BLENDED LEARNING IN TERTIARY EDUCATION: A SCIENCE PERSPECTIVE

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ABSTRACT

Blended learning has been suggested as having the potential to transform tertiary education through its ability to provide flexible learning options, cost reductions and high quality educational experiences. Combining the benefits of both the face-to-face and online learning environments, blended learning provides opportunities for tertiary education organisations to improve the engagement, satisfaction and achievement of students. Tertiary science is experiencing issues with student recruitment and retention due to it being complex and challenging to learn and often poorly taught. Blended learning, therefore, with its ability to support visualisation of abstract scientific processes, critical thinking and attitudes to science could provide a means to encourage students to study science. However, to date, most studies on blended learning in undergraduate science have focused on evaluating the implementation of a particular blended approach within a small number of science classes or have considered only the teacher or student perspective. This study sought to explore both lecturer and student experiences of blended learning within undergraduate science whilst also considering the institutional context within which science teaching and learning operates.

A case study methodology was used to investigate blended learning in undergraduate science in a New Zealand university. Data collection methods included interviews with university management, lecturers and students. Management interviews were used to determine the university's stage of blended learning adoption and to provide the institutional context for the study. Lecturer and student interviews provided a rich description of each group's experiences and perspectives of blended learning in science. These were supplemented with lecturer and student surveys which provided breadth to the findings.

The findings revealed both the institutional and disciplinary context influence lecturer and student perspectives of blended learning. They also highlighted the similarities between lecturer and student experiences. Lecturer perspectives and issues have long been taken into consideration by tertiary organisations when planning their blended learning implementation. However, this study suggested that student needs and support are equally as important and recommended that they receive the same attention.

CHAPTER ONE

INTRODUCTION

Globally, fewer students are interested in studying science at higher levels (OECD, 2008). In addition, those who do choose science courses at undergraduate levels are unsatisfied with their experiences (DeHaan, 2005) which leads to high drop-out rates (Ulriksen, Madsen & Holmegaard, 2010) and fewer science graduates. This poses a problem for society where both science literate citizens as well as trained scientists are essential both to overcome the challenges and seize the opportunites of the 21st century (Barber, Donnelly & Rizvi, 2013).

Blended learning refers to the combination of face-to-face and technology-enabled learning environments (Gerbic, 2011). By integrating the strengths of each learning environment, providing learners with flexible access to a wider range of support materials and enabling critical thinking and reflection, blended learning offers the potential to improve learning outcomes (Garrison & Kanuka, 2004). A growing body of evidence suggests that blended learning can also increase student engagement and satisfaction (Smythe, 2012). Therefore, a blended learning approach in undergraduate science may help to recruit and retain science students.

Blended learning implementation, however is complex (Yuen, 2011) involving lecturer knowledge of how to use the technology, pedagogical adaptations, student learning preferences and institutional factors such as the availability of technology. The benefits and challenges of blended learning have been well documented. However, to date, research has mostly focussed on either lecturer or student perspectives of blended learning environments (Gerbic, 2011; Yuen, 2011; Owens, 2012; Reed, 2014) and few have considered a science perspective. This thesis will take a more holistic approach (Bluic, Goodyear & Ellis, 2007) and seek to understand a range of different perspectives on blended learning within an undergraduate science context by considering those of university management, lecturers and students. With the ever increasing global emphasis on science education, and with blended learning proclaimed to be the future of tertiary education, it is timely that we understand the current blended learning environment in undergraduate science from multiple perspectives. Therefore, this study will focus on two research questions:

1. What are undergraduate science lecturer and student perceptions and experiences of blended learning?

2. How do the institutional and disciplinary contexts influence lecturer and student perceptions and experiences?

Establishing the alignment between the perspectives of management, lecturer and students as well as considering the influence of both the institutional and disciplinary contexts will shed light on current practices and inform future planning for blended learning.

