory and the ZPD’s relationship to Vygotsky’s more holistic Sociocultural Theory of learning. Little is known of the parameters of the ZPD - what does it mean to be a ‘more capable peer’? What are the characteristics of the ZPD? How can the ZPD be used to understand critical thinking development?

It is these questions that I have set out to investigate in the context of the long-term development of critical thinking in zoology students.

**What is Known and Not Known about Vygotsky and the ZPD?**

Vygotsky’s career as a psychologist was brief, due to his premature death in 1934 from tuberculosis at the age of 38. Vygotsky had suffered from tuberculosis for fourteen years. Nevertheless, during his 10-year career, he wrote more than 100 books and articles (Meece & Daniels, 2008). Vygotsky’s publications, however, were banned in the Soviet Union and did not become accessible again until the late 1950s and early 1960s (Schunk, 2004). The problem was that Vygotsky had connected some of his work with pedology (the science of child development) which was at odds with the Communist Party who had decreed it to be ‘reactionary bourgeois pseudoscience’ (Davydov & Kerr, 1995).

In addition to the accessibility issue, many of Vygotsky’s ideas had not been fully elaborated before his death (Meira & Lerman, 2001) as he had been ill for most of his adult life knowing that he could die at any time. His thinking also changed markedly over the course of his productive life. For this reason, quotations drawn from various stages of Vygotsky’s life can provide a misleading account of his thinking. For instance, in his early writings, Vygotsky was greatly influenced by
Pavlov’s thinking. He displayed an approach to learning theory that was heavily
dependent on stimulus response connections, reflexes, and reactions. This was
completely unlike his thinking in the last 5 or 6 years of his life when he was
developing his Sociocultural Theory (van der Veer & Valsiner, 1991).

Vygotsky was also primarily a producer of oral narratives and this would have
contributed to a greater fragmentation of ideas, repetition, and a lack of cohesiveness
in his works (van der Veer & Valsiner, 1991). There are also on-going issues of
problems with the translation of the existing American editions (van der Veer &

Vygotsky died before he had been able to explore the determinants of his ZPD model
fully and since its re-discovery in the West it has been largely untested (Schunk,
2004). Part of the problem stems from the fact that it appears that Vygotsky himself
developed various formulations of the concept of the ZPD. For instance, much of his
early work was used in the narrow context of traditional intelligence testing and was
only later gradually broadened to encompass the general problem of the relationship
between education and cognitive development (Van der Veer, 1991; Meira &
Lerman, 2001).

Vygotsky’s ideas have had a major influence on higher education today, despite the
challenges of illness, translations, supressed and incomplete works. Contemporary
theorists who have built on the work of Vygotsky and have themselves developed
theories that have had a major impact on teaching and learning are: Cross & Angelo
made explicit the link between their work and that of Vygotsky’s. The connection
between the works of the other theorists and Vygotsky’s, is my own.

Cross & Angelo (1993) developed a system known as CATs or Classroom
Assessment Techniques that is based on Vygotsky’s ideas. In particular, the principle
of finding out what students are learning in the classroom and how well they are
learning it is very similar to the notion of the ZPD. For, like Vygotsky’s theories, the
emphasis is on observing and improving learning, and assessment techniques are
chosen to fit the subject matter and the needs of the classroom. Cross and Angelo
also argue that assessment should be mutually beneficial to both the student and the teacher.

With respect to curriculum design, Biggs & Tang (2007) have also been influenced by Vygotsky’s thinking. They proposed a theory of ‘constructive alignment’ (CA) which is pure Vygotskian thinking. In constructive alignment teachers need to be aware of what the intended outcomes of instruction is, that is, what they want students to learn. Teachers then need to devise activities for students that will achieve these outcomes. They also need to ensure that they provide an appropriate learning environment to encourage students to perform these learning activities. Finally, the student outcomes need to be assessed to see if they match the intended outcomes.

Lave & Wenger’s (1991) theory of communities of practice is a social learning theory similar to Vygotsky’s. It suggests that learning requires active participation and what people learn will be relevant to them as participating members of a particular community. There are connections here to Vygotsky’s notion of ‘enculturation’ where learners establish meaning by using the tools and signs of a particular group. These ideas are explored more fully in Chapter 4 (p87).
Chapter 2: Methodology

INTRODUCTION

In this chapter, I outline the details of the research design and methods that were selected to address the guiding questions and aims of the research.

As discussed in the introduction and literature review, the aim of the study is to investigate how students develop as critical thinkers over three years of a zoology degree programme. The purpose is to contribute to a theory of teaching and learning critical thinking and to ascertain if the ZPD can help researchers understand more about the complex nature of learning to be a critical thinker. The guiding questions for the research are as follows:

• What are the key curriculum experiences that facilitated students’ development as critical thinkers?

• How do social interactions affect students’ development as critical thinkers?

• How can the ZPD guide teaching and learning of critical thinking?

A research methodology should not only describe and analyse the methods used to generate and interpret data, but also present the philosophical framework within which the research project develops (Lather, 1992). This is because a researcher’s beliefs about what can be known (ontology) and how it can be known (epistemology) influences all subsequent stages of the research; such as the choice of research questions and the method used to answer these (Grix, 2002). Furthermore, Grix claims good research requires making these assumptions, paradigms, and frameworks explicit as it allows the research to be understood in a way that permits constructive dialogue and criticism.
Grix (2002) identified the core components of the research process as:

- ontology,
- epistemology,
- methodology,
- methods and
- sources.

He suggested that in order to be able to produce research of quality and transparency, it is crucial that the researcher understands the inter-relationship between these core components and that they are articulated clearly.

This chapter, therefore, provides a broad overview of the process used in this research. It is my intention to articulate clearly the core components of my research to ensure transparency and support my credibility and integrity as a researcher. Because the relationship between different parts of research is hierarchical, I will begin with my ontological and then my epistemological position as this makes it clear why I have chosen an interpretive methodology (which is the focus for the subsequent section). Following Grix’s outline, the next section of this chapter is the methods (sampling and recruitment techniques, and participant demographics) and then the sources of data (which includes ethical consideration, data analysis, and trustworthiness). I argue that these too, are logically linked to the research methodology.
ONTOLOGY

My ontological perspective is a starting point in this research. Recognising and understanding myself, as a researcher, who is part of the research process is important because this influences my epistemological perspective and therefore, my methodological choices.

Ontology is defined as a theory of being, how we see the world and our place in it (Grix, 2002). An ontological perspective is shaped by upbringing, education, work, family and experiences of interacting with people, technology and the natural world. These interactions shape who I am, how I think and behave, and what my aspirations, values and attitudes are.

My ontological perspective is that learning involves personal and social transformation. This position has been informed over a number of years from the participants in this study, from my supervisor, and from the higher education community. It has been reinforced by my own experiences of working within two disciplines (zoology and higher education), learning the language of a new discipline and discovering different ways of conducting research. Exploring my ontological positioning was an important developmental milestone in undertaking this research. Acknowledging and understanding my ontological positioning has given me confidence in articulating how I view the world.

I now see universities as institutions of transformation. In a Vygotskian sense, I view universities as dedicated learning environments to promote ways of being; they are not simply places for the acquisition of knowledge. As students struggle to make sense of who they are, the curriculum influences the kind of person they become. In short, this research has made me question the purpose of a higher education and this has changed me as a teacher and as a person.
EPISTEMOLOGY

If ontology refers to the nature of reality, then the closely related term ‘epistemology’ is concerned with how researchers can know the reality they wish to describe (Scott & Morrison, 2006).

As Grix states ‘people can come to think in certain ways, which are bound by certain cultural and social norms and parameters, for example those established by disciplines in academia’ (Grix, 2002, p178). My zoology background has given me a particular world-view that predisposed me to conduct research in a particular way. My role as a researcher was to understand the physical world using the scientific method (specifically the inductive-deductive approach). This approach involved making observations that led to the generation of hypotheses and subsequent predictions. These predictions were then tested using carefully designed controlled experiments. I did not, necessarily, view the world as having an existence independent of social actors, because, after all, ‘facts’ are socially constructed and consensually validated: as opposed to consisting of existing truths validated by nature. Science is after all, human interpretation of natural laws – rarely perfectly objective, but continuously vetted through the expectation that observations and experiments are repeatable, and hypotheses testable.

When I obtained my teaching position, my research interests changed, as I became increasingly interested in how students learn and how we, as teachers, can support learning. I quickly discovered that researching the social world is not the same as researching the physical, and more importantly when conducting research that involved people, I was no longer interested in experimental manipulation or testing of an objective ‘truth’. Instead, I wanted to investigate meaning and understanding. I wished to understand the participants’ different perspectives and then examine the implications of these different perceptions (or realities).

After more than 6 years of conducting qualitative research, my epistemological perspective is now situated within sociocultural and interpretative paradigms. These paradigms suggest that knowledge is not generated in isolation, but that it is generated through interaction, shared understanding, and it is co-created. Therefore, all parties come to the encounter with their own experiences, skills and knowledge
and both parties will change from the interaction. This interpretation leads me to believe that discovery of knowledge from this epistemological perspective is contextual, unpredictable and socially constructed.
METHODODOLOGY

My interest in the development of critical thinking as a research topic, the purpose of the research, and my research questions (stated in the Methodology, and Introduction and Overview Chapter) are a reflection of my ontological and epistemological view. My research approach is phenomenological, because it reflects this position and allows me to understand the multiple social constructions of meaning given to a particular context by the research participants. A phenomenological study describes a person’s lived experiences of a concept or a phenomenon (Creswell, 2007). In this research, the phenomenon under investigation is the experiences of critical thinking development within the zoology curriculum. My role as a researcher, therefore, is to get close to the participants in order to understand the varied and multiple meanings of their experiences. I then make an interpretation (shaped by my experiences and background) on the meanings that they have about the world. The understanding that develops is viewed not as being objective, but rather as being co-constructed as I interact with the participants (Denzin & Lincoln, 2003).

The challenges for phenomenology, as identified by Creswell (2007), include carefully selecting the participants so that they all have experienced the phenomenon under investigation, and understanding the role of the researcher in the research process. In this study, the first challenge was unproblematic as the criteria for inclusion in the project meant that all participants would have experienced the zoology curriculum. I was mindful, however, that student experiences of critical thinking come from a myriad of sources (including non-zoology papers). As a researcher, I was open to all of these sources of development and the impact they might have on student learning.

Exploring my role as a researcher was influential in my methodological choices. During the research process, I have reflected on my own values, attitudes and experiences in relation to my approach to data collection and interpretation of findings. I liken my ‘insider’ perspective to that described by Moustakas (1995) ‘being-with’ in the research partnership. According to Moustakas, ‘being-with’ involves being present as an individual who brings knowledge and experience into the relationship and uses this to facilitate being fully involved, by exploring and
sharing the experience together. The research space then becomes separated from other parts of life and professional work as the researcher and research participants focus exclusively on an exploration of ideas and experiences in order to learn and construct knowledge.

All methodologies have their limitations. For the positivists, reliability and validity are important criteria for evaluating the quality of research and its trustworthiness. Reliability is the extent to which research findings can be replicated (LeCompte & Preissle, 1993) however this is problematic as an interpretive methodology deliberately tries not to control or manipulate conditions or variables, but rather aims to provide an accurate portrayal of social realities as they are perceived by the participants (Cohen, Manion, & Morrison, 2000). Further, human behaviour is never static, and the social contexts that are investigated are assumed to be multi-faceted and highly dependent on the social context (Merriam, 1998).

Lincoln and Guba (1985) propose the use of ‘dependability’ and ‘consistency’ as alternative criteria appropriate to interpretive studies. The emphasis shifts from being able to obtain replicable results, towards providing sufficient evidence for the reader to concur that, given the data collected, the results make sense; that is, they are consistent and dependable. As Dey (1993) argues: ‘If we cannot expect others to replicate our account, the best we can do is explain how we arrived at the results’. Dependability in this context can be maximised through prolonged engagement in the field allowing continual data analyses and refining of constructs to ensure a match between researcher categories and participant realities, member checks or respondent validation. At the end of this chapter, I have addressed the criteria for judging the quality of this research.
Method

Where methodology includes epistemology and the interpretive framework that guides a particular research project, method refers to techniques for gathering empirical evidence (Lather, 1992). Students’ experiences of development of critical thinking are central to this thesis, but a Vygotskian perspective of development focuses not just on the students but also their teachers, the curriculum and their environment, and how these influence the development of critical thinking. Therefore, all of these data sources will inform the study. The interpretive research methodology used (and hence its design) strives to align Vygotskian processes with respect to student learning. In order to understand something as complex as the development of critical thinking, an approach is required that reflects the ‘systemic’ nature of the phenomenon under investigation as all elements of the study are interdependent.

Sampling and Recruiting

This study took place in the Department of Zoology, University of Otago, between 2006 and 2008. The participants were not selected based on any particular criteria except that they needed to be majoring in zoology. Participants were obtained by posting an announcement on the BlackBoard Course Management System (CMS) for the first year Animal Biology (BIOL112) paper. In this announcement, details of the study were posted, as well as what the students’ commitments would be, and how they themselves might benefit. They were asked to contact me directly by email or telephone if they were interested in being involved with the study. At this point, the students were given ethics consent forms (see Appendix A) and more information about the project (Appendix B). There was a good response to this initial announcement, but in order to increase the number of participants a further recruitment took place by talking to the students directly in the laboratory sessions. Thirty students expressed an interest in the project (approximately 10% of the first year cohort), however two withdrew before taking part in any interviews, and one student was not included as he was not sure if he was going to major in zoology.
Participant Demographics

Twenty-seven students took part in the study. Nineteen participants (70%) came from outside the Otago area and this is typical for first year students at the University of Otago. The remaining demographics of the participants are presented in Tables 2.1a and 2.1b (p46-47).

Table 2.1a Interview participant demographics including; major subject, year of study and programme enrolled for.

* In 2006, all of the participants had zoology as one of their major subjects. At the University of Otago, it is possible to have more than one major subject. Other majors listed were; ECOL Ecology, ANTH Anthropology, MANT Management and PHIL Philosophy.

** All students in 2006 had the Bachelor of Science (BSC) as their listed programme. Three students had enrolled for a double degree. Two of these were for a Bachelor of Arts (BA) and one was for a Bachelor of Commerce (BCOM).

<table>
<thead>
<tr>
<th>Major*</th>
<th>Total</th>
<th>Year of Study</th>
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<td>BSC/BA</td>
<td>2</td>
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<td>1</td>
<td></td>
<td>BSC/BCOM</td>
<td>1</td>
</tr>
<tr>
<td>MANT 1</td>
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<td>1</td>
<td></td>
<td></td>
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<td>PHIL 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 2.1b Interview participant demographics including gender, date of birth and the years in which they took part in interviews.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Gender</th>
<th>Date of Birth</th>
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<td>✓</td>
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<td>F</td>
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<td>✓</td>
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</tr>
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<td>F</td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
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<td>✓</td>
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<td>X</td>
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<td>F</td>
<td>1987</td>
<td>✓</td>
<td>✓</td>
<td>X</td>
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</tbody>
</table>

Total | 27    | 22    | 18    |
Sources of Data

Student Semi-structured Interviews (Years 1-3: 2006-2008)
I took an active interview approach because of my ontological and epistemological position and this is supported by Freebody’s suggestion that interviews can ‘provide insight into individuals’ constructed social worlds’ (Freebody, 2003, p137).

An active interview is a collaborative process where meaning is actively constructed in the interview encounter (Holstein and Gubrium, 1995). The interview process requires attention to be placed on both what is asked and how it is asked. The encounter provides for a ‘reflective space’ where both the researcher and interviewee have the opportunity to recall ideas, consider new information, insights, ideas or events that have not been understood before, or make connections or links through the process of co-construction of knowledge. The ideas, insights, new or different understandings may unfold spontaneously during the course of the interaction, or they may require great effort with careful questioning and probing.

The interview space facilitates the collection of ‘rich data’ through the participants telling their own stories concerning the phenomena of interest. It requires the researcher to be actively engaged in the interview, to be attentive to providing a safe space where the researcher and interviewee work with each other in partnership. The interview becomes an occasion to construct understanding, not merely to convey information (Holstein & Gubrium, 1995). I endeavoured to collect rich data in the interview encounter, by developing trust and rapport, exhibiting genuine interest and attention, and providing appropriate responses to verbal and non-verbal cues. I was mindful of the purpose of the active interview to provide an occasion that is likely to produce data in which new ideas can be discovered. An active interview aligns well with my interpretive, co-constructive research approach that values multiple ways of knowing and seeks shared understanding.

A total of 67 interviews were carried out over the years 2006-2008 (Table 2.1b, p47). Twenty-seven of these were in 2006, 22 in 2007, and 18 in 2008. All interviews were conducted face to face, except for one interview that was conducted over the phone as the student had returned home to look after her mother who was unwell at the time.
When looking at students’ experiences of developing as critical thinkers, the guiding interview questions (see Appendix D, p172) emphasised Vygotsky’s holistic approach to understanding development. These questions, therefore, focused on the following: the students; their environment; the teachers; the curriculum, and how all of these influenced students developing as critical thinkers.

The following section outlines the specific methods used to collect interview data.

- Prior to the first interview, participants were sent a brief personalised email outlining in lay terms what the project was about (Appendix C). To provide a framework for the interview, I asked each participant to think about his or her best learning experience in the BIOL11 course (the foundation zoology paper). I also asked them to think about what it was about this experience that made it important. Finally, I asked them to think about how they had changed as a learner. I wanted the tone of the interview to be conversational (rather than a formal interview), so I deliberately noted that these ideas would be explored together.

- Audio-taped interviews were undertaken of approximately thirty five to sixty minutes duration. Participants were interviewed using a semi-structured technique. This open interview framework enabled students to explore their thoughts and carefully reflect on issues that they determined as important. The purpose of these interviews was to discover how students learn, what they learn, and how this learning changes over time.

- After each interview, I made reflections in a research diary to provide documentation of the unique context of the interview.

- Interviews were transcribed. All information was coded using pseudonyms and dates to protect anonymity, and was stored securely.
**Student Interpersonal Process Recall (2008)**
In addition to the semi-structured interviews, one 3rd year tutorial was video-taped for the purposes of allowing students to take part in an in-depth exploration of their experiences using the technique of Interpersonal Process Recall (IPR). In this process, the videotape is used as a tool to help the participants understand and reflect on a learning situation (Kagan et al., 1969). The purpose was to gain further insight into the social interactions that result in the construction of critical thinking.

The specific methods used were as follows:

- In the first semester of 2008, four participants were videotaped discussing their group projects with their supervisor (who in this case was also their lecturer).

- Next, so that the participants would feel unrestricted to comment on anything that they thought was important, the supervisor was asked to leave the room.

- The video of the interaction between the students and their supervisor was immediately played back to the students and they were asked to pause the video at any time they wished to make a comment. During the play back of the video, these reflective conversations were audiotaped. My role as facilitator was to ask questions to stimulate reflection and recall. I did not ask questions of fact, but instead asked probing questions such as ‘How did that make you feel?’ ‘Could you tell me more about that?’

The idea behind IPR is that recall is patchy at the best of times, but by reviewing a videotape to recall one’s thoughts and feelings, and then articulating these during a tape review, IPR can stimulate tacit thinking. The method has been used in a variety of ways for different purposes (Kagan, 1984). It was hoped that IPR in this instance could give some insight into the tacit thinking of students as they interacted with their teacher.
Other Sources of Data

The main sources of data used in this thesis were the interviews and IPR. The secondary sources listed below were used in a variety of ways to help me interpret the main sources. This interpretive function included elements of checking meaning and clarifying my own understanding of emerging ideas. Being in contact with students outside of the interviews also allowed a new relationship to be formed and students to feel more connected to this longitudinal study. Over the course of the project other sources of data were:

1. informal conversations with participants
2. email correspondence
3. course documents (such as laboratory manuals)
4. course objectives
5. final examinations
6. my reflective diary
7. and research blog
ETHICAL CONSIDERATIONS

An ethics application involving human participants was approved at a Departmental level in accordance with University of Otago institutional policy and procedures (see Appendix A). Once the participants indicated that they were interested in taking part in the research, a written information sheet (Appendix B) was provided along with a consent form (Appendix C). These forms demonstrated that the participants acknowledged that they understood the purpose of the research and their participation, that their questions had been answered to their satisfaction and that they had the right to request further information at any stage. Participation was acknowledged as voluntary and therefore, they could withdraw from the project at any time without disadvantage. In addition, participants were made aware that the interview approach incorporated semi-structured, open-ended questions.

Interviews were transcribed and the participants’ names were made anonymous and pseudonyms are used in this thesis. Only the researcher had access to the data and the name of the respondent from whom the data was collected. The academic supervisor and the transcriber had access to the data but not to the participants’ names. Participants were aware that the results of the research might be published and available in the library at the educational institution.

In addition, email correspondence was sent to all participants reminding them that the interviews were anonymous and that they were welcome to comment on my findings. These findings were disseminated in my research blog, a Departmental seminar, and a published paper (see Appendix F, p176).
DATA ANALYSIS

A general inductive approach was used for data analysis in this research (as described by Thomas, 2006). The method is a simple and straightforward approach for deriving findings (themes, concepts) from raw data through detailed readings of the data transcripts. In a general inductive approach, the researcher determines the important themes, and selects the data to support, describe and elicit meaning from these. This approach ‘fits’ with my ontological and epistemological position in this research, where the primary purpose is for me (the researcher - practitioner) to gain understanding and meaning from participants’ experiences of critical thinking development.

The process of general inductive analysis as described by Thomas (2006) and used in this research is as follows.

1. Preparation of raw data files

   Raw data files (voice-recorded interviews and IPR) were transcribed verbatim and saved as text-formatted electronic files. The interviewer and participants were clearly identified by coding the interviewer as ‘I’ and participant as ‘P’ for the precise sequence of the interview. Electronic versions of the transcripts were imported into the qualitative analysis software ‘HyperResearch’.

2. Close reading of the text

   The transcribed data (text) was read (in hard copy) multiple times to gain an understanding of the content and themes covered within the text. Notes were made on each interview transcript and coded within HyperResearch by highlighting important or common phrases. Note, HyperResearch was used to facilitate searching and retrieving codes, it was not used as an analytical tool.
3. Creation of categories

Categories or themes were identified and defined. During this process, I was able to use actual phrases derived from the text segments to use as category labels for the common themes that emerged. Text was coded into categories and transferred to a matrix display for further analysis.

4. Overlapping coding and uncoded text

Thomas’s inductive approach allows for segments of text to be coded into more than one category and some text may not be coded into any categories if the researcher views them as irrelevant to the research aims and questions. Overlapping data were re-scrutinised, therefore, through the matrix displays to assist in the refinement of data and to reduce the number of category labels to those that best represented the key themes.

5. Continuing revision and refinement of categories

This final stage of the inductive process involved merging common categories, searching for contradictory points of view and new insights, and selecting appropriate quotations that convey the core theme of each category. I found that selection of key quotations for each theme assisted in further refinement of the categories. This process was also useful to identify any further areas of overlap and decision-making about text that was not congruent with the research aims and questions. Continuing revision and refinement of categories was done through the matrix display for ease of managing the data analysis.
TRUSTWORTHINESS

The intention is that the findings from this qualitative research will meet the criteria of ‘trustworthiness’ so that the participants and readers of this research will be confident that the findings are grounded in the data (Lincoln & Guba, 1985). Guba (1981) proposes that the following four criteria should be considered in the pursuit of trustworthiness.

1. Credibility

Credibility with respect to qualitative research is the confidence that the researchers have accurately recorded the phenomenon investigated (Shenton, 2004). I ensured credibility by using well-recognised research methods (semi-structured interviews’, interviews transcribed verbatim’, and by using the general inductive approach for data analysis). Participants were selected to be as inclusive as possible of the ‘multiple voices’ that represented the diversity of the student population and in doing so I gained a greater knowledge of the wider group. I used triangulation of methods (interviews and IPR) and supporting data from course documents to provide a context and help understand and explain the students’ experiences. Shenton (2004) suggests that in order to ensure honesty in participants’ responses, there should be opportunities for participants to refuse to participate in the research. This will ensure that the interviews are with participants who are genuinely willing to take part in the study and contribute to the data. Before any interviews had taken place, in my study, two participants withdrew for personal reasons, without any repercussions. Another participant, who was not interviewed in her second year, wished to come back into the study in her third year. This suggests to me that the participants were aware that their input was voluntary and they understood they could leave the study (or come back into it) at any time without fear of repercussion.

Another way of ensuring credibility is through opportunities for scrutiny of the research project (Shenton, 2004). One way of achieving this is through peer scrutiny by the research community. Some of the findings of this research have been published in an international journal of high standing, and
over the course of the study, I have presented research outcomes at conferences on six occasions. I also used a research diary as a form of ‘internal’ scrutiny to evaluate the project as it progressed, to record and monitor my thoughts on patterns and theories that emerged.

2. Transferability

Transferability is concerned with allowing readers to make connections to the themes in the research. Throughout the results and discussion chapters, I used verbatim quotations from interview participants and those that provided qualitative comments in the survey to provide ‘rich’ descriptions of student experience. Sufficient depth in reporting, in addition to making explicit the research approach, methods, participant demographics, data collection and analysis, allows the reader to consider the findings in terms of potential application to their own context.

3. Dependability

I take the position that a positivist’s perspective of dependability would be problematic in qualitative research, where the context is unique and never static. Dependability refers to the fact that if the research were repeated, in the same context, with the same methods and with the same participants, similar results would be obtained (Shenton, 2004). I know that I have changed as a researcher and as a person from what I have learned from the participants and I have evidence that they also have changed from being involved in this study and reflecting on their learning (see Chapter 3, p69). The specifics of what has been learned can never be repeated, as these are unique for this particular context and if the study were repeated, the exact results would differ. The general features of what was learned, how it was learned, and what facilitated learning would, however, remain valid. What I have tried to do, therefore, is to ensure that the processes within the study are reported in detail, thereby enabling a future researcher to repeat the work, if not necessarily to gain the same results. I have demonstrated dependability by providing a detailed explanation of the research design and methods. I have
examined the data within a relevant theoretical framework, and I have documented any ethical considerations.

4. Confirmability

According to Guba (1981) another criterion to judge the trustworthiness of qualitative research is confirmability. According to Shenton, confirmability is to ‘ensure as far as possible that the work’s findings are the result of the experiences and ideas of the informants, rather than the characteristics and preferences of the researcher’ (Shenton, 2004, p72). My reflective diary was used in this research to document my beliefs and acknowledge any predispositions that I had when interpreting the data. I have been alert to data that did not support the theory and I have discussed these in the thesis.
CONCLUSION

The core components of my research have been described in depth to provide transparency in the research process and therefore demonstrate my commitment to achieving high quality research. I have outlined my position as a researcher in terms of my ontological and epistemological perspectives, and in doing so I have demonstrated alignment and congruency with my methodology and methods in order to answer my research questions. I have included justification for choices in data collection and analysis approaches.

I wish this thesis to be judged in terms of whether I have displayed mastery of an appropriate methodology and theoretical material, but with consideration to a topic that is complex and difficult to research. I hope that this thesis has something of interest to say – I think it has (and my publication in an international journal would support this). It is not enough to have something to say, however, if it is not accessible to the reader. This too, is how I would like to be judged.
Chapter 3:
Critical Thinking and Curriculum

The following chapters (3, 4, and 5) are the findings chapters. They have been divided up this way in order to help answer the following research questions.

- What are the key curriculum experiences that facilitated students’ development as critical thinkers? (Chapter 3)
- How do social interactions affect students’ development as critical thinkers? (Chapter 4)
- How can the ZPD guide teaching and learning of critical thinking? (Chapter 5)

ABSTRACT

Vygotsky realised the importance of instruction for learning and development, and although he did not address curriculum effects directly, his intention was that his theory would lead to better methods of instruction (Howe, 1996). In Chapter 3, I investigate how curriculum experiences contribute to students’ development of critical thinking and I consider these in light of the Ennis’ (1989) typography of critical thinking instruction.

In the Department of Zoology, University of Otago, most students are not taught critical thinking directly, but instead they take part in various activities that are thought to indirectly help them learn the skills and dispositions required of a scientific researcher, one of which is critical thinking.

Student-interview transcript data were used to gain an understanding of how students developed as critical thinkers over the course of the undergraduate programme; how students changed as learners, their best learning experiences, and the expectations they had of the zoology curriculum.
The results suggest that critical thinking development was also associated with some key curriculum experiences, in particular group project work in the students’ third year. From first to third year, participants reported taking personal responsibility for their learning, improvements in their writing, and changes in their attitude towards learning. The best learning experiences were hands-on activities (Year 1), interactions with staff (Year 2) and finally autonomy in what and how they learned (Year 3).

Some students expected more freedom in the early stages of their degree and this raises questions about teachers’ and students’ expectations of the curriculum. If critical thinking is one of the purposes of a higher education then teachers and students need to share this understanding. The curriculum should then be designed around activities that require students to think critically, rather than what to think, and they need to be assessed appropriately.

Learning zoology is based upon a ‘facts first’ curriculum as a foundation for critical thinking in the later years. Critical thinking principles, however, are not made explicit and it is assumed that students will become more critical in their thinking by taking part in research activities. Although the participants reported increases in their ability to think critically using this model, it does beg the question if this is the best way of organising a curriculum. For example, if aspects of year 3 were brought forward to year 1, would this allow for a better development of critical thinking?
INTRODUCTION

Students will acquire factual knowledge as they go through the course of their degree programme, and knowledge of a topic is necessary for critical thinking. There are, however, many dimensions to student learning that will affect their capability for critical thought, and we currently know little about how higher education experiences contribute to this development (Norris, 1985; Renaud & Murray, 2007).

In this chapter, I look at how the zoology curriculum affects the development of students as critical thinkers. I begin by providing details on the structure of the zoology degree programme, and then I report on activities and course objectives that relate to critical thinking development.

The Structure of the Zoology Degree Programme

Zoology is one of the most interdisciplinary subjects in science and this is reflected in the fact that the staff consists of ecologists, physiologists, developmental biologists, geneticists, evolutionary biologists, mathematicians, and even filmmakers. There is considerable flexibility in the choice of subjects that students can take and this includes both science and non-science papers.

The BSc is a programme of papers with a combined value of not fewer than 360 credit points (see Table 3.1 p62). The degree must include at least 180 points at 200-level or above. The remainder of the 162 credit points that is required to complete a degree (in addition to those specified for a Zoology major) can be made up from a wide range of subjects at 100-, 200- and 300-level in areas as diverse as anatomy, biochemistry, botany, chemistry, computer science, ecology, genetics, geography, geology, mathematics, microbiology, physics, physiology, psychology and statistics. Students are also permitted to include up to 90 points from non-science papers.
Table 3.1 Paper requirements for a Bachelor of Science (BSc) majoring in Zoology

<table>
<thead>
<tr>
<th>Level</th>
<th>Papers</th>
<th>Points</th>
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<tbody>
<tr>
<td>100-level</td>
<td>BIOL 112 (Animal Biology)</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>CELS 191 (Cell and Molecular Biology)</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>STAT 110 (Statistical Methods) or STAT 115 (Introduction to Biostatistics)</td>
<td>18</td>
</tr>
<tr>
<td>200-level</td>
<td>ZOOL 221 (Animal Designs for Living)</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>ZOOL 222 (Evolutionary Biology)</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>ZOOL 223 (Animal Physiology)</td>
<td>18</td>
</tr>
<tr>
<td>300-level</td>
<td>Three of</td>
<td>54</td>
</tr>
<tr>
<td></td>
<td>ZOOL 313 (Environmental Physiology)</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>ZOOL 314 (Neurobiology)</td>
<td></td>
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<tr>
<td></td>
<td>ZOOL 315 (Behavioural and Evolutionary Ecology)</td>
<td></td>
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<td></td>
<td>ZOOL 316 (Biological Data Analysis and Computing)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ZOOL 318 (Freshwater Ecology)</td>
<td></td>
</tr>
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<td></td>
<td>ZOOL 319 (Conservation Biology)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>GENE 312 (Evolutionary Genetics)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>One further paper from</td>
<td></td>
</tr>
<tr>
<td></td>
<td>GENE 314 (Developmental Genetics)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MARI 301 (Marine Ecology)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MARI 302 (Biology and Behaviour of Marine Vertebrates)</td>
<td></td>
</tr>
<tr>
<td>Plus</td>
<td>180 further points; must include 54 points at 200-level or above.</td>
<td>180</td>
</tr>
<tr>
<td></td>
<td>Up to 90 points may be taken from outside Science</td>
<td></td>
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<tr>
<td>Total</td>
<td></td>
<td>360</td>
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</table>
The Zoology Curriculum and Critical Thinking

The overarching concept behind the zoology curriculum is that learning to become a zoology researcher will develop the required critical attributes of higher education (which includes the ability to think critically).

I have taught zoology for 12 years in the Department where this study takes place and I understand that the curriculum is organised around the idea that factual knowledge needs to be acquired before critical thinking is achievable. Although this assumption has never been queried, first-year students concentrate on learning facts and theories. They are then expected to apply these as they gradually develop their critical capacities through research training that culminates in a semi-independent project in their third year.

At first year, many of the curriculum activities that students do to enhance critical thinking are passive, such as listening to a lecturer talk about research during a teaching block. Activities that are more active focus on establishing technical skills that will help in critical thinking, for instance, learning how to use the library database to retrieve journal articles.

At second year, students are involved in more practically oriented activities and up to 30% of the final mark involves writing research reports based on three field trips. The aim of these reports is to develop data handling skills, presentation skills, and scientific report writing skills to address a set of questions. The emphasis is on appropriate writing style, correct citations, and formatting. The second year laboratory reports are also highly structured and students are given detailed feedback on their writing. The classes are smaller and the curriculum content is becoming more detailed.

Group work is emphasised at all stages of the undergraduate zoology curriculum, however, during their third year of study, group project work often involves students coming up with their own research questions, collecting and analysing data and presenting their findings to the rest of the class. As well as being assigned independent project work, third year students are no longer taught from a textbook, instead, they are asked to analyse and critique published literature that is discussed during class time.
The zoology curriculum at the University of Otago and the one used in this study is classified as ‘immersion’ using Ennis’s (1989) typography. The immersion technique involves providing students with thought-provoking subject matter. Students get deeply immersed in the subject, but general critical thinking principles are not made explicit.

The course objectives from various papers (from 1st to 3rd year) that provide a foundation for developing students as critical thinkers are presented in the following table (Table 3.1, p65). These course objectives are made available to the students in various course documents and on the Course Management System - BlackBoard. How these objectives translate to teaching activities is also not made explicit to students.
Table 3.2 Existing course objectives from 1st – 3rd year in the Department of Zoology that provide a foundation for developing students as critical thinkers.

<table>
<thead>
<tr>
<th>1st Year</th>
<th>2nd Year</th>
<th>3rd Year</th>
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<tbody>
<tr>
<td>Appreciate and demonstrate the importance of thinking scientifically</td>
<td>Critical thinking, self-evaluation and self-confidence</td>
<td>The ability to think critically. In particular, you should be able to evaluate whether or not the answers you have obtained are sensible, and what they mean biologically.</td>
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<tr>
<td>Analyse issues logically bearing in mind all viewpoints &amp; make informed decisions</td>
<td>Critically evaluate different theories</td>
<td>Understand how to critically evaluate literature.</td>
</tr>
<tr>
<td>Appreciate the need to communicate information &amp; arguments effectively using written &amp; oral skills</td>
<td>Written communication skills</td>
<td>Communication</td>
</tr>
<tr>
<td>Understand &amp; demonstrate how to work as part of a team</td>
<td>Work individually and as a team</td>
<td></td>
</tr>
<tr>
<td>Develop intellectual independence &amp; foster a commitment to lifelong learning</td>
<td>Self-responsibility for learning</td>
<td></td>
</tr>
<tr>
<td>Know how to access information about biological issues</td>
<td>Learn how to obtain information from multiple data sources</td>
<td>How to locate &amp; synthesise information</td>
</tr>
<tr>
<td></td>
<td>Integrate and interpret information from different sources and judge its quality</td>
<td>A knowledge of when you need to ask for help in order to use more advanced statistical techniques.</td>
</tr>
<tr>
<td></td>
<td>Develop an inquiring mind</td>
<td>A healthy scepticism of other people's statistics.</td>
</tr>
</tbody>
</table>
Critical Thinking in Scientific Training  

Critical thinking is not the exclusive domain of those who practice the scientific method, but if one thinks about critical thinking as requiring discrete skills and dispositions required for determining the authenticity, accuracy and worth of information or knowledge claims (Beyer, 1985), viewed in this manner, it fits well within formal and applied scientific frameworks. Indeed critical thinking has even been equated to scientific thinking (Schafersman, 1991) because scientists use criteria to make judgements about the quality of something (for instance the experimental design or statistical analysis used) and this process involves acquiring information and evaluating it to reach a well-justified conclusion or answer. Therefore, critical thinking should be learned during a scientific apprenticeship.

Brookfield (2012) claims that the natural sciences have informed other traditions of critical thinking (analytical philosophy and logic, pragmatism, psychoanalysis, and critical theory) by stressing the importance of observation and evidence gathering. It also encourages a disposition of openness: ‘the most passionately held convictions are open to being revised, or even abandoned, in the face of evidence (including personal experience) that they are wrong’ p38. In short, all knowledge is provisional.

Researchers who use the scientific method, therefore, tend to be cautious when presenting or being presented with numbers and percentages. They try to make sure that any comparisons are not misleading and they are careful not to overstate their claims. They are also careful not to confuse causation with association because, as humans, we tend to ‘see’ events that are associated, or ‘go together’ as events that cause one another (Browne & Keeley, 2005). The scientific method tries to avoid natural human bias by using appropriate experimental designs (including control treatments) and statistical techniques.

Critical thinking is part of the scientific method and therefore needs to be part of a zoology student’s education. Critical thinking, however, should be pervasive and we see a need for its application in many things we do, for example talking with peers or reading the newspaper. There are links here with Vygotsky’s claims that scientific concepts and everyday examples are interdependent.
What follows is an example that epitomises some of the attributes of a researcher using the scientific method and how these apply to critical thinking. In this example, the zoology student challenged the data – it was not a personal attack, but rather a critique of the evidence put forward to support the claim that had been made. The purpose was not to refute the data but critically examine it. He saw this as his role and responsibility as a scientist to provide the public with reliable information. This is an example of critical thinking in action. So curriculum and training for critical thinking can also examine values and align with everyday concepts.

In recent news (Clayton, 2011) data was presented that suggested it was possible to predict earthquakes from an analysis of the moon’s cycle. This item was particularly relevant as it occurred shortly after the Christchurch, New Zealand earthquake which killed 181 people (2011 Christchurch earthquake, n.d). Understandably, after the quake the people of Christchurch were scared and wanted answers as to the likelihood of another. An argument was put forward that there was an increased chance of an earthquake in the Christchurch region based on the position of the moon. The reasoning was that a full moon would put more pressure on the Earth’s crust and increase the likelihood of an earthquake in regions close to or on fault lines (as in the Canterbury regions of Christchurch).