This chapter provided a brief overview of the research rationale and context of this study. Chapter 2 extends this with a review of the research literature describing the challenges facing tertiary education and undergraduate science and the potential role of blended learning in addressing these challenges. The review then outlines how the adoption and implementation of blended learning, like any organisational change, is complex involving many stakeholders and conditions. It ends by discussing that research which involves multiple stakeholders and considers that disciplinary differences are needed to inform successful adoption of blended learning and to realise its full potential.

In Chapter 3 the methodology of the research and a description of the qualitative case study design are provided. The aim was to research blended teaching and learning in undergraduate science in one university in New Zealand using multiple sources of data collected from management, lecturers and students. The selection and nature of participants are outlined and discussions on the data collection methods, data analysis, ethical considerations, validity and reliability are also provided.

In Chapter 4 the findings from the management interviews are discussed, firstly to position the university within the blended learning adoption framework proposed by Graham, Woodfield and Harrison (2013) and then to develop key themes describing the university management's perspectives on blended learning. The findings are discussed with reference to the current research literature.

In Chapters 5 and 6 the findings from the lecturer and student aspects of this study are presented. In each chapter, the results of the lecturer or student surveys are described and then a rich description of the lecturer or student interviews is provided. The key lecturer or student themes that were developed from the data are described.

In Chapter 7, the findings and themes from the management, lecturer and student aspects of the study are each discussed in relation to the current research literature.

In Chapter 8, the conclusions drawn from the combined management, lecturer and student data are presented in relation to the two research questions posed in this study. Implications for

tertiary organisations are discussed along with the limitations of this study and suggestions for future research.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The chapter begins with a description of the challenges facing science education. It then outlines the potential for blended learning to address these challenges. It considers the influence that the institution has on the adoption and implementation of blended learning and the use of blended learning in science disciplines. It discusses the perspectives and experiences of lecturers and students and ends by discussing the need for research involving multiple stakeholders and considering disciplinary differences in order to inform the successful adoption of blended learning and to realise its full potential within undergraduate science. Throughout the literature review, where relevant, the New Zealand context of this study is discussed.

2.2 The status of undergraduate science

Internationally there are declining numbers of students who choose to study science at higher levels or to pursue science as a career (for example, Osbourne & Collins, 2001; Goodrum et al., 2001 and Sjøberg et al., 2004 both as cited in Braund & Reiss, 2006). Furthermore, science disciplines have some of the highest drop-out rates (Ulriksen et al., 2010). Students have reported that undergraduate science is challenging, often lacks relevance (Parkinson, Hughes, Gardener, Suddaby, Giling & MacIntyre, 2011) and is poorly taught (Kardash & Wallace, 2001). Students' lack of academic motivation and interest in science leads them to neglect their studies and, as a result, have unsatisfactory levels of achievement (Hassan, 2008).

The story is the same in New Zealand. There has been a concern from the New Zealand government and worldwide about whether there are sufficient and sufficiently qualified graduates to maintain the national 'knowledge economy' (Parkinson et al., 2011, p.2). Data from the 2009 Australasian Student Survey of Engagement (AUSSE) showed that nearly one third of New Zealand natural and physical science students had seriously considered leaving their degree (Comer & Brogt, 2010). Participation and interaction for New Zealand science students were reported at lower levels than both in other disciplines and in the same disciplines in Australian universities: almost 50% of students had never given a presentation, 75% never contributed to a discussion in class and over 70% had never worked with other students in class or as part of a

study group. These students were also less engaged in work-integrated learning experiences and reported lower levels of career readiness than students from other disciplines (Comer & Brogt, 2010). There have been calls to change science teaching approaches (Henderson, Beach & Finkelstein, 2011) in order to encourage more students to study science at tertiary level and to pursue science careers.

Science education, therefore, is 'at an important crossroads' (Anderman, Sinatra & Gray, 2012, p.89). Researchers advocate for science learning environments which are learner-centred, collaborative, provide real-world relevance for science, authentic learning experiences (Osborne & Hennessey, 2006) and emphasise skills and competencies as opposed to rote knowledge (Tytler, 2007). However, most of tertiary teaching is still based on an outdated transmission model of teaching and learning (Owens, 2012).