A zoology student from the University of Otago analysed this same data set and he revealed that earthquakes had been predicted on most days throughout the year. The student concluded that when someone makes this many predictions it is straightforward to go back to the data and make a claim of cause and effect. This particular student then examined the phases of the moon and compared these to the aftershock activity. He found that there was no correlation and the huge scatter amongst the data meant there was no predictive power whatsoever.
RESULTS AND DISCUSSION

The results and discussion of this chapter is subdivided into the following four sections:

1. Students Developing as Critical Thinkers
2. Students Changing as Learners
3. Curriculum – Best Learning Experience
4. Curriculum Expectations

1. Students Developing as Critical Thinkers

This section describes the participants’ development of critical thinking in general terms, each year, for the three years of their undergraduate degree.

All students found it hard to define critical thinking in their first year of study and there was very little evidence from the way in which they described their learning that what they were doing required much in the way of reasoning or evaluation of knowledge. By their third year, however, there is no doubt that the students involved in this study had developed in their ability to think critically, especially in their conception of critical thinking as involving the assessment of evidence (Ennis, 1962). Critical thinking at this time was described as ‘critiquing things’, ‘independent thinking’ and ‘developing their own ideas’. Some recognised their thinking changed because of the increased confidence that came from success in research tasks, and the insight that their own ideas could be valued by others. This important development was clearly seen as part of professional formation and students reported that they needed to ‘think like a zoologist’ to be successful. Most recognized that such thinking could also be transferred to other inquiry situations. For instance, some students who took particular ecology or psychology papers on scientific method and critical thinking were able to transform what they had learned about arguments and evaluation and apply it equally to papers they were taking in the zoology programme.
They always say the whole point of a degree is critical thinking, I've definitely found that to be true. Everyone has their own motivation for saying things and making a point. For every article you read they're always driving at something underlying that I never would have thought about before. Especially doing conservation ecology at the moment, just the arguments that everybody has, comes out to what they want it to say and it's really made me think about you can't just accept what everyone says.

Gina (Year 3)

There was also evidence for critical thinking through students reflecting on what and how they learned. This phenomenon could be seen at all stages and was at least, in part, due to the students’ participation in the study. That is, the students benefited from being reflective about their learning rather than it being a requirement of the curriculum per se. During the final stages of the study, the participants’ relationship with their teachers changed, as the teachers became important role models for dispositions such as 'having an open mind'.

2. Students Changing as Learners

In this section student insights into their learning (that is, how had they changed as learners) are reported as 11 interrelated themes. Not all of these themes would directly encourage critical thinking skills or dispositions but they are the foundations of a learning environment that has the potential to be critical. For example, students recognising in first year that they have to take more responsibility for their learning does not promote critical thinking per se, but without students recognising the need to take this responsibility, it is unlikely to set the conditions for critical thinking. Of course, this argument applies to student attitudes, confidence and knowledge.
The participants reported the most profound change in their first year of study was that they were now taking more responsibility for their learning (Figure 3.1 and Table 3.1, p70-72).

Figure 3.1 Participants were asked, ‘How have you changed as a learner? ’ each year, for the three years of their undergraduate degree. Their answers were categorised and the number of responses from each year (Y1, Y2, Y3) is presented. Note it was possible for participants to name more than one best experience or none at all.
Table 3.3 Participants were asked, ‘How have you changed as a learner?’ each year, for the three years of their undergraduate degree. These are the theme descriptions from their categorised responses and used in Figure 3.1.

<table>
<thead>
<tr>
<th>Theme</th>
<th>Theme description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taking personal responsibility</td>
<td>Students found themselves paying more attention in class and being more disciplined with their work habits.</td>
</tr>
<tr>
<td>Understanding University</td>
<td>The biggest changes that occurred to these students were learning benefits resulting from understanding the University system or figuring out what the lecturers really wanted for an assignment.</td>
</tr>
<tr>
<td>More interaction and learning from groups</td>
<td>Students valued the interaction that they got from working with others. This included learning to trust others.</td>
</tr>
<tr>
<td>More relaxed about learning</td>
<td>The biggest change for students was that they became less concerned about their ability as learners</td>
</tr>
<tr>
<td>Positive attitude towards learning</td>
<td>Students who reported a more positive attitude towards learning had learning as their number one priority. They were learning for themselves and not necessarily for a higher grade. They were learning for the sake of knowledge and cared whether understanding was taking place.</td>
</tr>
<tr>
<td>Improvements in writing</td>
<td>Students noticed an increase in their vocabulary and improved structure in their writing. They also noted the importance of developing evidence-based arguments.</td>
</tr>
<tr>
<td>Increased confidence</td>
<td>Students reported the most profound change for them as learners was an increase in their confidence. For instance in group situations they would have the confidence to put their own opinion forward or were able to approach a lecturer for clarification of a topic.</td>
</tr>
<tr>
<td>Theme</td>
<td>Theme description</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-----------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Decreased confidence</strong></td>
<td>These students noted feeling less confident as their study habits deteriorated.</td>
</tr>
<tr>
<td><strong>Knowledge awareness</strong></td>
<td>Students had self-awareness of knowledge (whether they knew something or not) and that this knowledge was being built on. They also commented that they were gaining an appreciation that knowledge is contestable.</td>
</tr>
<tr>
<td><strong>Learning style awareness</strong></td>
<td>Some students reported an awareness of their learning style.</td>
</tr>
<tr>
<td><strong>Self-awareness</strong></td>
<td>This theme included students who developed a self-awareness of what they wished to do (or not do) as a career and an awareness of how they viewed the world differently because of what they had learned.</td>
</tr>
</tbody>
</table>
Taking personal responsibility for their learning was attributed by at least one student to realising that University is different from school. At first year, teachers at University will not ‘chase them up’ for late assignments and so forth. Some interpreted this as an attitude of not caring.

A transition period occurred in the second year, where students saw improvements in their writing, increased confidence, and they reported that they understood the system better. This was also the year that most reported that as a learner they felt ‘they had gotten worse’. These students were commenting on the deterioration of their study habits. For two of the students the reason given was that they now realised that they were academically capable of passing the course. That is, they were in a better position than in the first year of knowing their own capabilities and this led to them either having ‘lazier’ study habits, or the realisation that they needed to work harder. One student commented that she had taken on too much extra work both inside and outside of the University, and reflected that due to time pressures she no longer had a feeling for the course as a whole. Despite these students reporting that as learners they had gotten worse, they had obviously been able to reflect on their learning so that they were in a position to take action. Honest reflection and a willingness to take action is an important attribute for critical thinkers (Facione, 1990).

By the third year, the most marked change was a more positive attitude to learning (Figure 3.1, p70). Explanations for this attitudinal change are discussed more fully in the next section (Curriculum – Best Learning Experiences).

3. Curriculum – Best Learning Experience

Participants were asked about their best learning experiences for each year of their undergraduate degree. This research strategy enabled a graphical overview that represented students’ ideas about what curriculum experiences they valued and how these changed over time. Their responses were categorised into seven themes. These reported ‘best learning experiences’ did not all directly translate to critical thinking development, but an understanding of what students valued and why, and how this
changed over time, is certain to guide teachers in the ways they might support critical thinking and encourage students to think about this dimension of their learning.

In the beginning of their degree, most students reported that they found the ‘hands-on’ activities of the laboratory sessions to be their best learning experience (Figure 3.2, Table 3.2, p74-76). There were a number of reasons given for this, but the majority felt that the laboratory exercises were a way of making abstract ideas more concrete. For instance, reviewing a stylised picture of a mammalian heart from a first year textbook is quite a different learning experience from performing a dissection on a possum and examining the heart *in situ*. In the second year, interactions with teaching staff became more important. In the third year the best learning experiences were still focussed on hands-on activities (namely group project work), but the reasons why they were valued were different. In the third year students valued being able to take part in authentic research projects where they were able to collect their own data, perform their own analysis and relate this back to their research question. These activities required a highly critical student.

![Figure 3.2. Participants were asked, ‘What was your best learning experience?’ each year, for the three years of their undergraduate degree. Their answers were categorised and the number of responses from each year (Y1, Y2, Y3) is presented. Note it was possible for participants to name more than one best experience or none at all.](image)
Table 3.4 Participants were asked, ‘What was your best learning experience?’ each year, for the three years of their undergraduate degree. These are the theme descriptions from their categorised responses and used in Figure 3.2.

<table>
<thead>
<tr>
<th>Theme</th>
<th>Theme description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hands-on activities</td>
<td>Students placed importance on having hands-on activities, which were opportunities to learn about things that they encountered in lectures, textbooks, or even on television. They valued these experiences because it made more sense to them to see things that previously they had only read about or encountered in abstract terms. They also commented that these new experiences made it more interesting and this helped their understanding or helped them remember details that they would not have been able to remember had they encountered the material in more traditional settings.</td>
</tr>
<tr>
<td>Interactions with peers</td>
<td>Students valued the conversations that they had with their peers because it allowed sharing of knowledge. The fun aspect of group work was also acknowledged.</td>
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<tr>
<td>Autonomy</td>
<td>Students valued taking charge of their own learning. In the project work, in particular, they learned a lot by being able to design their own research projects, collect the data themselves, and then carry out the analysis and interpretation. In addition, they saw the practical implications of the projects and this was important to them. They felt as if they were being prepared to be able to conduct ‘real’ research.</td>
</tr>
<tr>
<td>Interactions with teaching staff (lecturers and teaching fellows)</td>
<td>For some students, the interactions they had with staff were reported as their best learning experience. In particular, written and oral feedback was important as these interactions increased students’ interest and altered their perceptions of zoology as a subject. Lecturing staff also acted as role models in terms of what it was like to do research.</td>
</tr>
<tr>
<td>Structure</td>
<td>For some students their best learning experience related to structure within the curriculum. For instance, first year lectures which included focus breaks (a five-minute break during the middle of a lecture) were deemed useful, as was any link between lecture content and the laboratories.</td>
</tr>
</tbody>
</table>
### Theme | Theme description
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**Personal attributes of teaching staff** | Students recognised the impact of the personal qualities (such as being passionate and enthusiastic about their subject) of the teaching staff and rated these as their best learning experience.

**Personal development** | Students noted that being challenged in the classroom, being confident within themselves and responding to these challenges contributed to their personal development.
The best learning experience reported by the students was different in each year of the study. This could simply be a reflection of changes in curriculum activities from first to third year. For instance, students rated doing independent project work highly, but they were not doing this until their third year. Project work, however, also involves hands-on activities, yet only one student rated hands-on activities as being their best learning experience in the third year (Figure 3.2, p74). For the others, it was the experience of devising and developing their own projects, collecting and analysing data, and answering real research questions that made it their best learning experience:

Being able to have the freedom to design an experiment and carry it out. Just the support of the instructors was just a really cool experience. Going through the whole process of designing an experiment, carrying it out, getting the results in three days. It was pretty awesome. Because the whole thing wasn't just handed to us, we had the freedom to make our own experiment and come up with it [ourselves].

(Jacqueline, Year 3)

In the quote above, Jacqueline highlights the importance of taking ownership of her learning and yet she acknowledges the support of the teaching staff (which tends to be post-graduate students or post-doctoral fellows who have a close working relationship with the course co-ordinator). In these third year projects, the role of the supervisor was also different from their early laboratory experiences.

We were responsible. In our group, we had to set it up. We had to find what we wanted to look at. We had to go and look at the machines that we wanted to use. We obviously had gotten (unint.)... from our supervisor but it was mainly just based on what we did, how we wanted to do it. If we wanted to do something different, we could do it and the supervisor was just there to show us how to use the machine.

(Dex, Year 3)
In this quote, Dex explains how his group had control over what, and how they learned, and that the supervisor was there to support this. Of course, not all project work provided positive learning experiences.

Rob: What were some of the differences between the two projects?

Gina: The [project name removed], they gave you the task. And they said, right, you're going to use these different methodologies. This is the background on it. We [still] had to figure out a lot of the background ourselves but it was using a lot of techniques and ideas that we wouldn't have come up with ourselves. Whereas with the other one, it was just sort of like, aphids do something. Go and test them. It was really simplistic, not as interesting.

It was unstructured and we weren't really supervised as much, so we pretty much just pottered along at our own pace and then occasionally, someone would check in with us. I just didn't enjoy it as much because it didn't feel like we were doing anything that productive. Whereas with the other one, we were constantly in the lab, looking at slides or helping make them and doing all sorts of backlighting, we were trying new techniques. The papers published about it are all, from last year, really new and it was good. It felt like we were doing something productive.

Rob: Did it feel like you were doing science?

Gina: Doing science instead of just doing a little project to keep us amused.

(Gina, Year 3)

Here, Gina reflects on two projects she was involved with and the different experiences she had. It appears to be very difficult to strike the correct balance in scaffolding research activities that are open-ended and allow students to answer their own research questions, with those that are more prescriptive and have fixed
outcomes (Wass, Harland, & Mercer, 2011). These are challenges that teachers face when designing a curriculum that models critical thinking by using research activities. One participant in her third year commented on a project that was quite prescriptive (because of the large class size) and how this made her feel.

_I think independent work is good because, I imagine that when you're given something independent to do you can be creative and design your experiment and all that but I think it wasn't quite possible because we were such a big group last semester. And so we were just given specific projects and this is how you do it. We had to write proper resources but I mean pretty much everything was laid out for us. So it was easy, in a way. But I didn't feel very inspired because we are third year and, I kind of thought that we would have more challenges, in a way. But maybe it was just a project that I got assigned to._

(_Rachel, Year 3_)  

4. Curriculum Expectations  

This section examines what the participants had expected from a zoology curriculum and the impacts that this may have on critical thinking development.  

The best learning experiences of students might also reflect their expectations of the curriculum. For instance, students who expect to be taught factual knowledge in their first year would quite possibly favour a course that was highly structured, with lots of support material (online and in hardcopy). Whereas a student who expected to be challenged, and to have a certain amount of autonomy over what they were taught, would favour quite a different curriculum. When students were first interviewed, most compared their experiences with high school and reported that while they had expected something different at University, it seemed to be an extension of school, although the context for learning was radically different because of the freedom to choose whether or not to study. Learning, however, was still described as memorising information to satisfy course requirements and pass exams:
The grades that you get in university are quite different to what I'm used to getting. You don't get any feedback and you can't discuss it. You may need to just have to go, well, I'll just work as hard I can and learn as much as I can about the topic and then hopefully, whatever grade I get will reflect that.

(Caroline, Year 1)

Two participants in this study had an expectation to learn factual knowledge in the first year and to build on that knowledge in subsequent years. Here Tania acknowledges the importance of learning facts, but she also realises that in order to do research, this by itself is not sufficient.

I think it's great. We need to learn facts because it's a basis for everything but if you don't learn how to think for yourself and how to work things out yourself, you won't be able to do any research. You won't be an effective person.

(Tania, Year 1)

Participants also noted that there was limited capacity within the curriculum for independent thinking at second year as can be seen in this quote from Caroline.

You kind of get an impression that you're just meant to not think for yourself yet and still have to just look at everyone else's research and see what they're doing and just say what everyone else has come up with rather than actually putting your own ideas in there and I think, in a way, that's true because we haven't actually done any research into our own areas yet, but I've talked to other people about it as well and they do see that as a slight restriction.

(Caroline, Year 2)

The tacit assumption in the zoology curriculum is for second year to be a logical scaffold into third year, where students are given more opportunity to conduct
original research. For some students, however, this seemed to be too prescriptive and leave no room for original or creative thought. Caroline also reflects Wenger’s frustration of a curriculum that requires students to please teachers at the expense of developing their identity (Wenger, 1998).

*I mean you spend all your time at high school just doing exactly what you're told and figuring out what the teacher wants and just giving them that and you kind of expect, when you come to university, it will be a bit different but it's the same kind of just figure out what the lecturer wants or whatever and do that, but then again, if you think about it, trying to get things published in journals, I mean that's what life is like. You just have to figure out what people want, to a certain extent.*

*(Caroline, Year 2)*

Although, participants noted that there were limited curriculum experiences that required independent thinking at second year, this had changed by the time students had reached their third year of study:

*Well the overriding one that I've already mentioned is that this year is much more focused on a specific problem that we go into more depth in and this year it allows and encourages us to think for ourselves and to use that thought in our reports, backed up, of course, by scientific evidence and other peoples' research. But in the second year level, that was, or it seemed to be frowned upon.*

*(Tania, Year 3)*

In the third year, the students designed their own projects, collected and interpreted their own data, and presented their findings to their classmates. They also commented that they felt that they would not have had the same experience if they had not had the foundations that had been laid out in the first and second year of their study. Yet, this is the only model that students encountered so it may be difficult for
them to appreciate alternatives, especially when they recognise and value what they learned in the early stages of the degree programme.

From the second and third year of study, the participants commented that they felt that they were finding out what it was like to be a scientist. For some this was a revelation and they no longer wanted to do research.

*I'm not interested in the scientific side of things. I can see I will never be a scientist. I'm just more of a do person and I don't know if I'm very good at it. It's just a feeling I'm getting, I don't think I'll be wanting to do research, sit and write information for a long time. Maybe because I'm quite simplistic and I like to just go out and do it.*

*(Rachel, Year 3)*

*I realise like, this year, that I just don't really like doing research. I don't like writing the reports. I don't like doing stats, you know. I like knowing stuff, you know. I'm going to be one of those cool Mums. You know, when kids ask questions, I'll be able to answer them* (laughs).

*(Jacqueline, Year 2)*

It was not until after 2-3 years of study, that many of the participants saw zoology as a field of research. Prior to this, most had a limited understanding of what it means to be a zoologist, let alone what it is like to carry out research. Despite the curriculum being orientated towards developing generic skills required of a research scientist, many students (at least at the outset) simply wanted to learn more about animals. If a student has no desire to learn through research, and we assume doing research reflects similar processes required for critical thinking, it is certain that they miss an opportunity to develop as critical thinkers.

It is possible to integrate successfully critical thinking and research into an entire curriculum. Spronken-Smith et al. (2010) presented such an example with their redesigned undergraduate ecology programme at the University of Otago. The idea
was to introduce learning through an inquiry-based curriculum with the aim to embed critical thinking and research skills into all stages of the programme. They identified internal and external drivers necessary for the project to succeed. Some of these included a willingness of teaching staff to reduce the amount of content that they taught, a 'buy-in' to the philosophy of the programme, and sustained interaction with staff to allow the programme to develop. It was beyond the scope of their paper to report on how students felt about the new curriculum, but some of the students involved in the ecology programme at the time of the study, were simultaneously involved in my research on critical thinking. Evidence from my study suggests that an inquiry-based curriculum that is focussed on students thinking like disciplinary experts is likely to increase the feeling that students were also part of a research culture (discussed more fully in Chapter 4). The philosophy of the University of Otago, however, is that students at first year are able to take a variety of papers from different disciplines. Developing a research culture is harder in such a fragmented curriculum, where students are offered a 'pick and mix' of different papers from various disciplines. Furthermore, some students may not wish to be part of such a research culture.
SUMMARY

In this chapter, the effect of the zoology curriculum on critical thinking development was examined. Rather than looking at instructional changes and measuring the impact this has on critical thinking (which in the early stages was an abstract idea for students), this study started with the assumption that learning to undertake research as part of the curriculum could act as a proxy measure for the development of critical thinking. The results suggest that critical thinking development did occur, but it took time. In the second year of the study, some participants found the curriculum quite prescriptive and limiting, but by third year they were given freedom to answer authentic research questions of their own choosing and for most participants this was a very rewarding experience.

This study raises questions about teachers’ and students’ expectations of the curriculum. Learning zoology was based upon a ‘facts first’ curriculum as a foundation for critical thinking in the later years. This study, however, gives evidence that some students expect more freedom in what and how they learn in these early years. Teachers have freedom in what and how they teach, but if, as Wenger suggests 'Learning is a response to the pedagogical intentions of the settings' (Wenger, 1998, p 266), then the focus of future research could examine the impact of early socialisation experiences and/or a move away from a curriculum in years 1 and 2 dominated by facts and theories.