2.3 A role for blended learning?

The term 'blended learning' has been in use since the year 2000 (Bluic et al., 2007) and, over the following decade, has emerged as the dominant label over others such as 'mixed mode learning', 'hybrid learning', 'combined learning' (Moskal et al., 2013, p.) and 'integrated learning' (Verkroost, Meijerink, Lintsen & Veen, 2008, p.501). However, despite its ever increasing use within educational literature and practice, there is no overall consensus on its definition.

It is generally agreed that, in its broadest sense, blended learning is 'the combination of traditional face-to-face and technology-mediated learning' (Graham et al., 2013, p.4). Narrowing the definition from here immediately becomes more difficult. Even the use of the word 'combination' can be contentious as for some it implies that online learning is simply added or 'bolted-on' to face-to-face learning without addressing the need to re-design the overall teaching approach (Verkroost et al., 2008). This need for any definition of blended learning to address the pedagogical changes essential for its successful delivery means that definitions of blended learning often substitute 'integration' for 'combination'. They may also take this emphasis a stage further as in Garrison and Kanuka's (2004) widely cited definition: 'the *thoughtful* integration of classroom face-to-face learning experiences with online learning experiences' (p.96, emphasis added) or that of Niemiec and Otte (2005): 'the integration of online and face-to-face instruction in a *planned, pedagogically valuable manner*…' (p.17, emphasis added).

Blended learning sits within the continuum of course delivery modes between entirely face-to-face and entirely online courses. Whilst most definitions apply to the entire spectrum of blended learning, others have attempted to categorise it. Taking the perspective that blended learning is 'an instructional approach that substitutes online learning for a portion of the traditional face-to-face instructional time' (Owston, 2013, p.1), the Sloan Consortium defines 'blended' courses as having 30-80% of course content delivered online (Allen & Seaman, 2006, p.4). Courses where less than 30% of the content is delivered online are defined as 'web-enhanced' and are grouped with along with 'traditional' face-to-face courses where no content is delivered online. At the other end of the spectrum, 'online' courses have more than 80% of their content delivered online (Allen & Seaman, 2006). A number of other authors have similarly adopted definitions of blended learning in which face-to-face time is replaced by online activity (e.g. Graham et al., 2013; Owston et al., 2013; Moskal et al., 2013; Vaughan, 2007) although they are not specific regarding the proportions. They maintain that there are 'virtually unlimited possible combinations, each one no more or less valid than all the others' (Moskal et al., 2013, p.15) and therefore no 'set formula for the reduction of class time' (Vaughan, 2007, p.83).

Some definitions make reference to blended earning as relating to specific types of media. The frequently cited definition of blended learning developed by Garrison and Kanuka (2004), for example, initially appears to be inclusive of all instructional approaches, but closer examination of their definition finds it potentially limiting, referring to the 'blend of text-based asynchronous internet technology with face-to-face learning' (p.96). Garrison and Vaughan (2005 as cited in McGee & Reis, 2012) share the same view noting 'the true benefit of blended learning is in integrating face-to-face verbal and online text-based exchanges and matching each to appropriate learning tasks' (p.9). Most definitions, however, imply or make reference to a wide variety of online media. What this might include is captured in Mortera-Gutiérrez's (2012, p.316) list of the most used elements within blended learning situations which includes collaboration software, threaded discussions, online testing, video-conferencing, audio-conferencing, virtual classrooms, e-mail-based communication, e-learning platforms, discussion boards, chat rooms and computer conferencing. Moore and Gilmartin (2010) argue for a still broader perspective of both the face-to-face and online aspects and see blended learning as incorporating a range of learning materials, resources, types of assessments and in-class activities.

Whilst most authors tweak the broadly accepted definition, more individual perspectives of blended learning are also represented in the literature. For Verkroost et al. (2008), blended

learning does not necessary involve an online component since they view it as 'the total mix of pedagogical methods, using a combination of learning strategies, both with and without the use of technology' (p.501). Oliver & Trigwell (2005 as cited in Bluic et al., 2007) doubt the conceptual integrity of blended learning arguing that its focus is not learning per se but teaching. They propose the alternative terms of 'blended teaching' or 'blended pedagogics' (p233). Littlejohn and Pegler (2007 as cited in Gerbic, 2011) refer instead to 'blended e-learning' which identifies two important concepts for campus-based programmes being that of introducing some form of e-learning and doing so in a face-to-face setting. Glogowska et al. (2011) define blended learning partly in terms of its use of different learning spaces, noting that 'students may engage in learning on university or college campus, at work, at home or between places with appropriate technology' (p.887).

Therefore, as Driscoll puts it (2002, p.54 as cited in Mortera-Gutiérrez 2006, p.315) 'blended learning means different things to different people, which illustrates its widely untapped potential'. Furthermore, as individual institutions have tried to make blended learning policy and delivery decisions it has become clear that 'context plays a vital role for construction of a workable definition' (Moskal, et al., 2013, p.15). They have thus begun to frame blended learning in a way that suits their particular institutional characteristics such values, mission, student acceptance and teacher responsiveness (Moskal et al., 2013).

The case study at the centre of this study is a New Zealand tertiary institution. However, this context provides little to assist the development of a definition. The New Zealand Ministry of Education defines blended learning simply as 'learning that is enabled or supported with the use of information and communication technologies (ICT)' (MinEd, 2010a), the Tertiary Education Commission appears to refer only to e-learning and relevant documentation from the institution itself similarly does not reveal a definition. Therefore, for the purposes of this study, I have chosen to follow the definition of Bluic et al. (2007, p.234):

> *Blended learning' describes learning activities that involve a systematic combination of co-present (face-to-face) interactions and technologically-mediated interactions between students, teachers and learning resources*

The reasons are as follows: Given the exploratory nature of this study, its phenomenological approach and its desire to understand the blended learning from the participants' perspectives, this definition of blended learning is suitably broad. By noting the importance of pedagogy and the involvement of both teachers and students in the

learning process, it also follows the study's aim of considering multiple perspectives simultaneously. Furthermore, it allows for different uses of the face-to-face and online environment and is open enough to accommodate the rapidly changing technology landscape and the thus the changing nature of blended learning. However, following the conclusion of Moskal et al., (2013) that blended learning is 'evolving, responsive, dynamic...organic' (p.16) this is viewed as a working definition and as such it may be re-shaped by the context and findings of this study.

Blended learning offers the opportunity to provide learning experiences which take advantage of the strengths of the face-to-face and technology-mediated environments whilst avoiding their weaknesses (Donnelly, 2010). For tertiary education, blended learning has offered the flexibility to reach a wider, more diverse student population and to respond to students' expectations for the inclusion of technology in their learning (Chen et al., 2010). At the same time employers are demanding ICT-competent graduates (O'Toole & Absalom, 2003) since scientists use ICT inherently as part of their work. Furthermore, blended learning can support student-centred learning environments (Benson et al., 2011) where the affordances of blended learning environments include promoting higher-order thinking, critical reflection and motivation, improving academic achievement, enhancing and enriching interaction and facilitating student self-regulation of their learning (Monteiro & Morrison, 2014).

The positive influence of blended learning can also be extended to science disciplines. Science specific studies, although small in number and often narrow in focus, have demonstrated that blended approaches can assist with visualisation in molecular subjects (Rundgren & Tibbell, 2010), conceptual understanding (Dori & Belcher as cited in Baepler, Walker & Driessen, 2014), problem-solving ability (He, Swenson & Lents, 2012), attitude to science (Duda & Garrett, 2008) and the development of scientific laboratory skills (Toth, Ludvico & Morrow, 2014). Therefore, a blended learning approach could be part of a strategy to make science more engaging and relevant thereby retaining science students and increase the number of science graduates.