Vignette

I finish this chapter with an excerpt from Rosemary’s transcript where she reflects on a third year ecology field trip and the transformative nature of this experience. The issue Rosemary talks about is not about disputing facts. It is a clash of value judgements, both of which are informed scientifically and yet there is disagreement. This experience seems to have given Rosemary an appreciation for questioning information and viewing things from an alternative view, both of which are attributes desired by critical thinkers. The suggestion here is that certain classroom experiences can have a profound impact on what students learn, and that as teachers we need to
be mindful of this as we think about the pedagogical intentions of the curriculum (see also Brookfield’s (2012) observations that significant moments in critical thinking are often associated with unexpected events or ideas).

Rosemary:  It was quite good this semester, going with ecology. We went and saw the yellow-eyed penguins out Boulder Beach and that's the first time we've gone and seen something, actually interesting rather than going and collecting invertebrates from the leaf litter or something. Seeing something that's actually important to New Zealand and something that you know really means something. That was quite cool, and they had the people who came along, we had one guy from DOC and we also had, one of the guys who used to work for DOC but now he's a tourist operator and because they both had different views they had a bit of an argument which was awesome as well.

Rob: Why did you find that awesome?

Rosemary: It was just because the main thing I found at uni is just that you've got so many people's opinions and some lecturers I think have given a little bit of a one sided opinion and it's good to see, the other side because normally people would be like, well with the DOC guy, he was like, now we want minimal disturbance. It's not good for all these people to come here and the tourist guy was saying, why are we saving these birds if the public can't enjoy them? Like it's, you're not saving them, you know, you're kind of saving them for the people but then you're not letting them see it.

Rob: So what did you think about those two sides to the argument?

Rosemary: I think they were really both valid but it was quite good because we haven't really seen, like for example, with the tourist operator, like seeing that side of it. We're pretty much coming from science which is more the DOC side and the
conservation side where this was, not about umm, ohh, it's hard to explain, just kind of, I guess, in a more like practical sense as well for the every day person, not for the scientist kind of thing.

Rob: Are there ways that you think that experience then has changed you?

Rosemary: Yeah, it just makes me look at things from different ways. Like, that's what I found with this whole year really, is, like the whole thing that they're trying to teach us is like, critical thinking. Like, not for us to just agree blindly with what they say. It's for us to take the information that they've given us and then we can do it ourselves.

Rob: And how does that make you feel then?

Rosemary: It's good. It makes me feel, I don't know, more prepared or something.

(Rosemary, Year 3)
Chapter 4: Critical Thinking and The Social Environment

**Abstract**

Vygotsky claimed that interactions with more capable peers are essential for development within the Zone of Proximal Development (ZPD). For Vygotsky, social interactions are both culturally and historical situated. They involve more than simply learning from others - the way people think shapes their world and how they engage with the world shapes their thinking. Thus, Vygotsky saw enculturation as an essential aspect of development.

Student-interview transcript data and Interpersonal Process Recall (IPR) was used to describe the process of student enculturation into the Department of Zoology and the contributing factors to this. Six separate, but interconnected, themes of the social environment that make critical thinking more likely were identified:

(i) Relationships with peers  
(ii) Relationships with demonstrators and lecturers  
(iii) Written and spoken ability  
(iv) Attitudes to learning  
(v) Confidence  
(vi) Ideas about knowledge

There was evidence from this study that students benefited from knowing (and being known) by lecturing staff. Interactions with their peers was also important at all stages of their degree programme, although in year 1, the fragmented nature of the course structure meant it was often difficult for students to get to know each other.

The results from this study reflect Vygotsky’s thinking about the role of the social environment for higher-order learning and in an idealised educational environment, these factors would be taken into consideration. In particular, this study highlighted the importance of personal interactions with peers, laboratory demonstrators, and
lecturers for the development of critical thinking. Students need to be able to talk about issues, identify their own assumptions and biases, and cultivate willingness and an ability to see the world through other people’s eyes. The participants noted that relationships changed as they themselves became valued more both by other students and by their teachers. As students became comfortable with the curriculum content and grew in confidence, this was reflected in their written and oral ability. Students also reported a change in their ideas about knowledge.

I argue that for the development of critical thinking to occur, teachers should not lose sight of learning that occurs outside of a prescribed curriculum and the importance of the social environment in which this learning takes place. Of particular note were the changes in relationships that the participants had with the lecturing staff and peers over time and the impact this had on their learning. Lecturers were largely anonymous to first year students and if improved relationships are important, the challenge is how we can affect a change at the first year level when the degree structure is characterised by large class sizes and modular courses.
INTRODUCTION

As the name suggests, Vygotsky’s Sociocultural Theory, emphasises learning as a socially and culturally constructed activity. That is, Vygotsky considered the social environment necessary for learning, and that social interaction transformed learning experiences through a process of enculturation in which a person acquires the values, beliefs, and behaviours of a particular social group or culture (Doolittle, 1997; Schunk, 2004). Lave and Wenger (1991) also described a social theory of learning similar to Vygotsky’s, in that they see learning as an inherently social activity that requires active participation and continues throughout life. Moreover, they noted that when groups of people share the same interests or concerns, and interact regularly, they learn from each other. For example, when students form a study group, in addition to learning content, they are also learning about taking responsibility for their own learning and participating in discussion. Wenger described such groups as a ‘community of practice’ (Wenger, 1998).

Certain conditions need to be met before a group can be considered a community of practice. For instance, its members:

1. Are committed to the practice and have a shared competence that distinguishes them from non-members.

2. Have a sustained history of mutual engagement. That is, the members need to interact and learn together.

3. Are practitioners who develop a shared repertoire of resources (experiences, stories, tools, ways to support their work together).

Vygotsky used the term enculturation to refer to the process where people develop their identities within an existing organisation or group. That is, over time they will tend to take on the beliefs, norms and practices of the group. In communities of practice, the emphasis is also on both the community and the individual. Neither can exist without the other, for they are defined by each other. Communities of practice may change over time or they may be resistant to change. They are a source of knowledge creation and knowledge acquisition.
Wenger seems to have taken a sociocultural view of learning and developed a theory that curriculum designers and teachers can use when considering student-learning outcomes. Wenger (1998) noted that communities of practice are important for the formation of identities and he criticised traditional learning environments that are too disconnected from what is going on outside of the classroom and too homogenous to allow students opportunities to develop their individual identities. Wenger argues that students can only form identities by participating. The traditional classroom, however, is characterized by ‘a teacher sticking out and a flat group of students learning the same thing at the same time’. In these situations, competence usually means ‘pleasing the teacher, raising your hand first, getting good grades’ (Wenger, 1998, p269).

Teachers have a significant role in establishing positive student-teacher relationships (Eames, 2008). Eames claims that the advantages of such a relationship from the students’ point of view was that it helped them feel more relaxed and confident and in turn they were more inclined to ask questions and become involved in classes.

However, social interactions, which result in learning, are not always between the student and the teacher and there has been growing interest in the importance of peer communication (Damon, 1984). This kind of learning goes beyond what is taught explicitly in the classroom or stated in course objectives, and includes what it means to be a student (Havnes, 2008; Wenger, 2007). Havnes (2008) claims that learning from peers is different to learning from teachers because it allows more space for ‘disharmonious discussions, diverse solutions and conflicting arguments’ p202. The language that peers use is often closer to the students, compared to what teachers use, and the power dynamic is different (Brookfield, 2012).

Vygotsky’s theory also argued that language (both spoken and written) is important for development, as language acts as a mediator between the social environment and the individual by providing the conduit through which ideas and behaviours become internalised (John-Steiner & Mahn, 1996). Over the course of a degree programme, students will learn discipline-specific language that will become more meaningful, as they become enculturated into that discipline. Language, therefore, as noted by O’Donnell (2007) ‘is not only a tool by which knowledge or instruction can be transmitted to newcomers to facilitate participation. It is itself a practice of the
community and its acquisition is a process’ (p. 322). Learning the language of a discipline has implication on the capacity for critical thinking because, as Peck states ‘critical thinking involves asking very pointed questions of claims or information, not just any questions will do’ (cited by Beyer, 1985). In order to ask useful questions, students need to have acquired the language of the discipline and be confident in their ability to use the language appropriately.
RESULTS AND DISCUSSION

The results and discussion section of this chapter is subdivided into three sections.

1. Developing a Community of Critical Thinkers Through Research.

In this section, I provide a commentary on how students experienced the process of enculturation into the Department of Zoology. I note, in particular, the various effects of introducing students into a research culture.

2. Key Social and Cultural Determinants

The participants in this study identified various contributing factors that either helped or hindered their developing of a sense of belonging; these are identified in this section of this results chapter.

3. The Importance of the Social Environment

In this final section, I report on the importance of the social environment in which critical thinking development occurs. These are discussed as six separate, but interconnected, themes.

- (i) Relationships with peers
- (ii) Relationships with demonstrators and lecturers
- (iii) Written and spoken ability
- (iv) Attitudes to learning
- (v) Confidence
- (vi) Ideas about knowledge
1. Developing a Community of Critical Thinkers Through Research

In the first year, participants noted that the Department of Zoology was very research focussed and this was evident when lecturers spoke about their own research during their teaching block. In the first year, there was no evidence that the participants had developed an identity as a zoology student within the department and a contributing factor to this was that students studied papers in up to seven other departments. Therefore, there was not the sustained interaction between students necessary for a community of practice to become established (Wenger, 1998). Students commented that the environment was generally a positive one with enthusiastic teachers and three participants referred to the ‘relaxed’ nature of the course.

The second year of study was characterised by students writing highly structured laboratory reports where they were given detailed feedback on their writing. The classes were smaller and the course content was becoming more specialised. Although many did not view themselves as part of the Department, as such, there was a sense of starting to develop an identity as a zoology student as can be seen from the interview transcript with Rachel in her second year.

Rob: So do you feel like you are part of the, the zoology programme now?

Rachel: I think this year, more so, because everybody, I guess they're more in tune into with what they want to do or with what they're doing and I think the people who are still here this year, probably want to do it.

(Rachel, Year 2)

In the third year, students were assigned independent project work. They were no longer taught from a textbook, and instead they were asked to read research journal articles that would be discussed during class time. It was at this time that participants started to talk about their third year class as a ‘family’ and demonstrate a duty of care towards their peers. Here Sarah compares her zoology experiences with other papers that she is taking. ‘The Link’ refers to a physical space between the Student Union
building and the Central library. It is a social space with shops, couches and wi-fi access.

*I've been to other lectures like Law and I feel they're more separate, sort of they're going for themselves whereas zoology's great. Like, you know The Link, we just find groups of people there and we'll just go sit down and chat and then we do little study sessions and just everyone comes along. I honestly feel like we're more of a family than a lot of other departments. We just all get along and I mean we're doing a Zoology Ball as the moment but it's for Ecology and Botany as well and, it really helps to have friends that helps in the learning process too."

*(Sarah, Year 3)*

2. **Key Social and Cultural Determinants**

The key negative and positive social and cultural determinants that contribute to a student’s sense of belonging were identified from student transcript data and Interpersonal Process Recall (IPR). The assumption here is that if learning is socially constructed, recognising determinants that make students feel as though they are an integral part of the Department of Zoology (or relevant social group) will facilitate their development.

**Negative Factors**

In the initial stages of the study, students did not feel as though they ‘belonged’ to the Department of Zoology. Students commented that the large size of the first year classes prevented them from having any substantial contact with teaching staff. Due to this limited contact, they felt anonymous to them. One student commented on the ‘environment being sterile’. Sterility, he assumed, was because the papers he took were from a variety of different disciplines and that he had not begun to specialise in
any one particular subject. This student found it difficult to get to know his fellow classmates, as he could not tell if they were going to carry on in zoology.

_I don't know how many people in that lab or whatever are going to go on and do zoology next year. There's other courses that they could be doing, so I think once it starts, in zoology next year, I think I'll find there to be a complete difference. People are still wondering which direction they're going to go._

(Jason, Year 1)

For Jason, zoology would start at 2nd year. For others, despite not readily identifying themselves as belonging to a zoology culture, they defined each other in terms of whether or not they were majoring in zoology. Not all students that take first, second, or even third year zoology papers intend to major in zoology and this could have had a negative effect on feeling part of the social zoology major group. Zoology students saw non-zoology majors as having less interest in the subject. Consequently, some of the participants commented that zoology students tended to gravitate towards each other and form sub-groups within the larger class.

The interactions that zoology majors had with non-zoology majors took on a different kind of importance, as these interactions seemed to separate students in the cohort. In the quote below, one of the participants in their third year of study reflected on talking to non-science students.

_I think it's just being around non-science students. Seeing their views about animals and stuff ..... people that aren't in the, scientific field at all aren't interested in animals at all. It's just kind of a reality thing and you just realise that cynically, that maybe most people don't care about animals._

(Liana, Year 3)

Some aspects of the existing course, if changed, would have contributed to students’ sense of belonging. For instance, one student noted that the paper code of the first
year zoology paper did not begin with the ZOOL prefix (which was standard for zoology papers in the second and third year), and if it had been, this would have contributed to her sense of belonging. It is not a trivial matter, however, to change the course code of a paper. The current BIOL112 course code is seen by teaching staff to reflect its foundation status and relevance as a suitable paper for all science majors. There is concern amongst the teaching staff that if the course code was changed, other departments may no longer recommend this paper to students, and there would be a drop in student enrolments with funding implications.

The participants also commented that lectures and laboratory sessions were not taught in the Department of Zoology. If they had been, this physical presence would have contributed to a sense of belonging, as the students would have been able to, for example, ‘read the research posters on the walls’. [Note: since this study, changes have occurred and first year students now have their laboratory sessions located in the main Zoology building].

**Positive Factors**

The factors that contributed to a positive feeling of belonging (Table 4.1, p98) tended to occur later in the degree programme. Some of these were a consequence of smaller class sizes and getting to know (and be known by) the lecturers through repeated group exercises. In small class sizes, students feel more inclined and confident to ask questions and to get to know their teachers and classmates (Eames & Stewart, 2008).

Even at first year, students felt comfortable talking about zoology to other students and there was evidence that sharing of knowledge, attitudes and values was an important part of their experiences, as can be seen in this quote from one of the participants in her first year of the study.

*This is just a personal experience, but all the people that I've met that are really, really into zoology and animals, just can't stop talking about it and I think that creates a certain kind of identity compared to someone who is just doing it for points.*

*(Rachel, Year 1)*
One student, in her third year, noted lecturing staff were more approachable. She thought this was because students were now thought of as potential postgraduates. Other factors that contributed to a feeling of enculturation included the personality of the Head of Department; that is, whether they were a ‘people person’ or not.

Some of the participants in this study became involved in departmental activities, such as being a class representative in the staff-student liaison committee. One commented on how this experience made her feel ‘part of the process for the department’ as she felt her suggestions had been listened to.

Second and third year summer studentships (where students receive a stipend for working on a 10 week research project) also had a big impact on those selected as can be seen from an excerpt from a transcript by Joanna as she comments on her summer work experience at the end of her second year of study.

It’s hard trying to fit it in but A, the money’s quite good and B, it's just cool, being able to work with people who are at the top of their field or, they're doing good research. There's been another spin-off of that, is Jasmine*, I don't know if you know [her] she's amazing, like taking me out to coffee and talking to me about how life is going and stuff. She's been a huge encouragement and from that studentship, hopefully I'm writing up a paper this summer as well. So, I don't know that you can encourage studentships in your research, but I think that was brilliant. Yeah, probably one of the best things I've done.

(Joanna, Year 3)

*Jasmine (name changed) holds a Post-Doctoral position in the Department of Zoology.

Wenger (1998) writes about the importance of ‘old-timers’ paving the way for novices to become participating members of a community of practice. Here Joanna clearly identifies the positive influence of taking part in authentic research activities. Joanna is benefitting from learning from established researchers - she has been acknowledged as a co-researcher, has received personal encouragement, and has been made to feel part of academia (she did in fact have her work published).
The students involved in this study did not report any effects (positive or negative) from learning about the involvement that other students had in Departmental activities.

A summary of negative and positive factors that contribute to a student’s sense of belonging are presented in Table 4.1.

Table 4.1 Positive and negative factors that influence students’ perception of belonging in the Department of Zoology

<table>
<thead>
<tr>
<th>Negative</th>
<th>Positive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large class sizes</td>
<td>Small class sizes</td>
</tr>
<tr>
<td>Lack of specialisation in subject papers</td>
<td>Repeated group experiences</td>
</tr>
<tr>
<td>Lack of identifying paper code</td>
<td>Personality of the Head of Department</td>
</tr>
<tr>
<td>Physical location - lectures / labs not located in the Department of Zoology</td>
<td>Approachable lecturers and teaching staff</td>
</tr>
<tr>
<td>Physical environment – lack of posters</td>
<td>Participating in Departmental activities (including research)</td>
</tr>
<tr>
<td></td>
<td>Opportunities to talk about zoology</td>
</tr>
</tbody>
</table>
3. The Importance of the Social Environment

Students’ development of critical thinking was attributed to individual factors (students maturing, working out what they wished to do career wise and so forth) and interpersonal factors (changes in relationships with teachers/peers), but all occurred within a specific social environment. Six factors of the social environment that were major contributors to a student’s ZPD for critical thinking were identified from student transcript data and Interpersonal Process Recall (IPR) (see Figure 4.1). These factors are mutually dependent, for instance, increased confidence allows students to challenge ideas and change the relationship that they have with lecturing staff. Conversely, an improved relationship with lecturing staff will contribute to increased confidence. These factors are discussed with reference to their role of the social environment for students to develop as critical thinkers.

![Figure 4.1](image)

*Figure 4.1 Key factors (i-vi) of the social environment for the social construction of critical thinking in an idealised educational situation. The arrows show that the relationship between each factor and the social environment is reciprocal.*
(i) **Relationships with Peers**

Vygotsky’s theory emphasises the importance of social interactions for individual development (John-Steiner & Mahn, 1996) and from their first year the students involved in this study recognised that their peers contributed to their learning. In some ways, this may not seem surprising as first year students at Otago are similar in terms of their demographics; the majority have come straight from high school, most live in a residential college, and many come from outside the Otago region. The students who participated in this study would therefore share common attitudes, expectations, and behaviours. At the same time these students also acknowledged differential levels of expertise and background experiences, and they realised they could experience critical dimensions of learning from their peers, especially in laboratory situations.

She would ask different questions from me because I was quite interested in the reproductive system [of the shark] whereas she was looking at the different organs and the gall bladder and stuff like that which was quite cool and together, we definitely would have asked more questions than we would have apart because we were looking at more things and kind of stimulating interest off each other.

*(Joanna, Year 1)*

Here Joanna is not being taught directly by her peer, but she still values working with a partner as she recognises that the different interests that people have causes them to ask different questions and this can be mutually beneficial. Not all students were able to benefit from such a social arrangement. For instance, two older students found the first year environment sterile and acknowledged that the differences in their ages were an obstacle to communicating with younger students.

Havnes (2008) claims that when students learn from each other (as in peer-mediated learning), students learn more than what is prescribed in the curriculum. Here Caroline reflects on the learning that occurred from her group project work experience in her first year.
I think a lot of it you wanted to be friends with these people and especially because I didn't know that many people in the class, this was an opportunity to know people and so, you didn't want to be too domineering. You can't really just sit back and expect everyone to work the way you want to work. I think what we should have done at the start, was figure out how well people wanted to do it. Because, obviously my expectations of how we were going to do it and how hard we were going to work on it, were a lot different to theirs.

(Caroline, Year 1)

Students noted a change in their relationship with their peers over the course of the degree programme. In the initial stages, peers were valued as they could offer different insights into what was taught, but with respect to learning course content, they were still predominantly used as a check on understanding. This relationship was quite different once the participants were in their third year.

It really is more like a family. It's very unified and everyone works together really well.

(Tania, Year 3)

Conversations at this time became more academically focused. Participants identified certain members in their classes who had strengths (particularly in statistics) and actively sought those people.

A lot of it was because statistics were involved, that's not my strong point. I know Jackie doesn't like it either. Joanna and Liana both did stats papers at the same time and they didn't just type out the answers and then say, hey, here's the stats. They took us to the computer room and showed us how they did it and explained why they did it. I find someone on my level can help me understand a bit better, which is what Joanna and Liana did for us. And same with Jackie because she started on the same level as me.

(Sarah, Year 3)
Both Joanna and Liana were not ‘on the same level’ with Sarah with respect to statistical knowledge, but they demonstrated empathy for Sarah and took time and effort to help. They could have simply provided her with answers, but they recognised that this would not necessarily help her understanding of statistics.

Data from this study emphasised the important role that peer interactions have for learning beyond what is directly taught in the curriculum, such as what it is like to be a student (as suggested by Havnes, 2008). The results also demonstrated that in later years peers were important for teaching curriculum content as they developed their expertise in specific subject areas. This change happened within a social environment where students were prepared to help one another as they formed their identity as zoology researchers and became more confident with their knowledge abilities.

(ii) Relationships with Demonstrators and Lecturers

If students are to question evidence and or assumptions (a requirement for critical thinking, Facione, 1990) it is essential that they be in an environment where they feel comfortable challenging authority and can put forward their concerns.

In the early stages of their degree, postgraduate student laboratory demonstrators were able to spend time with students and explain concepts. They also provided an insight into what it was like to do research and they formed a social bridge between students and lecturing staff, who were seen as inaccessible. By the third year, students had quite easy relationships with lecturers, and students could contribute to discussions knowing that these teachers valued their knowledge. In part, this was due to the lecturers getting to know the students, but also the participants reported that they now knew their lecturers personally.

Some students commented that they ‘could get inside the head’ of their teachers, demonstrating that teachers were modelling a type of thinking that students were keen to access. Zoology teachers were described as ‘passionate’ about their subject and part of this passion translated into classroom practice. There was a duty of care evident for students, and teachers were perceived to have a positive attitude toward
student learning. Roy explains below the importance of a positive learning environment where students are comfortable asking their lecturers questions.

*I think the students do want to get to know the lecturers and know what they’re doing because that adds so much more than just going along to the lectures and listening in. We've just been three years in the same class and we know all the lecturers now and been through them all but they've been a bit more sociable, you know, recognise you and talk to you and the funny thing is that is such an important part of the learning process because if you didn't know any of these people, it means it's more difficult to talk about what you're doing academically.*

*(Roy, Year 3)*

In this study, participants clearly valued a positive learning environment where they knew, and were known, by teaching staff. They highlighted the personal dimension of their relationships with teaching staff and gave similar reasons to Eames (2008) for factors that contributed to these positive relationships. These were; the perceived approachability of teachers, the size of classes, and informal teaching environments.

*(iii) Written and Spoken Ability*

In Vygotsky’s theory, language is an important mediator between the social and the individual and is the key to knowledge co-construction (John-Steiner & Mahn, 1996). Beyond the first year of study, students felt comfortable talking to each other about zoology, and this sharing of knowledge, attitudes, and values was part of their experiences. Talking with peers was important for students, both as a check on their understanding and as a way of gaining new perspectives.

As the students learned the language of the discipline and became more confident with it, they observed that the questions they asked (in class and when reading the literature) became more focussed. Being able to ask appropriate questions is a skill necessary for critical thinking as they learn to challenge the reasons put forward as to
why they should accept a certain conclusion and they check their own assumptions and bias. Questions are also important as sometimes terms are ambiguous or the meanings of certain key words unknown and clarification is needed before an argument can be accepted or rejected.

Developing students’ abilities to ask appropriate questions was seen as a strategy for teachers of critical thinking (Facione, 1990). In the Interpersonal Process Recall exercise in this present study, the teacher was seen to model critical questions and one participant reported how she was starting to internalise this habit of questioning, so that it would become part of her own thought processes.

In this study, there was evidence for increased confidence in students’ abilities to ask questions. This came about through a better understanding of themselves in the institution, but also gaining confidence in using discipline specific language. One student in her third year reflected on how she now uses language more to help her learning.

That's definitely changed in the way that I'm learning a lot more. I used to just be a kind of sit and look at my notes, read type person and now I'm a lot more kind of discussing things and figuring things out with other people.

(Caroline, Year 3)

Within distinct groups there are conventions for the way the people speak – these are known as ‘speech genres’ (Smagorinsky, 2007). Zoology is no different; there are technical terms and concepts to become familiar with and being able to use the language of the discipline is part of the enculturation process. In the quote below, Sarah not only describes how using discipline specific language helps her learn factual content, but also it changes the relationship she has with her peers.

Rob: Do you use or do you make a conscious effort to try and use the, the specific vocabulary when you’re talking to your friends and things like that?
Sarah: It’s funny. I actually do now. Like in semester one, I wasn’t very good at it because I was just like, ohh, all these new words but now I try to. Like especially with my friend, [name removed]. We always used it, like all these big words, which sound really cool, but just talking about it makes you learn it. It’s just helping so much because people understand what I’m saying. I’m not trying to explain what I mean and having them not understand me. I can just say a term and they’ll all know exactly what I mean.

(Sarah, Year 1)

Like speech, writing can be viewed as an act of critical thought and knowledge construction, rather than simply an outcome of these processes (Emig, 1977; Flower, 1979). Flower (1979) distinguishes between two forms of writing; a writer-based prose, which is the adult equivalent of what Vygotsky described as children’s egocentric speech, and reader-based prose, which involves the writer transforming their ideas and concepts. In this study there was some evidence that writing transformed student thinking.

Whereas I think that's one good thing about the essays, it does make you take all the information and it does actually make you start to think for yourself. Even though you may not end up writing it down, it's still in the part of bringing it all together and trying to fit everything in logically. It does make you start to think while you're writing.

(Caroline, Year 2)

So I'm also learning how to rephrase what they're asking so that, like the person who's marking it may have not known about the topic. So now I'm learning how to write as if it's, they're learning to understand it.

(Sarah, Year 2)
Conducting experiments, reviewing scientific literature and ultimately writing scientific reports gave students a platform on which to base their ideas. All of these processes help develop critical thinking.

*I think writing the report really does help because you have to know about the subject that you're writing. So you're forced to write and you're forced to think about what you've written, what you have read and what you have written. Sometimes it's easier for you to think about something but it's really hard for you to phrase it, just write it down and to convince others too. So that process actually helps with thinking more deeply.*

*(Holly, Year 2)*

Participants also noted an improvement in their technical writing abilities, as evident by the increased speed, ease and confidence in their written work. They spoke of the reports they were required to write in second year and the influence this had as they learned to write within the discipline.

*In the first semester this year, it would have taken me three weeks to write a report because I'm sitting there, going, I don't even know how to start the first line, you know but now my brain's been trained into, if I know I've got to do this, I've got to do that, okay. This is what I think. Okay. I'm going to put it in here. You know, we've been trained, the process is working out quite well now. So there is that added confidence in that I may not know much about this topic but I know how to set it out, so if I go and do my research, I know I can figure it out somehow.*

*(Kirsty, Year 2)*

In summary, there was evidence from this study that over the course of their undergraduate degree, writing ability improved and this was attributed, in the most part, to the writing exercises in their second year. There was also some evidence that the act of writing improved the quality of students’ thinking (although they were only
required to write three reports in their second year). Vygotsky’s work emphasised the primacy of speech as the ‘tool of tools’ (Smagorinsky, 2007) for the construction of meaning. This study suggests that the act of writing itself may also be an important vehicle from which new thoughts emerge.

(iv) Attitudes to Learning
By third year, many students reported that learning was no longer driven mainly by grades and exams, but also by intrinsic motivation, such as a love for the subject and a wish to know more. These are important characteristics of critical thinkers (Facione, 1990).

*I think there's definitely been a big change between second year and third year as opposed to first and second, in terms of people's willingness to learn and take part in things and just be more interested in learning and knowledge as opposed to an end goal, which is strange considering, we're closer to that end goal, whatever it happens to be. But third year, I've found it's changed a lot in that people are taking part in discussions just like I am, and they seem more interested in the knowledge and the experience as opposed to just doing their little bit and getting through.*

*(Caroline, Year 3)*

Participants reported that changes in attitudes towards learning might be due to a number of interconnected reasons. One participant noted that she was interested in the subject material, but also she was treating her studies as a University experience rather than just simply to get a degree (this fact was also mentioned by two other participants). Personal development in terms of working out what they wanted to do with their University qualification was a contributing factor for many participants and there was evidence that exposure to group projects in their third year helped inform this inquiry.
The participants also noted that they were not just learning about zoology. They recognised that they were learning life skills and learning about trust, and personal responsibility. This was particularly evident with group projects as these shaped their attitudes through social interactions.

So just being in university, you [learn that you] can rely on other people to do what they say they'll do and to turn up for group meetings and stuff and you learn that other people do care about their education which I think is pretty important because it changes your attitude towards working with people.

(Liana, Year 3)

(v) Confidence

Having confidence to formulate your own ideas and then having the confidence to express them is necessary for critical thinking (King & Baxter Magolda, 1999).

Many of the participants in the study reported how they noticed an increase in their confidence, especially by the time of their third year. Again, the third year project work was instrumental in affecting this change, as can be seen in this quote from Tania in her third year.

We did a lot of group projects. I'm sure you already know that. We'd work in about groups of four to run our own project and that was our major piece of assessment, apart from the exam, for this semester and I found that that really reinforced everything. It was a good learning experience and for people who are going on in the discipline, I think it gives you a lot more confidence that you can do it and you're not necessarily scared of postgraduate work because to a much smaller degree, you've done your own project already.

(Tania, Year 3)
There is evidence from the study that students developed their confidence by partaking in group-project work, by having their contributions valued by lecturers, by the grades that they obtained and by becoming more knowledgeable about zoology.

(vi) Ideas about Knowledge
Kuhn (1999) recognised that critical thinking requires an evaluative epistemology. An evaluative epistemology recognises that not all opinions are equal and ‘knowing’ is understood as a process that requires judgement, evaluation, and argument (skills necessary for critical thinking).

In Year 1, there was limited scope for the participants to learn traditional curriculum content from their peers because they did not value their peers’ knowledge in the same way as they valued the knowledge of a lecturer or the textbook.

I don't really like talking to my friends about the subjects because they're going to tell you all the information and I don't really want to hear it from them. It's a bit weird (laughs). I'm always suspicious of my friends when they tell me stuff in regards to a course because I've known them to be wrong, like occasionally, and I'm always thinking, well that might be, but it might not be.

(Roy, Year 1)

Here Roy’s suspicion also shows a critical mind that has the potential to be applied later to the critique of, for example, journal articles, a lecturer’s knowledge claims or his own work. During this first year, the participants did not challenge what they had been taught by lecturers, but they were given very few opportunities for doing so and consequently knowledge was viewed more as factual. Students valued and expected to be taught declarative knowledge forms and this quote from Andrew in his first year suggests that an alternative, more critical environment may have been unsettling.

Andrew: We’re definitely not ready to go out there and actually start thinking about things properly. We have to just do the basics because of our lifestyle and stuff.
Rob: Because of your lifestyle?

Andrew: We’re still 18 and stuff. We’re not quite ready to track the depths of our thoughts and sort of advance and use our imagination really deeply to sort of answer, especially like doing science degrees, we’re not quite there for a few years.

(Andrew, Year 1)

For Andrew to have this insight is interesting, and an important aspect of critical thinking development is an epistemological shift towards seeing knowledge as contestable (see Kuhn, 1999). As mentioned previously, students did not generally challenge what they had been taught during their first year, but by the third year, they had understood knowledge in a different way. Liana, in her third year of study, illustrates this transition.

So I have to learn to relax in that sense, so I have to really put my own interpretation on my scientific writing because that's important because that's what you're really doing. You as a researcher, you have to make your own conclusions and that's how you contribute to the scientific knowledge. You don't just regurgitate people's things over and over again because then no new knowledge would come up. Well, that's how I think about it anyway.

Liana (Year 3)

In her third year, one of the participants commented on the fact that group members, working on the same projects, collecting the same data, would interpret their results in quite different (not necessarily wrong) ways. This insight was important for them as they realised that knowledge was contestable, even the knowledge of the teachers.

Just because they're the teacher, they don't know everything. They're not always right which is a really mean thing to say but just because you're being taught it doesn't mean it's right because science is always subject to change. That's why they can't really give us
textbooks anymore because it's all this new information that they're giving us as resources, they just give us these scientific articles and that's a great way to learn.

(Liana, Year 3)

Developing an evaluative epistemology in students may be as easy as altering the way in which material is presented. For instance, rather than simply presenting information as ‘facts’ that students need to know for the exam, material of a more controversial and unresolved manner may facilitate the epistemological shift required for critical thinking. Students may be given a topic for which there is no ‘right’ answer and they could be asked to provide justifications for which explanations are better. In doing so, students still learn core background information, but would also begin to develop critical thinking. Despite some participants stating that they were not ready to engage in critical thinking, in the quote below, Dex states that one of the most valuable lessons he has learned was realising that scientific knowledge is uncertain and contestable (and this was in his first year).

Dex: Probably one of the most valuable lessons I’ve learned [is that] nothing’s quite as black and white or nothing really is black or white. There’s always going to be grey in everything, no matter what.

Rob: Can you elaborate what it was that made you realise that?

Dex: I don’t know whether I got frustrated trying to read the textbook or not, but, I’d read 10, 15, 20 pages and I’d get to the end of the page and it’s pretty much says that kind of happens sometimes, but not really. We don’t actually know what is happening.

Dex (Year 1)
SUMMARY

Vygotsky’s Sociocultural Theory recognises that what students learn and their personal development are interconnected. This study highlights students developing as critical thinkers is a very complicated process, that takes time, and the importance of the social environment should not be underestimated.

Vygotsky recognised language as the primary mediator for the development of meaning within a particular group. Being able to use discipline specific language was also an imperative part of the development of the students. Initially, talking about zoology was important for identifying friends and confirming understanding. In the later years, students learned about scientific conventions in writing, but also identifying arguments and evaluating evidence (skills necessary for critical thinking). By the end of the study, there was evidence for students having developed confidence in their ability to carry out research and a sense of purpose of what they wished to achieve. It remains unknown what effect it would have on the development of critical thinking if students were able to carry out genuine research inquiry in the first year of study.

This study acknowledges and embraces the notion that students do not learn in a vacuum, rather they are learning and influenced by all sort of factors outside of the zoology curriculum; these might include friends, flatmates, parents, as well as being involved in a study that looked at the development of their learning.
In summary, if critical thinking remains an aim for higher education, teachers and students need to be aware of the following social considerations:

1. The importance of peer interaction should not be underestimated for learning beyond what is prescribed in the curriculum.
2. Demonstrators and lecturers play an important role in academic socialisation and students need to be in an environment where they are comfortable asking questions and challenging authority.
3. Learning the language (both written and spoken) of the discipline is necessary for the evaluation and construction of arguments required for critical thinking.
4. Students are not likely to engage with the notion of critical thinking if they have a different expectation of the course, or feel that they are personally not ready.
5. Students need to be given opportunities to develop their confidence so that they can ask questions.
6. For critical thinking to occur students need an evaluative epistemology so that they can evaluate different perspectives and opinions.
Chapter 5: Critical Thinking and the Zone of Proximal Development

ABSTRACT

Vygotsky’s Zone of Proximal Development (ZPD) model explains how social interaction leads to individual development, however, the parameters of the model remain largely uncontested. Student-interview transcript data and Interpersonal Process Recall (IPR) were used, therefore, to understand various aspects of Vygotsky’s ZPD.

Three themes provided the focus for this chapter. First, I used student interview data to investigate the nature of the ZPD for critical thinking and considered, in particular; reciprocal learning, movement through the zone, and the emotional nature of the zone. Second, using both student interview data and IPR, I examined the key scaffolds from first to third year in the zoology curriculum. Finally, I used the theses findings that were also confirmed by the research literature, to discuss the implications of using the ZPD for critical thinking development.

The ZPD model traditionally suggests that movement occurs through the zone in a single linear direction; the evidence from this study suggests that this is not always the case. Learning trajectories are much more complicated than this.

This study revealed that the ZPD could be an emotional, fragile place. Students remarked on the joy of learning and the joy of being changed by their learning experiences, but at times, they were also clearly frustrated and annoyed with what they had to learn and how they learned it.

Vygotsky did not specify the nature of the guidance and collaboration that promotes development in the ZPD (Wood & Wood, 1996). In this study, conventional scaffolds at first year tended to be material supports and included textbooks, course documents, computer simulations and so forth. In later years, scaffolds that were more effective at promoting the development of critical thinking included student
group projects on self-selected research topics and informal conversations with teachers and peers. Students noted these scaffolds in later years structured their thinking and modelled dispositions necessary for critical thinking.

The following recommendations for using the ZPD for teaching and learning critical thinking are made:

1. To use the ZPD to think about the development of individual students rather than teaching a homogenous group.

2. To diagnose what students are already capable of achieving – the Zone of Current Development (ZCD) – and this becomes the starting point of instruction.

3. To think very carefully about how to scaffold in the ZPD.

4. To design activities which will help students create a ZPD for critical thinking and develop their full potential as critical thinkers.
INTRODUCTION

Vygotsky developed various formulations of the concept of the ZPD before he died, only 15 months after first publically introducing it (Meira & Lerman, 2001). For instance, much of his early work was used in the narrow context of traditional intelligence testing and later gradually broadened to encompass the general problem of the relationship between education and cognitive development (Meira & Lerman, 2001; van der Veer & Valsiner, 1991). He died before he was able to explore the determinants of his ZPD model fully and since its re-discovery in the West, it has been largely untested (Schunk, 2004).

Several criticisms have been levelled at the ZPD metaphor, or perhaps more importantly, how researchers have interpreted the ZPD. For instance too much emphasis is placed on either the learner, or the teacher, at the expense of the reciprocal nature of learning in the zone (Doolittle, 1997; Ferholt & Lecusay, 2010). In addition, rather than a zone that pre-exists prior to interaction between a teacher and a learner several researchers suggest that the ZPD should be recast as an emergent zone that evolves through joint activity (Meira & Lerman, 2001; Newman & Holzman, 1993). More empirical research into the nature of the zone and what this means for critical thinking is warranted. This would lead to our ability to better understand student development and inform the model.

In Figure 1.3 (p34), I introduced the idea of a ZPD created when a task is perfectly suited to the knowledge and skills of an individual. The task is challenging, but it is not beyond what the individual is capable of achieving. In order to help a teacher assist the learner to reach their ZPD potential, the metaphor of scaffolding has been proposed to guide teacher thinking and practice (Bruner, 1975a). Scaffolding represents the support a learner is given to attain a goal or engage in a task otherwise out of reach (Davis & Miyake, 2004). For example, as the learner masters each element of the task, the teacher may ‘remove’ the scaffold support and gradually pass more control to the learner.
RESULTS AND DISCUSSION

The results and discussion section of this chapter is divided into three sections as follows.

1. The nature of the ZPD for critical thinking

   In this section, I used student interview data to look at the nature of the ZPD for critical thinking and consider, in particular; reciprocal learning, movement through the zone, and the emotional nature of the zone.

2. Scaffolding for critical thinking

   Vygotsky did not specify the nature of the guidance and collaboration that promotes development in the ZPD (Wood & Wood, 1996), however, an understanding of scaffolding in the ZPD is one attempt to address this question. In this section, I used student interview data and IPR to examine the notions of emotional scaffolding and the temporal and dynamic features of scaffolding for critical thinking. Two models of scaffolding within the zoology curriculum were identified; conventional scaffolding (which in the zoology curriculum involves material supports and research activities), and informal interactions between the learner and their teachers and peers.