Blended learning was proposed to have 'transformative potential' (Garrison & Kanuka, 2004, p. 95) in addressing the challenges of higher education. However, whilst it may be the 'single greatest unrecognised trend in higher education today' (Young, 2002 as cited in Garrison & Kanuka, 2004, p. 96) in terms of the 'explosive growth' (Norberg, Dziuban & Moskal, 2011, p. 207) in the number of blended courses, the nature of the 'blends' being adopted mean that blended learning environments have rarely been used effectively to promote student learning

(Owens, 2012). The most common student experience of blended learning has combined traditional didactic face-to-face lectures with the provision of supplementary online resources (Torrisi-Steele & Drew, 2013; Nanayakkara & Whiddett, 2005; Benson et al., 2011; Sharpe, Benfield & Francis, 2006). The transformative potential of blended learning, therefore, is not being realised.

2.4 Institutional influences on blended learning

Research interest in blended learning in the tertiary context is high. A recent study of academic publishing on blended learning (Halverson, Graham, Spring & Drysdale, 2012) showed that 66.1% of publications focussed on the higher education sector including the most cited article by Garrison and Kanuka (2004) on the transformative power of blended learning in higher education. Most of this research has focussed on staff or students and fewer studies have explored the institutional adoption of blended learning (Porter, Graham, Spring & Welch, 2014). Despite this, the benefits, challenges and success factors of blended learning at the institutional level have been well described.

2.4.1 Institutional benefits of blended learning

Blended environments may also encourage approaches that foster active learning (Garrison & Kanuka, 2004; Vaughan, 2007), appeal to students with varying learning styles (Kennepohl, 2012) and lead to improved learning outcomes for students (e.g. Means, Toyama, Murphy, Bakia & Jones, 2010 as cited in Owston, 2013). Blended learning also increases opportunities for students to participate in tertiary education (Taylor & Newton, 2013). By creating both temporal and geographical flexibility (Porter et al., 2014) blended learning allows students who live some distance from a university (Poon, 2013) and those with employment issues or family responsibilities (Vaughan, 2007) to enrol in study programmes. Furthermore, students are said to have ‘greater satisfaction with blended courses, compared with both traditional face-to-face and fully online modes of education’ (Owston, York & Murtha, 2013, p.38). Therefore, since the reputation of an institution is ‘often linked to...increasing student...satisfaction’ (Vaughan, 2007, p.89), effective blended learning could enhance an institution’s reputation. Blended learning is also seen as offering tertiary institutions opportunities to reduce costs through automated assessments, shared resources, staffing substitutions and the improved administration of large courses through learning management systems (LMS; Twigg, 2003). The largest cost savings

are suggested to be realised via blended models which reduce seat time thereby reducing space requirements and operating costs (Vaughan, 2007).

2.4.2 Institutional challenges of blended learning

There is growing evidence highlighting the potential benefits of blended learning within higher education. The challenge for tertiary education institutions has been to position their institutions to take advantage of blended learning to meet growing expectations for higher quality learning (Garrison & Vaughan, 2013). However 'even though the literature suggests that blended learning offers many advantages for higher education, there has been difficulty scaling it up on campus' (Owston, 2013, p.1).