3. Using the ZPD for critical thinking development

   In this final section I use my thesis findings, which have been confirmed in the literature, to discuss the implications of the two scaffolding models for creating a zone for critical thinking development.

1. The Nature of the ZPD for Critical Thinking

   Reciprocal Learning

   Teaching and learning are not isolated phenomena. It was beyond the scope of this project to interview the participants' teachers about what they had learned from
interacting with the students, however, there was evidence from the student data that learning was not always unidirectional and teachers were a genuinely open to student opinions, as noted by Adrian as he reflects on his second year experiences.

*I have seen opinions valued. For example, in one paper last year we were doing geckos and there'd be lots of discussion and everyone could freely give their opinions. And one highlighted point was [one] of the lecturers asked the question to one of the groups ‘why do the male have hemipens or something like that in lizards’ and the person replied ‘Is it just the same reason that you know, like, male and female mammals both have nipples kind of thing?’ They were all like good point, but it was taken on. It wasn't dismissed because it wasn't the answer they were looking for necessarily, they were very accepting of it kind of thing and they seemed generally quite open to new ideas

(Adrian, Year 3)

When students interact with teachers and ask questions that challenge them, the quality of the teacher’s reasoning may also improve (as they check their own assumptions and evidence for their position) (Browne & Keeley, 2010). Students will only challenge their teachers, however, if they are in an environment where they feel safe to do so. Again, we see the importance of the social environment for the development of critical thinking.

**Movement through the ZPD**

The results from this study also suggest that movement through the ZPD is not always a smooth transition and not in a single linear direction as can be seen from Roy’s comment below.

*That was the section on gene replication and stuff. I did get the gist of it, but I didn’t understand the really minute processes of it. And so we’d talk about like the protease and all these different names and I*
wouldn’t know what they meant. But then I’d go and look them up and I’d be like, ohh, I do know what they are, but later on I’d forget them. So I suppose at the time you feel like you’re doing enough study so you do know it and then later on you think, I don’t know. It’s sort of like it comes and goes.

(Roy, Year 1)

Comments like Roy’s above give weight to the idea of recasting the ZPD as a fragile place (Meira & Lerman, 2001). A zone that is not as robust as first thought may have implications for how we (as teachers) support students moving through a zone for critical thinking and what helps (or hinders) this movement. For instance, we may not want to be so focussed on a teacher pre-determined endpoint, or we may wish to accept the zone as co-constructed.

The Emotional Nature of the ZPD

Data from this study also suggested that the ZPD could be a very emotional place. Despite students remarking on the joy of learning and of being changed by their learning experiences, at times, they were also clearly frustrated and annoyed with what they had to learn and how they learned it, as can be seen from the quote from Tania below.

The actual doing the work that was fun. It was just when we got our mark back, when we saw that we weren’t actually being marked on what we did or how hard we worked or anything, that it became frustrating.

(Tania, Year 2)

Here, Tania’s learning is still very driven by assessment, but she is also commenting on the emotional attachment she has to her learning experience and in particular, when receiving feedback on what was valued (Caffarella & Barnett, 2000).
How students are assessed needs to be carefully thought out, because of the impact that assessment has on learning (Haas & Keeley, 1998). If it is easier to require students to pass exams based on declarative knowledge forms, rather than test their critical thinking, this may create a culture of unquestioning dependence that is at odds with developing critical thinking abilities. In the quote below, Caroline reflects on how unsettling it was for her to be assessed in a way that required her to do more than rote learn information and how this changed her approach to learning.

*We've been specifically told from the start that they're not rote learning questions. That you have to know your knowledge but then you have to apply it and that's definitely changed dramatically and it was quite uncomfortable to begin with even though I do like that idea. Going from this completely different style of just memorising sheets of paper to just reading over them and I felt terribly under prepared going into the exams this semester. I was so nervous. So it's changed my learning to just reading over things and getting an understanding of what's going on behind it and the ability to critique things and so that comes from the change in assessment because I basically see what the assessment's going to be and then I just tailor whatever I'm doing to that, you know.*

*(Caroline, Year 3)*

Despite the emotional character of learning, there was no evidence from the student interview data that the teachers acknowledged the emotional side of learning, empathised with students or incorporated emotional considerations into their teaching.

There are, however, opportunities for exploring how we think. In a course such as bioethics, we might expect controversy and emotional attachment over the moral and ethical choices faced in medical research. In zoology, we also are faced with ethical choices and there are opportunities for students to explore the reasoning behind their opinions. For instance, what do students think about dissecting animals at first year? Why do they hold these opinions? Would it matter to them if pest species were used rather than native animals? How would it change their learning experiences if they
were exposed to some of the reasoning behind the perspectives of the teachers in a zoology course? These are just some of the questions that zoology students could explore when considering their own position on the use of animals for teaching purposes. If students went through such exercises, they would have the opportunity to think about the assumptions, biases, and values behind their reasoning (Browne & Keeley, 2010). This is not to say that biases and assumptions should be bracketed out or dismissed, but rather recognised and acknowledged as legitimate and healthy human qualities.

2. Scaffolding for Critical Thinking

*Emotional Scaffolding*

The idea of scaffolding students by helping them build emotional as well as cognitive relations to what they are learning was suggested by Rosiek (2003) drawing on the work of Vygotsky. Here, teachers use analogies, metaphors and narratives to influence students’ emotional response (such as the uncertainty experienced in scientific inquiry) to promote student learning. In an example given by Rosiek, a teacher knew that a group of students played basketball; therefore, an analogy was made between the uncertainty of scientific inquiry and a basketball game. In a basketball game, you are not always aware of what an opponent will do, but by making a move, you can ‘draw them out’. In scientific inquiry, you also do not always know the outcome before you start - but by performing the inquiry correctly, you are in a better position to move forward. Thus, by offering this analogy this science teacher was able to emotionally scaffold the students’ learning so that their experiences of uncertainty associated with scientific inquiry were replaced by one that they were more familiar with (basketball). The difference being that the uncertainty experienced in basketball was seen to be tolerated and valued.

In the present study, there was no evidence from the student participants that teachers used metaphors or analogies to emotionally scaffold through the ZPD. Students positively commented, however, on the caring attitude of some members of the teaching staff and the genuine interest that they had in their learning. Two participants also thanked me for the opportunity to take part in the study; it seemed
that just taking part in this research project, and having someone to talk with about their learning was valuable. This made me feel very humble because I had always felt indebted to them for the time and energy they had given to the project and for sharing insights into their learning.

It remains unknown what effect emotional scaffolding with metaphor or analogies would have on student learning. If teachers show a genuine interest in student learning (rather than the subject) and take the time to get to know their students, then a different type of emotional scaffolding is possible.

*The Dynamic and Temporal Nature of Scaffolding in the ZPD*

The scaffolding metaphor has been criticised by Pea (2008) among others, for not giving enough attention to the temporary and dynamic character of learning. That is, the scaffold should change over time in relation to the strengths and needs of the individual learner. This is difficult in a large class where the curriculum materials have been designed for entire classes of individuals rather than for single learners. Scaffolding using teacher-student interactions may provide a much more effective way to respond to the individual needs of students. Because of large class sizes, many first year lecturers might feel overwhelmed if they were expected to engage with students at this level, but they could try.

The results from this study suggest that the development of critical thinking takes a long time (and presumably will continue to develop) and teachers need to consider this when thinking about scaffolding. Some questions that need to be addressed therefore are; how do we scaffold for critical thinking? When is scaffolding most effective? And how should it change over time in relation to the strengths and needs of the learner? The scaffolding approach used for a particular paper in a one-semester course would look quite different, and may have quite a different outcome, compared to a co-ordinated scaffolding approach throughout an entire undergraduate degree programme.
Conventional Scaffolds
The overarching concept behind the zoology curriculum is that learning to become a zoology researcher will develop the required critical attributes expected in higher education. In this section, I examine the way in which the curriculum provided scaffolding in each of the three years of the degree programme. The curriculum is organised around the traditional idea that factual knowledge needs to be acquired before critical thinking is achievable. First-year students concentrate on learning facts and theories. They are then expected to apply these as they gradually develop their critical capacities through research training that culminates in an independent project in year 3.

Another way of thinking about conventional scaffolding in the zoology curriculum is that it predominately involves students reading about science at first year, writing about science in second year, and finally doing science in third year (see Figure 5.1).

Figure 5.1 Main scaffolds for critical thinking (Reading, Writing, and Doing) from first to third year in the zoology curriculum. Bullet points show key curriculum experiences.
Chapter 5 – Critical Thinking and the Zone of Proximal Development

Student learning in year 1 was reported as being highly scaffolded through reading and engaging with written or digital artefacts, such as textbooks, handouts, laboratory workbooks and computer simulations. Students commented that support materials, especially the laboratory workbook and simulations, provided alternative ways to understand lecture content and served to structure their thinking. In addition, students felt that they were learning material for themselves, which increased motivation. The sheer volume of information they were asked to assimilate and master, however, seemed to preclude spaces for other types of learning. Most felt little ownership of either the process or outcomes of learning. Combined with a high level of material scaffold, this may have made students over-reliant on declarative and procedural forms of knowledge that on their own are unlikely to be appropriate as a foundation for critical thinking (Pithers, 2000). Furthermore, the data also showed that a student’s actual level of development, in terms of their prior experiences, knowledge and cognitive abilities, was not taken as a genuine starting point for teaching in the large 1st year classes.

Learning through research (reviewing primary literature and learning evaluative skills) appeared to scaffold a change at second year.

*I can imagine slowly picking up a sense of criticism towards the experiment. I'm sort of developing a critical eye on how they've gone through the experiment and if they've kept it all constant. I mean you assume they will because they're usually produced through an academic institution, but I feel like I'm getting more critical of the experiments.*

*(Roy, Year 2)*

Here Roy is developing inferences about methods and feeling more confident to challenge scientific authority. However, at this level there was an indication that some students still saw themselves as novices and that knowledge was created by and belonged to others. Data, however, suggested that research activity was central to knowledge-making and provided the primary scaffold for a student’s journey through their ZPD for critical thinking. If we accept the logic of Vygotsky’s Sociocultural Theory, doing research should start at the limits of the Zone of Current Development.
(ZCD) and when the learner takes part in authentic inquiry activities, a ZPD is created (Harland, 2003).

A key dimension of all research exercises was writing. Nine students commented either on how their writing had improved or on the benefits of taking part in writing exercises. Students wrote research-based essays, critiques of papers and research reports. There was little mention of how teachers contributed to this experience but any writing-intervention is likely to affect the outcomes for the ZPD. As such, any teacher-scaffold for writing needs to be carefully thought out because of writing’s potential as a tool for supporting the process of learning to think critically (Hobson & Schafermeyer, 1994).

When the 2nd and 3rd year students were asked to reflect on their 1st year experiences they suggested that a foundation of factual information had been necessary and they supported the status quo that ‘facts’ must come before ‘thinking’ and that it was the teacher’s role to provide this knowledge. At the same time, they also believed that what was important for them to take away from university was the ability to evaluate, make judgements and create their own factual knowledge.

Caroline: It was hard to go through that rote learning stage ... I don’t think I’d be where I am now and as confident in doing research and my own project if I didn’t have that base knowledge.

Rob: Perhaps it does not have to be separated out as much?

Caroline: The knowledge is very important but the fact is that it was knowledge without thinking for yourself or any kind of critique.

(Caroline, Year 3)

In this example, the student supports the 1st year experience while recognising the difficulty associated with it. If learning through being actively engaged in research was used more in 1st year, dispositions necessary for critical thinking development might be formed earlier. Some would argue that there would inevitably be less space
for subject knowledge, however, and there is a widely held assumption that without a sufficient store of factual knowledge, critical thinking becomes difficult (Kuhn, 1999). Yet ‘knowledge in the context of discovery and knowledge in the context of transmission are entirely different enterprises’ (Barnett, 1992, p 623). If this idea is accepted, teachers could seek a new equilibrium with more research inquiry and less factual information, and then test the new enterprise to see what difference it makes to student learning and critical thinking. It is hard to see how such a change could be resourced with large 1st year classes that are ever increasing in size because of the continued shift to mass-higher education and concurrent rationalisation of courses. It may be much easier for academics to provide a ‘facts first, inquiry later’ curriculum and believe that this is the correct educational philosophy, even when there is evidence that potential for critical thinking is lost.

Reiser (2004) identified two distinct approaches to scaffolding in science education. The first is to simplify the task for the learner and reduce complexity. In the present study, this was apparent in the large first year classes where scaffolding included using guided textbooks, course materials and supported problem-solving exercises, with a move from high to low teacher-dependence. The second approach focuses on problematizing the learning experience, which is seen to be more productive in terms of developing evaluation, thinking and reasoning skills (skills required for critical thinking). Learning through research provides an example of a problematized ZPD because it requires students to take responsibility for their own thinking and maintain engagement with complex issues. Both are seen as an essential part of developing higher thought processes through inquiry (Dewey, 1938). A problematized approach requires teachers to stand back from interventions to allow student-struggle and thus foster the development of ‘thinking for oneself’ and a disposition towards education as a process rather than an outcome. Reiser (2004) cautions, however, that in a curriculum we need balance in our scaffolding approaches. Learners will not be served well by overwhelming complexity without suitable structure or a structured approach that strips away complexity altogether. The question remains what difference would it make to critical thinking in both the short and long term if a problematized strategy, such as learning through research, was adopted more often at first year.
A key difficulty with a problematized model is that it requires students to be proactive in their quest for learning and not all students will feel comfortable with this approach. In the modular system found at Otago, students have choice in which courses they take and there is anecdotal evidence that some programmes with a reputation for self-directed learning and inquiry are avoided. Not all 1st years seem to want control of their learning which would negate certain forms of scaffolding for critical thinking and therefore result in a different potential for their ZPD.

**Informal scaffolds**

Although curriculum planning and course activities scaffolded the development of critical thinking over the 3 years, data showed that less formal or unplanned social experiences were also essential. These included peer support, peer and teacher conversation, teachers acting as role models and changing perceptions of the programme culture.

Most first year students involved in this study viewed knowledge as a personal possession, but by 3rd year, all but one had changed their ideas about the social nature of learning. Teachers and student-peers became more important to each other and there was evidence that both groups became a necessary part of an individual’s ZPD and essential for the development of critical thinking.

In 1st year, there was no culture of student-lecturer interactions, in part because of the large class size, but mainly because students were reluctant to engage with lecturers. By year 3, this situation had changed:

"We've just been three years in the same class and we know all the lecturers now and been through them all but they've been a bit more sociable, you know, recognise you and talk to you and the funny thing is that is such an important part of the learning process because if you didn't know any of these people, it means it's more difficult to talk about what you're doing academically"

*(Roy, Year 3)*
Roy recognises the consequence of the informal interpersonal role of the lecturer. Some lecturers may have been more receptive to getting to know students or this change may simply have been a function of smaller-class sizes and prolonged contact time. Nevertheless, students reported that their changing relationship with lecturers was both subtle and central to higher-order thinking. Improved access to teaching staff allowed them to explore their understanding of the course material at a much deeper level and some reported that their questions gradually became more sophisticated as confidence in their relationship with the lecturer increased. It was also quite common for lecturers to scaffold students through student-led conversations rather than teacher-led assumptions. These conversations often included careful questioning and then direction by the teacher, and data showed that students could be keen observers of this process.

*It’s like he’s getting at something and I knew because he started directing the question and I had forgotten that that was what the study was all heading towards. You know, you get tied up with doing a study; you forget that you asked a question and that’s why you’re doing it in the first place. So the whole time I think he kept going back to what was the [research] question.*

*IPR tutorial transcript*

Lecturers were clearly seen as role models at 3rd year as students undertook their research inquiries with support coming mainly from conversations with supervisors.

*I think that it is funny learning from someone like [the supervisor] because you can sit there and look quite passive but at the same time, I have written two pages because he is structuring my thoughts. He isn’t necessarily giving out the answers but he is helping us lead up the process of getting somewhere.*

*IPR tutorial transcript*
Teachers who supervised student research needed a different set of scaffolding skills. They diagnosed students’ actual developmental levels before taking appropriate action and this contrasted markedly with the support provided at 1st year, in which a highly structured pre-determined curriculum regarded student knowledge, skills, abilities and dispositions as similar across a large cohort (see Table 5.1). Students commented that after a conversation with a lecturer (or sometimes a peer), it was much easier to recall knowledge, and they talked to lecturers about other things that were important to them, such as careers and qualifications.

Table 5.1. Key developmental stages and scaffolding support for critical thinking in the zoology programme and the possible impact on Vygotsky’s ZPD

<table>
<thead>
<tr>
<th>Year</th>
<th>Conventional scaffolding of critical thinking</th>
<th>Informal scaffolding of critical thinking</th>
<th>Impact on ZPD for critical thinking</th>
<th>Student conceptions; critical thinking as:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st year</td>
<td>Textbooks; computer simulations; problem-solving exercises; lectures</td>
<td>Rare lecturer and peer conversation; some demonstrator conversation</td>
<td>Assumptions about student ZCD and unlikely to maximise ZPD</td>
<td>Applying formal knowledge to problems</td>
</tr>
<tr>
<td>2nd year</td>
<td>Research training exercises; lectures</td>
<td>Lecturer and peer conversation</td>
<td>Learning to diagnose ZCD and maximising ZPD</td>
<td>Evaluating evidence; embedded in subject</td>
</tr>
<tr>
<td>3rd year</td>
<td>Original research; research in teams; lectures</td>
<td>Lecturer and peer conversation; peers take more responsibility for others</td>
<td>Diagnosing ZCD is necessary and maximising ZPD</td>
<td>Evaluation of evidence; embedded in subject; used in different contexts; taking action</td>
</tr>
</tbody>
</table>
Relationships with laboratory demonstrators were also valuable, especially at 1st year when they were more accessible than lecturing staff. Demonstrators would talk about how to study and typically sort out a student’s problem when they were stuck. They tended, however, to go no further in their teaching than providing basic support or help with study skills and this situation was recognised by one student as inadequate to their learning needs.

Similarly, students as ‘more-capable peers’ tended to provide only factual help in the early stages but in later years talking to peers became an active way of rehearsing ideas and reinforcing new knowledge. Friends were generally more willing to put in effort to help, and students perceived that peers would not judge them in the same way as a lecturer. Comparing knowledge to that of one’s peers was also important and such comparative evaluation could have unexpected outcomes for critical thinking. For example, one student observed that several individuals writing-up a group research project had produced ‘completely different’ accounts from the same data, and from this experience, they became aware that the principle of researcher interpretation must also hold for papers published in science journals.

Peer interaction, however, tended to be limited to affirmation or simple compromise rather than a situation where ideas were subject to robust challenge. In this sense, the ZPD is likely to be attenuated, as ‘challenge’ must be an important scaffold for the development of critical thinking. Furthermore, peers were not always suitable scaffolders as data showed that those who seemed more knowledgeable could irritate those who were not ‘up to their level’ and peer-knowledge might not be trusted, especially in the early years.

_I'm always suspicious of my friends when they tell me stuff in regards to a course because I've known them to be wrong. I'm always thinking, well that might be true but it might not be. I'm always very suspicious of people my own age that are telling me things about biological systems or whatever and saying this is what it is. I don't trust that sort of information._

(Roy, Year 1)
Overall, these social interactions changed students as learners and from 2nd year there was a notable shift in focus from ‘self’ to a more collaborative environment. In the wider group there was evidence that some students were prepared to make time to support their peers, and this change could be interpreted as an example of ‘critical action’ (Barnett, 1997). These formal and informal conversations helped students towards what one described as ‘thinking like a researcher’. Curriculum components that provided conversational space included fieldwork, research training exercises and group research projects. These supported changing dispositions as students matured and formed new attitudes towards their own learning and that of their peer group. Willingness to take responsibility for others was a key dimension of both learning and critical thinking at 2nd and 3rd year because students were required to collaborate in research. There is concern, however, if students take forward the individualistic culture observed in 1st year, then the collaborative dimension of critical thinking (Barnett, 1997) typical of later years becomes more difficult to accomplish.

3. Using the ZPD for Critical Thinking Development

In the research literature the ZPD is generally defined by what a person could achieve with assistance on a single task (see review by Chaiklin, 2003). In this longitudinal study, I was interested in development over the course of a three-year undergraduate degree programme. Therefore, I did not look at students' abilities to complete a specific task per se, but rather I investigated the experiences of students and their perceptions of how they had developed as critical thinkers and examined this in light of the theoretical model of the ZPD.

The ZPD can be used as a tool for thinking about how teachers and learners interact to promote development. In this section, the ZPD concept is explored further as I provide two models based on the ZPD with alternative outcomes for critical thinking.
Using my thesis findings, that have been confirmed by the literature, I suggest that a ZPD for critical thinking should include the following five dimensions of learning experiences (see Figure 5.2). These are:

1. **Having a suitable background knowledge** in the subject area.

2. Possessing certain **dispositions** (such as being open-minded).

3. Being able to use **cognitive skills** (such as being able to reason and evaluate evidence).

4. **Reflection** (through reading, writing, speaking) to improve the quality of thinking.

5. Having an **evaluative epistemology** (understanding knowing as a process of judgement and evaluation).

*Figure 5.2 Zone of Proximal Development for critical thinking and dimensions of learning experiences that scaffolded students.*
A person may have well-developed cognitive skills in reasoning and evaluation, but not have the background knowledge to form critical judgements. Similarly, a person may possess background knowledge on a topic, but simply not be prepared to engage with the evidence of others. If a curriculum does not acknowledge all dimensions of critical thinking, or focusses on only a few dimensions at the expense of others, the capacity for learning to think critically may be diminished.

The first year zoology experience was characterised as learning facts (which is reinforced through assessment). Learning skills (such as performing dissections) and reading about zoology were also key characteristics. In second year, students were involved with more independent reading, writing of laboratory reports and finally in third year, independent project work (which involved out of class discussions and sharing of data). The zoology curriculum (and I suspect many others) is based on a 'facts-first' curriculum. The premise being, students need to have the appropriate background knowledge in a subject area in order for them to think about it critically. I question what the effects would be on the ZPD if, instead of a content-orientated curriculum, from the outset the curriculum was more orientated towards these five dimensions of learning experiences (see Figure 5.2, p132). A curriculum that focussed on all these dimensions, in each year, might achieve this ZPD for all students. A critical thinking curriculum would also be quite challenging to implement and would require different forms of assistance and a cultural shift for teachers (possibly less knowledge scaffolding in the early years, but more personal interaction with students).

The value of the ZPD model proposed here is two-fold.

1. It helps teachers focus on teaching individual students rather than thinking about students as a homogenous mass.

2. It helps teachers think about the best way to move students through the ZPD.

The development of critical thinking is complex and multi-causal, and models are not meant to exemplify how things actually happen; rather they are a construct and a useful reference point for thinking about how students develop as critical thinkers and how we can support student development.
This study has already given some evidence as to the benefits of writing to structure thinking (Chapter 5, p125; Figure 5.2, p132). As an example of how teachers could use Vygotsky's Sociocultural Theory and the ZPD in the classroom, I have provided a series of recommendations for designing writing activities to support critical thinking (Table 5.2, p135). The table was adapted from Doolittle (1995) who used Vygotsky’s theory to provide recommendations for the use of co-operative learning tasks. The same principle equally applies to writing activities.
Table 5.2 *Writing activities to promote critical thinking based on Vygotsky’s Sociocultural Theory* (from Doolittle, 1995)

<table>
<thead>
<tr>
<th>Recommendations using Vygotsky’s sociocultural theory and the ZPD</th>
<th>Writing descriptions and examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teach using whole authentic activities</td>
<td>Writing activities should be genuine, not contrived or artificial. For instance, students should be introduced to the type of writing that is carried out by scientists and to the benefits of learning to write well.</td>
</tr>
<tr>
<td>Create classroom activities that require social interaction</td>
<td>Writing is generally considered an individual activity, but social interaction allows students to exchange ideas and experience new behaviours. Students might be given opportunities to peer review each other’s work and provide constructive feedback.</td>
</tr>
<tr>
<td>Closely monitor student progress in order to assign tasks that are within a student’s ZPD</td>
<td>Writing activities that are not in a learner’s ZPD will be ineffective at stimulating development, therefore any writing activities will need to be carefully scaffolded and monitored.</td>
</tr>
<tr>
<td>Activities must precede a student’s development.</td>
<td>Writing activities should be targeted at the upper end of the ZPD, so that students must develop in order to master the task.</td>
</tr>
<tr>
<td>Tasks should only be able to be completed with assistance.</td>
<td>If the writing task is such that the learner does not need any assistance, then the learner is not in their ZPD, but rather they are performing at the level of actual development.</td>
</tr>
<tr>
<td>Provide sufficient support to enable the student to perform challenging tasks successfully, and then gradually withdraw support as the student becomes more skilled.</td>
<td>The writing activities must be scaffolded so that support can be gradually withdrawn at a later stage.</td>
</tr>
</tbody>
</table>
SUMMARY

Intuitively, we know that teaching and learning are in a reciprocal relationship, however, the ZPD is generally thought of as a property belonging solely to the learner, and the teacher’s role is to create the ZPD. Another conception, however, situates the ZPD as belonging to both the teacher and the learner. That is, it acknowledges that the teacher and the student are learning from each other in the ZPD. In terms of a ZPD for critical thinking, if teachers share their learning with their students and give insights into the reasoning and logic behind their thinking, it is possible that the teachers’ thinking will also improve, in addition to creating the idealised zone for students.

Another characteristic of the ZPD highlighted by this study is that the ZPD can be an emotional, fragile place. Often this characteristic of the ZPD is not recognised by researchers, but there is some evidence from this study of the benefits of acknowledging the emotional aspects of learning. Similarly, the model presupposes that movement through the ZPD occurs in a single, linear direction. People learn things and then forget them. Alternatively, they think they know them, but they do not. This study reminds us that movement through the ZPD is not always experienced as unidirectional and we need to be mindful of this when thinking about the ZPD as a model for critical thinking development.

Vygotsky believed that instruction will lead development, therefore students need to be stimulated, but not beyond what they are capable of achieving. This research, therefore, looked at key scaffolding strategies to move students through the ZPD for critical thinking, from 1st to 3rd year across the zoology curriculum. At first year, scaffolds, which are primarily aimed at testing factual knowledge, may not serve students well if there is an overreliance on rote learning information and the aim of the curriculum is to develop students as critical thinkers. In 2nd and 3rd year, research activities and easier access to teachers changed students’ experiences radically. Teacher conversations were crucial to scaffolding and maximising the ZPD for evaluation and critical reflection. Peer conversation altered in focus during this period and some students began to take more responsibility for others with respect to consciously trying to develop higher-order learning. These students were able to
integrate ideas, apply critical thinking to new contexts and take critical action when scaffolding others.
Chapter 6: Summary and Conclusions

SUMMARY AND CONCLUSIONS

This thesis set out to examine students’ experiences of developing as critical thinkers over the course of their degree programme. Critical thinking instruction within the zoology programme was classified as ‘immersion’ using the typology of Ennis (1989). In the immersion method, general critical thinking principles are not made explicit; however, students are deeply immersed in the subject (in the case of zoology, through actively engaging in research-type activities). I also used a conception of critical thinking that incorporated both generic and discipline specific skills and knowledge and I used Vygotsky’s social constructivist theory and the ZPD to help understand how students developed as critical thinkers.

The study reinforces the observations by Brookfield (2012) that critical thinking development is a social process. Developing positive relationships between peers and teachers enhanced critical thinking skills. This research also highlights the important role of teachers in developing dispositions required for critical thinking. There was evidence for a direct and an indirect effect of this, but it remains to be seen what the full impact of this might be on student learning.

Critical thinking was developed by scaffolding for research (carrying out research activities) and the results of this study suggest that using the language and the tools (writing, critique and so forth) of the discipline will expedite critical thinking. It is argued that critical thinking needs to be experienced as an integral part of a complex cultural activity. For instance, it is not enough to introduce report writing into the curriculum and hope that is will enhance critical thinking development; instead, it is necessary to create an environment where students understand writing as a critical activity performed by scientists, which requires social interaction and self-reflection.

However, if critical thinking remains an aim for higher education and critical thinking is enhanced through research activities then it is necessary that both students...
and educators understand this phenomenon and it is likely that this will result in larger ZPD for critical thinking, than through the immersion method alone.

For the remainder of this chapter I report on the key findings of the study as they relate to the research questions, and I have headed each of the chapter sections with the relevant research question to make this link explicit.
Research Question 1: What are the key curriculum experiences that facilitated students’ development as critical thinkers?

![Diagram showing key curriculum experiences (Year 1-Year 3) of an undergraduate zoology degree.](image)

**Figure 6.1 Key curriculum student experiences (Year 1- Year 3) of an undergraduate zoology degree.**

Finding 1: Critical thinking development was associated with key curriculum experiences; namely third year group projects and activities that involved writing and talking about learning experiences.

All student changes occur within the context of an existing curriculum and this curriculum will influence student development (in the same way Vygotsky recognised that learning (or instruction) leads development). This study used a holistic view of critical thinking to understand students’ experiences. It was also a longitudinal study that looked at development over the entire course of an undergraduate degree. In this respect, this research is unusual. Many studies that look at critical thinking development only look at critical thinking over a one-semester course, or for one year.

The students involved in this study reported that at first year the curriculum was very content focused (see Figure 6.1). Learning facts was emphasized through assessment. Learning skills (such as performing dissections) and reading about zoology were also important. At second year, students were involved with more independent reading, writing of laboratory reports, and finally in third year they focussed on independent
project work (which involved out of class discussions and sharing of data). They valued these third year projects because they found them challenging, they had control over what questions they were going to research, how they were going to gather data, and how they were going to analyse and disseminate their findings. The students also commented on how important it was to have a project without a predetermined outcome. That is, they were not just repeating someone else's experiment – they were creating original knowledge in the process of discovery. Some students commented on the experiences as being 'real'. They could see themselves doing something similar for a job after their degree.

By the time they had completed their third year many students involved in this study had experienced an epistemological shift. They no longer sought out a ‘correct answer’, but instead were much more comfortable with knowledge being contestable (a condition that Kuhn (1999) argues is necessary for critical thinking development). What would be the impact on the development of critical thinking if first year students were introduced into research through open inquiry (such as they had experienced in their third year)? One student acknowledged that they understood the need for a 'fact first' curriculum, but this was the only model they had experienced. If teachers and students valued or at least, shared an understanding of the purpose of higher education that encouraged critical thinking development, we might see a curriculum that emphasises 'how to think' rather than 'what to think'.
Research Question 2: How do social interactions affect students’ development as critical thinkers?

Finding 2: An appropriate social environment encourages students to be confident learners and ask questions. This is crucial for critical thinking development.

This study highlights the importance of the social environment for the development of students as critical thinkers. The development of critical thinking does not occur in isolation, and as noted by Vygotsky, development occurs first through social interaction and then through the process of internalising what is learned. Social interaction was important for students in their first year, but there was limited capacity to learn curriculum content from each other because they did not value the knowledge of their peers in the same way as the knowledge of a lecturer or a demonstrator. Peers, however, were still important as a check on their understanding and for creating a learning environment that was fun. The students in this first year did not feel that they 'belonged' to the Department of Zoology or feel part of the zoology culture. In first year, students were typified as having an individualistic culture (see Figure 6.2).
In second year, as class sizes became smaller and the students had experienced sustained contact with one another, a transition period occurred. The participants reported that they were starting to feel like they were part of the Department. Finally, in the third year, students had developed a sense of community. It was not clear exactly what this community was. Was it a community of third year zoology students, third year zoology researchers or some combination of both? In their third year, students reported that they cared about what they were learning and recognised that the knowledge they were obtaining put them in a privileged position. They also noted a duty of care for their classmates and what their classmates were learning. To my knowledge, this phenomenon has not been reported in the research literature on student development.
Research Question 3: How can the ZPD guide teaching and learning of critical thinking?

Figure 6.3 Scaffolding effects on the ability to diagnose the Zone of Current Development (ZCD) and the potential to maximise the Zone of Proximal Development (ZPD).

Finding 3: Scaffolding strategies need to be carefully thought out if the aim is to create a zone for students to develop as critical thinkers

Central to the theoretical concept of the Zone of Proximal Development (ZPD) is the idea of scaffolded assistance in order to move individuals from their Zone of Current Development (ZCD) to the outer limits of the ZPD. In this study, I looked at students’ experiences of being scaffolded and I consider the effects on a Zone of Proximal Development (ZPD) for critical thinking. Scaffolds at first, second and third year were identified as being either conventional scaffolds (which in this context were text-books, computer simulations, and lectures) or informal scaffolds (such as conversations between students and lecturing staff, demonstrators, or peer to peer interactions). It was found that in large first year classrooms there was little opportunity for students to talk to their lecturers and little opportunity for lecturers to get to know their students as individuals. Any scaffolding in this environment was therefore based on assumptions about a student's Zone of Current Development (ZCD) and there was little capacity to develop critical thinking (Figure 6.3). Scaffolds in Year 1 focussed on reducing complexity, but also created minimal
opportunities for students to interact with staff. For instance, students were given
detailed hand-outs for all the lectures and lecture PowerPoints and audio podcast
were available for downloading through the Course Management System (CMS),
Blackboard. In contrast, the personal interactions that students had with lecturers in
year 3, allowed lecturers to diagnose student's ZCD and this created an opportunity
to maximise a ZPD through more appropriate scaffolding, primarily through
discussions involving questioning and answering.

In these later years, students were also scaffolded by taking part in original research
activities. Students found these projects challenging, but they also commented that it
was this facet of the projects that made them so appealing.

This thesis starts to illuminate the effects of the different types of scaffolds for
diagnosing the ZCD and the potential to maximise the ZPD. More research is needed
to investigate the effect of the type of scaffold and its influence on the development
of critical thinking.
LIMITATIONS OF STUDY

In the methodology section of this thesis, I addressed how I ensured trustworthiness in the data by considering the following four criteria; credibility, transferability, dependability, and confirmability. All research has its limitations, however, and any conclusions from any study should be understood in light of these. Four limitations identified from this study are listed below.

1. Interview Data
   The richness of the interview data was dependent on the interviewer and the participants being able to articulate clearly some complex ideas (for instance, ‘what is knowledge?’). Even then, the interview data is derived from students’ reported experiences of actual events. Reported experiences are prone to personal biases, are context dependent, and are time dependent.

2. Participants
   The participants who volunteered represented a range of opinions and drew on experiences from other courses. Some students who were part of this study also took ecology and psychology papers and they would presumably have been influenced by what was learned about critical thinking in these contexts - critical thinking is not the exclusive domain of zoology and it is difficult to tease out the general versus the specific impacts of a particular course.

3. Research Process
   There was some evidence in the study that participants changed their perception by simply taking part in this research. Students seemed to benefit from the opportunity to reflect on their learning and there was some evidence to suggest they had developed a new language to express this.

4. Teachers
   The original project design included interviewing the zoology teachers who were involved with the participants’ learning. It soon became
apparent that this was not feasible, as it would make the project too large. Because the teachers were not included in the empirical data, some assumptions were made based on my insider knowledge and these may not hold for all teachers.
**FUTURE RESEARCH**

This study has highlighted a need to examine critical thinking development from a longitudinal and holistic perspective, not one that just looks at student skills at identifying arguments, or examining the evidence of premises within a single year or semester.

It would be interesting to take the findings from this study and seek data in other departments at Otago (or perhaps other Zoology departments at other universities) to confirm similarities and differences. Given that critical thinking is on just about every university’s list of graduate attributes and most employers lists of desirable skills, my findings could also be examined from a University-wide perspective – what tools, like the ZCD and ZPD, does a university have to assure its graduates and stakeholders that students are in fact becoming critical thinkers? This may be particularly relevant given the emphasis on accountability resulting from the neoliberal climate discussed in the ‘Introduction and Overview’ section (p3).

Specific questions for future research might include:

1. What are teachers’ perceptions of critical thinking and how might they understand scaffolding critical thinking development in undergraduate teaching?

2. What might be the impact of undertaking research inquiry in first year on students’ ability to think critically in later years?

3. Critical thinking requires a subject, so what is the balance between gaining factual knowledge and thinking critically about it?

4. How does the way we assess students influence the development of critical thinking?
References


APPENDIX A: ETHICS APPROVAL APPLICATION


ETHICAL APPROVAL AT DEPARTMENTAL LEVEL OF A
PROPOSAL INVOLVING HUMAN PARTICIPANTS (CATEGORY B)

PLEASE read the important notes appended to this form before completing the sections below

NAME OF DEPARTMENT: Zoology

TITLE OF PROJECT: The Social Construction of Biological Knowledge

PROJECTED START DATE OF PROJECT: Monday 28th August 2006

STAFF MEMBER RESPONSIBLE FOR PROJECT: Dr Tony Harland

NAMES OF OTHER INVESTIGATORS OR INSTRUCTORS:

Mr Rob Wass (staff and student (PhD))
**BRIEF DESCRIPTION OF THE PROJECT:** Please give a brief summary (approx. 200 words) of the nature of the proposal:

The aim of this study is to examine the development of learning and knowledge in Zoology students as they pass through the different stages of their degree programme at the University of Otago. The practical outcome will be to develop a new understanding of student experiences that will help university lecturers gain a better understanding of their practice, particularly those who work in the biological disciplines. The study will also determine the nature of the relationship between educational theory and the practice of teaching and learning.

The aim will be achieved through the gathering and analysis of empirical data from students (over a three year period) and teachers (in year three). This investigation will be developed through semi-structured interviews, focus groups, and video-recordings for interpersonal process recall (IPR). The data will be examined in the context of current theories of learning and knowledge acquisition, and in particular the dominant paradigm of social constructivism.

**DETAILS OF ETHICAL ISSUES INVOLVED:** Please give details of any ethical issues which were identified during the consideration of the proposal and the way in which these issues were dealt with or resolved:

1. Participants will be student and staff volunteers recruited from the University of Otago.

2. When applicable, permission will also be sought from the class co-ordinator to video the volunteers.

3. Data as personal information will be collected from individual volunteers at interview, focus groups, and during video taping of classroom activities. Once data has been collected participants will not be identified in the research.

4. Participants will be informed that they may decline to answer, without explanation, any question that may cause discomfort.
5. Individuals will be informed about the nature of the research

6. Data will be tape-recorded and transcribed and stored in a secure departmental office and only the research team will have access to it.

7. Participants will be aware that data will be treated as confidential

8. Information from this study will be used in publications but no individuals will be identified.

ACTION TAKEN

☐ Approved by Head of Department

☐ Approved by Departmental Committee

☐ Referred to University of Otago Human Ethics Committee

☐ Referred to another Ethics Committee

Please specify:

..................................................................

DATE OF CONSIDERATION: ..............................

Signed (Head of Department): ..........................

Please attach copies of any Information Sheet and/or Consent Form
Notes concerning Category B Reporting Sheets

1. This form should only be used for proposals which are Category B as defined in the policy document "Policy on ethical practices in research and teaching involving human participants", and which may therefore be properly considered and approved at departmental level;

2. A proposal can only be classified as Category B if NONE of the following is involved:

   • Personal information - any information about an individual who may be identifiable from the data once it has been recorded in some lasting and usable format, or from any completed research;

     (Note: this does not include information such as names, addresses, telephone numbers, or other contact details needed for a limited time for practical purposes but which is unlinked to research data and destroyed once the details are no longer needed)

   • The taking or handling of any form of tissue or fluid sample from humans or cadavers;

   • Any form of physical or psychological stress;

   • Situations which might place the safety of participants or researchers at any risk;

   • The administration or restriction of food, fluid or a drug to a participant;

   • A potential conflict between the applicant’s activities as a researcher, clinician or teacher and their interests as a professional or private individual;

   • The participation of minors or other vulnerable individuals;
• Any form of deception which might threaten an individual's emotional or psychological well-being.

If any of the above is involved, then the proposal is Category A, and must be submitted in full to the University of Otago Human Ethics Committee using the standard Category A application form, and before the teaching or research commences;

3. A separate form should be completed for each teaching or research proposal which involves human participants and for which ethical approval has been considered or given at Departmental level;

4. The completed form, together with copies of any Information Sheet or Consent Form, should be returned to the Manager Academic Committees or the Academic Committees Assistant, Registry, as soon as the proposal has been considered at departmental level;

5. The Information Sheet and Consent Form should NOT include the statement “This proposal has been reviewed and approved by the University of Otago Human Ethics Committee” as this is inappropriate for Category B proposals. A statement such as statement “This proposal has been reviewed and approved by the Department of …., University of Otago” may however be used;

6. Please ensure the Consent Form and the Information Sheet have been carefully proofread; the institution as a whole is likely to be judged by them;

7. A Category B proposal may commence as soon as departmental approval has been obtained. No correspondence will be received back from the University of Otago Human Ethics Committee concerning this Reporting Sheet unless the Committee has concerns;

8. This form is available electronically at the following web address:

http://telperion.otago.ac.nz/acadcomm/categoryb.html
APPENDIX B: INFORMATION SHEET FOR PARTICIPANTS

THE SOCIAL CONSTRUCTION OF BIOLOGICAL KNOWLEDGE

INFORMATION SHEET FOR PARTICIPANTS

Thank you for showing an interest in this project. Please read this information sheet carefully before deciding whether or not to participate. If you decide to participate we thank you. If you decide not to take part there will be no disadvantage to you of any kind and we thank you for considering our request.

What is the Aim of the Project?

This project is being undertaken in fulfilment of the requirements for the award of the degree of Doctor of Philosophy.

We know that students develop as learners as they pass through their degree programme, but what do we really understand about these transitional experiences? From a development of learning perspective, the relationship between educational theory and experience are not well understood. The aim of this study is to examine the development of learning and knowledge in Zoology students as they pass through the different stages of their degree programme at the University of Otago.

When looking at student experiences, the guiding questions will focus on students, their teachers, the curriculum, and their environment and how these impact on learning and development. The second phase of the project will involve finding out what all the teachers involved in the education of these students have been trying to achieve for their students’ higher education.

The practical outcome will be to develop a new understanding of student experiences that will help university lecturers gain a better understanding of their practice, particularly those who work in the biological disciplines. The study will also
determine the nature of the relationship between educational theory and the practice of teaching and learning.

**What Type of Participants are being Sought?**

Participants will be first year students (that have listed Zoology as their degree major), and the teachers of these students.

**What will Participants be Asked to do?**

**Students**

*Interviews*

Should you agree to take part in this project, you will be asked to collaborate with the principle researchers over a period of three years to address the aims of the project. After the initial contact, this will involve taking part in a semi-structured interview (lasting approximately one hour) in each year of your degree programme. These responses will be recorded electronically and subsequently transcribed with anonymity. After each interview, you will be invited to comment on the interview transcripts, the constructed narratives, and suggest editing as appropriate.

*Videotape*

In addition to the on-going interviews the second year of the project will involve videotaping classroom activities (lectures and/or laboratories) for interpersonal process recall (IPR). IPR is a method to facilitate a deeper exploration of your learning experiences – watching a videotape of an event will trigger thoughts that may not be readably accessible for conscious inspection and this will help you reflect on the original situation.
A classroom activity will be videotaped and then you will be asked to review the tape in a group recall that will last about an hour. The process is facilitated by an inquirer whose key role is to ask questions that stimulate further recall. IPR discussion will be audiotaped and later transcribed verbatim. At the end of the IPR period a debriefing session will take place to ensure that you have no outstanding issues that might have arisen during the session.

N.B Videotapes will be destroyed after the data has been extracted.

Focus groups

In the third year you will be asked to take part in a focus group of four students to discuss questions based on the emerging themes of the research. In a plenary, student groups will report their ideas and engage in a wider discussion. This discussion will be video-taped and transcribed. You will be invited to read the report that comes out of the analysis and comment. It is expected that the focus group discussion and plenary together will take approximately one hour to complete.

Summary of student involvement

Year 1: Interviews (1 hour)

Year 2: Interviews continued (1 hour), videotaping and IPR (1 hour)

Year 3: Interviews continued (1 hour), focus groups (1 hour)

Please be aware that you may decide not to take part in the project without disadvantage to yourself of any kind.
Staff

Interviews

Should you agree to take part in this project, you will be asked to collaborate with the principle researchers in the third year of the study to address the aims of the project. After the initial contact, this will involve taking part in a semi-structured interview (lasting approximately one hour). These responses will be recorded electronically and subsequently transcribed with anonymity. After each interview, you will be invited to comment on the interview transcripts, the constructed narratives, and suggest editing as appropriate.

Videotape

In addition to the student interviews, the second year of the project will involve videotaping classroom activities (lectures and/or laboratories) for interpersonal process recall (IPR). Staff will not be involved in the IPR process but your classroom activities may be videoed. IPR will be a method used with the students to facilitate a deeper exploration of their learning experiences – watching a videotape of an event will trigger thoughts that may not be readably accessible for conscious inspection and this will help them reflect on the original situation.

N.B Videotapes will be destroyed after the data has been extracted

Can Participants Change their Mind and Withdraw from the Project?

You may withdraw from participation in the project at any time and without any disadvantage to yourself of any kind.
What Data or Information will be Collected and What Use will be Made of it?

As is usual for qualitative research, the data will be collected from a variety of sources; interviews, videotape analysis, and focus groups. This project involves an open-questioning technique where the precise nature of the questions which will be asked have not been determined in advance, but will depend on the way in which the interview develops. Consequently, although the University of Otago Human Ethics Committee is aware of the general areas to be explored in the interview, the Committee has not been able to review the precise questions to be used.

In the event that the line of questioning does develop in such a way that you feel hesitant or uncomfortable you are reminded of your right to decline to answer any particular question(s) and also that you may withdraw from the project at any stage without any disadvantage to yourself of any kind. All of the data collected will only be used for academic, non-commercial research purposes. The results of the project may be published and will be available in the library but every attempt will be made to preserve my anonymity.

You are most welcome to request a copy of the results of the project should you wish.

The data collected will be securely stored in such a way that only those mentioned above will be able to gain access to it. At the end of the project any personal information will be destroyed immediately except that, as required by the University's research policy, any raw data on which the results of the project depend will be retained in secure storage for five years, after which it will be destroyed.

Reasonable precautions will be taken to protect and destroy data gathered by email. However, the security of electronically transmitted information cannot be guaranteed. Caution is advised in the electronic transmission of sensitive material.
What if Participants have any Questions?

If you have any questions about our project, either now or in the future, please feel free to contact either:

Rob Wass or Dr Tony Harland
Department of Zoology Higher Education Development Centre
University Telephone Number: University Telephone Number:
03 479-5127 03 479 -8136
APPENDIX C: INITIAL EMAIL CORRESPONDENCE WITH PARTICIPANTS

Dear

Thank you very much for offering to help with my PhD research into Zoology teaching and learning.

This project is about student learning. There is a theory that says learning is a social practice and that knowledge is socially constructed. In simple terms this means that each of us learns from others (and therefore others learn from us) and this can happen in lots of different ways. Examples include: teachers talking, reading ideas in books, dissecting animals in laboratories and working in groups. This theory about social learning is the central idea for my study.

Before the interview, please think about the best learning experience you have had so far this year in BIOL112. What was it about the experience that made it important? We can explore this together. I would also like to ask you about how you think you have changed as a learner this year.

If you would like to discuss this further before the interview we can do this when I ring to arrange a suitable time to meet.

Best wishes, Rob

Note: Ethics information and consent form attached
Appendices

APPENDIX D: SAMPLE SEMI-STRUCTURED INTERVIEW PROTOCOL USED TO INTERVIEW STUDENT PARTICIPANTS

• Tell me about the best learning experience in your Zoology courses this year
• What was it about this experience that made it so important?
• What were the kinds of things that you learned?
• How did this understanding develop over time – please elaborate
• How has learning this material changed you?
• What did you know about this topic before?
• In what ways do you think that your prior knowledge is valued in the classroom?
• Can you give me examples where you have learned from others?
• Can you give me examples of when you taught others (helped them learn)?
• What do you think has been most effective in helping your understanding
• How do you know if you don’t understand something?
• What do you do about it?
• What have you learned from the feedback you have received on assignments etc?
• Can you give me an example of where you were asked to evaluate your own or someone else’s work? What happened? What did you learn? How did that make you feel?
• What have you learned about yourself through your writing?
• Can you reflect on a situation that required CT?
• What do you think are the main differences between Y2 and Y3?

• How have you changed in the last year as a learner?

• What is the learning culture in the class? How would you describe the culture for learning (atmosphere, attitudes towards, what the class is trying to achieve; testing, easy)

• How do you get immersed in this culture?

• How would you describe the Culture of University / Culture of Zoology and what is the social impact of this culture?

• What did you hope to attain in gaining a ‘higher education’?

• How do you think your Zoology course has prepared you for….

• Have you been taught tools that will let you discover …

• What are your plans after this year?
APPENDIX E: CONSENT FORM FOR PARTICIPANTS

THE SOCIAL CONSTRUCTION OF BIOLOGICAL KNOWLEDGE

CONSENT FORM FOR PARTICIPANTS

I have read the Information Sheet concerning this project and understand what it is about. All my questions have been answered to my satisfaction. I understand that I am free to request further information at any stage.

I know that:-

1. my participation in the project is entirely voluntary;

2. I am free to withdraw from the project at any time without any disadvantage;

3. the data (video-tapes / audio-tapes) will be destroyed after the data has been extracted but any raw data on which the results of the project depend will be retained in secure storage for five years, after which it will be destroyed;

4. this project involves an open-questioning technique where the precise nature of the questions which will be asked have not been determined in advance, but will depend on the way in which the interview develops. Consequently, although the University of Otago Human Ethics Committee is aware of the general areas to be explored in the interview, the Committee has not been able to review the precise questions to be used.

In the event that the line of questioning does develop in such a way that you feel hesitant or uncomfortable you are reminded of your right to decline to answer any particular question(s) and also that you may withdraw from the project at any stage without any disadvantage to yourself of any kind. All of
the data collected will only be used for academic, non-commercial research purposes

5. the results of the project may be published and available in the library but every attempt will be made to preserve my anonymity.

6. I understand that reasonable precautions have been taken to protect data transmitted by email but that the security of the information cannot be guaranteed.

I agree to take part in this project.

.............................................  ........................................
(Signature of participant)  (Date)
APPENDIX F: SCAFFOLDING CRITICAL THINKING IN THE ZONE OF PROXIMAL DEVELOPMENT REPRINT
APPENDIX G: REFEREED ABSTRACTS OF CONFERENCE PRESENTATIONS


Despite critical thinking being an avowed aim of higher education, we currently have little understanding of how higher education experiences contribute to critical thinking development in students. This showcase reports on a longitudinal qualitative research project of how undergraduate Zoology students changed as learners over their three-year degree. We were particularly interested in; how students developed critical thinking, how this was socially constructed and what the implications are for teaching practice. The students involved in this study reported an enhanced ability to think critically as they developed the ability to evaluate research literature, design their own research projects, and question their own assumptions and those of others. The data emphasises how important formal and informal interactions with peers and teaching staff are in this development. Students noted that relationships changed over time as they felt they became more valued by both other students and their teachers. As students became comfortable with the curriculum content, they grew in confidence (which was reflected in their written and oral ability). When students interacted with staff and peers in later years, they reported a change in their ideas about knowledge. Knowledge was no longer seen as an absolute, but rather contestable and uncertain. We argue that for critical thinking development to occur, teachers should not lose sight of the importance of the social context in which this development takes place. A genuine, deep understanding of student development, and how students change as learners, can inform the choices that teachers make in their courses.

*What is it about?*

Lev Semonovich Vygotsky was born in Russia in 1896. He was a prominent scholar in several disciplines, but he is perhaps most noted for his theories on the development of the human mind. In Vygotsky’s theory, interactions with the minds of others are crucial for individual development. He also recognised that the mind is shaped by culture and the history of that culture, and that this is a uniquely human characteristic (Plotkin, 2003).

In an attempt to describe the mechanism and the potential effect of learning on the development of the mind, Vygotsky devised a model called the Zone of Proximal Development (ZPD). The ZPD represents the amount of learning possible with assistance from a more capable peer. In the ZPD, the teacher and the learner work on a task that the learner could not perform independently because of the difficulty level. At a later stage, the individual will then be able to perform this task independently (Doolittle, 1997).

A common application of the concept of the ZPD involves scaffolding. Scaffolding implies that given appropriate assistance, a learner can attain a goal or engage in a practice otherwise out of reach (Davis & Miyake, 2004). Through verbal or physical assistance, task elements that are beyond the learners’ capabilities are controlled. As the learner masters the features of the task that they can grasp quickly, the teacher gradually passes more and more control back to the learner (Meece & Daniels, 2008).

*Why is it important?*

This paper reports on the findings of a three year longitudinal study that investigated the development of critical thinking in undergraduate Zoology students from a Vygotskian perspective. We argue that a high degree of physical scaffolding, such as detailed course booklets, lecture notes on course management systems, prescriptive
course requirements, and so forth, may promote a culture of dependence. Of more importance is to develop positive relationships of trust and respect with peers and teaching staff. Students are then more inclined to have the confidence to question and challenge ideas. With less physical scaffolding and more verbal assistance, students entered into a new relationship with their teachers where they felt that their opinions were valued and their attitude to learning was no longer focussed on grades but instead they developed a love of learning for its own sake.

*How the session will be run*

In the spirit of the TERNZ philosophy, where the contribution of all participants is important, this session will encourage attendants to reflect and share their experiences of scaffolding. We will explore notions such as; why do we scaffold? Is it for the learner, the teacher, or both? How do we scaffold? How do we know whether scaffolding has been effective? By the end of this session we hope to raise the awareness of scaffolding in the classroom and by sharing ideas of good practice, help ensure that we are scaffolding for the right reasons.

*References*


This paper explores the learning experiences of a cohort of Zoology students throughout their undergraduate degree programme within the context of the social constructivist theories of learning and knowledge acquisition, specifically Vygotsky’s concept of the Zone of Proximal Development (ZPD).

From a development of learning perspective, relationships between theories of learning and experience are not well understood. The dominant paradigm of constructivism suggests that individuals create their own new understandings based on an interaction between what they already know and can do, and the new knowledge that they come into contact with. The social constructivists (after Lev Vygotsky) would also argue that all knowledge is socially constructed, that is, the individual learns only from a social interaction of one sort or another.

Vygotsky created the model of the ZPD in an attempt to describe the process of the development of the mind from a social and cultural perspective. The ZPD bridges the gap between what is known and what can be known under adult guidance or with collaboration with a more capable peer. Vygotsky claimed that learning occurs in this zone and that learning leads development. However, Vygotsky died before he had been able to fully establish the determinants for his model. For the concept of the ZPD to have any utility to teachers we must test Vygotsky’s theory in practice situations. That is, how do students experience and understand this phenomenon?

Because it is such a foundation concept of a higher education this research focused on the development of critical thinking using Vygotsky’s model of the ZPD as a theoretical framework. Student participants were interviewed each year, for three years, during their undergraduate degree programme using a semi-structured interview technique. The purpose of these interviews was to discover how students learn, what they learn, and how this learning changed over time. Although still a ‘work in progress’ this paper reports some of these findings.
What is it about?

Lev Semonovich Vygotsky was born in Russia in 1896. He was a prominent scholar in several disciplines but is perhaps most noted for his theories on the development of the human mind. In Vygotsky’s theory, interactions with the minds of others are crucial for individual development. He also recognised that the mind is shaped by culture and the history of that culture, and that this is a uniquely human characteristic (Plotkin, 2003).

In an attempt to describe the mechanism and the potential effect of learning on the development of the mind, Vygotsky devised a model called the Zone of Proximal Development (ZPD). The ZPD represents the amount of learning possible with assistance from a more capable peer. In the ZPD, the teacher and the learner work on a task that the learner could not perform independently because of the difficulty level. At a later stage the individual will then be able to perform this task independently (Doolittle, 1997).

Vygotsky died before he had been able to fully explore the determinants of his ZPD model and since its re-discovery in the West about 40 years ago it has been largely uncontested (Schunk, 2004). This workshop will focus on some of the more puzzling aspects of his model in the hope that by doing this we can examine the utility of Vygotsky’s theories for Higher Education.

Why is it important?

One of the problems of the ZPD is that it appears to be intuitive and as something that ‘seems right’, largely uncontested. We have little idea about the explanatory power of the theory and the ZPD’s relationship to Vygotsky’s more holistic social-cultural theories of learning.
The following questions seek to illuminate some of the more puzzling aspects of Vygotsky's thinking:

1. What is the relationship between learning and development in adult learners?

2. What are the key social and cultural determinants in the student experience of learning?

3. Can the ZPD guide teaching and learning?

How the session will be run

Vygotsky’s work will be briefly introduced and the core problematic elements of each of the three questions will be explained in more detail. Some empirical evidence will be used from a longitudinal study of Zoology student’s experiences at the University of Otago. The three questions will then provide the focus for extended discussion.

References


*What is it about?*

The social constructivists would argue that all knowledge is socially constructed, that is, the individual learns only from a social interaction of one sort or another but where does this knowledge exist? Does it exist in the head of the individual; out there somewhere, for instance, in books; or is it somehow held vicariously between a more capable and less capable peer? To make matters more complicated, some social constructivists also argue that learning leads development. As teachers we can see that this happens; students change as they mature through four years of study and we gradually provide them with more advanced learning opportunities. What we do not know is the nature of the relationship between learning and development.

*Why is it important?*

The answers to these questions are important because in tertiary education, we almost certainly align teaching and learning through our espoused beliefs, our assumptions and our understanding of how knowledge is constructed and how learning takes place.

At the University of Otago, a longitudinal study is currently underway that examines the learning experiences of a cohort of Zoology students as they pass through their degree program. The study focuses on the social construction of knowledge and how this is understood by students and teachers.

In this TERNZ workshop we want to explore some of the early data from first year students and look at the implications of their various ideas about learning, development and knowledge.
How the session will be run

In this interactive workshop, the research project will be explained and then we will briefly present some of the outcomes on student learning experiences using two small case studies. The cases will form the basis of a discussion about constructivist theories and how these might inform teaching practice. The hope is that we can contribute to an understanding of the relationship between theory and practice.

This poster outlines the early stages of a research project examining the development of learning and knowledge in Zoology students as they pass through the different stages of their degree programme. It poses several questions that have not been addressed in the research literature.

From a development of learning perspective, relationships between theories of learning and experience are not well understood. The dominant paradigm of constructivism suggests that individuals create their own new understandings based on an interaction between what they already know and can do, and the new knowledge that they come into contact with. The social constructivists (after Lev Vygotsky) would also argue that all knowledge is socially constructed, that is, the individual learns only from a social interaction of one sort or another. Vygotsky called this phenomenon the zone of proximal development (ZPD). The ZPD bridges that gap between what is known and what can be known under adult guidance or with collaboration with a more capable peer. Vygotsky claimed that learning occurs in this zone and that learning leads development. But how do students experience and understand this phenomenon? Furthermore, how will insight into their own learning (through taking part in the research) alter their perceptions and their ability to learn, and what can teachers learn from these experiences?