Alignment of blended learning goals with the overall goals of the institution is considered essential to scaling up delivery from individual teachers to the wider organisation (Moskal, Dzuiban & Hartman, 2013), as is alignment between the goals of various stakeholders including the institutional, administrative, teacher and student goals (Newton & Ellis, 2006 as cited in Taylor & Newton, 2013). Institutions are well known as 'notorious resistors to innovation' (Garrison & Vaughan, 2013, p.24) which prevents changes 'critical to the success of blended learning' (Vaughan, 2007, p.91). Overcoming resistance can be achieved through leadership that demonstrates vision, courage and decisiveness (Garrison & Kanuka, 2004). Clear institutional policies and direction are also crucial (Garrison & Kanuka, 2004). Policies need to consider issues specifically relating to blended teaching and learning such as timetabling, resourcing and staff professional development as well as those which influence the wider context of faculty life such as workloads (Stacey & Wiesenberg, 2007) and recognition for teaching (Garrison & Vaughan, 2013). Insufficient support is seen as a barrier to teachers making the transition to a blended learning approach (Vaughan, 2007). As blended learning breaks down the usual place and time boundaries for where and when teaching activities take place, support for the online aspect of its delivery needs to become more responsive. Blended learning also calls for reliable technological infrastructure and technology management which is forward thinking and scalable (Moskal et al., 2013; Palmer & Holt, 2009).

2.4.3 Institutional evaluation of blended learning

A key component of initiatives aiming to change pedagogical approaches and influence student learning should be 'central data collection procedures to monitor success and inform policy on

faculty development and support‘ (Owston, 2013, p.2). However, given the ad hoc nature of blended learning implementation in tertiary education, institutions may not know the extent to which blended learning has been implemented by their staff (Graham et al., 2013). Furthermore, many tertiary teaching and learning evaluations were developed specifically for face-to-face courses and do not readily transfer to the online environment (Pombo & Moreira, 2012). Therefore, several frameworks which allow institutions to explore, measure and progress their adoption of e-learning have been developed including two major Australasian models: the E-learning Maturity Model (eMM; Marshall, 2010) and the Australian Council on Open, Distance and E-learning benchmarks (ACODE; Guiney, 2013). However, both frameworks were designed to evaluate the wider area of e-learning and both are complex to employ (Marshall, 2010; Guiney, 2013).

One recently developed adoption and implementation model is specific to blended learning. The blended learning adoption framework proposed by Graham et al. (2013; Table 1) aimed to ‘guide institutions of higher education in strategically adopting and implementing blended learning on campus’ (Graham et al., 2013, p.4). Drawing on Roger’s (2003) Diffusion of Innovation theory and the findings from six case studies, the framework identifies three categories of core institutional issues (strategy, structure and support) and describes the stage of adoption and implementation of each of the three categories (awareness/exploration, adoption/early implementation and mature implementation/growth).

The benefit of an evaluation framework specific to blended learning was demonstrated by Porter et al. (2014) who used Graham et al.’s (2013) blended learning adoption framework to describe the blended learning adoption/implementation issues in 11 US higher education institutions who were actively developing their blended learning from awareness/exploration (stage 1 of the framework) to adoption/early implementation (stage 2). The framework allowed the authors to be able to identify ‘patterns and distinctions regarding institutions’ strategy, structure, and support decisions during that transition’ (p. 194) including the need for a shared vision, supportive and sustainable technological and pedagogical infrastructures and the need to have both a common institutional understanding of blended learning but freedom for academic staff to make key decisions about their individual pedagogies. Key to this study, the findings were said to provide guidance to institutions wishing to make their blended learning to determine their stage of blended learning adoption and determine what issues may be required to develop more mature approaches.

2.5 Lecturer perceptions and experiences of blended learning

Teachers' conceptions of blended learning are not uniform. A common view is that blended learning is simply about variety in delivery but that this did not necessarily involve technology (Benson et al., 2011). How teachers view learning technologies is important as their views have been shown to relate to their approach to designing and teaching using these technologies (González, 2012). At the most basic level, blended learning is a means to address issues related to access (Ellis, Hughes, Weyers & Riding, 2009), to organise large courses (Benson et al., 2011; Yuen, 2011) or to provide students with information (Ellis, Steed & Applebee, 2006; Ellis et al., 2009; González, 2009; Yuen, 2011). In these examples, the online aspect of blended learning is seen as a pragmatic management and dissemination tool rather than a way to improve student understanding. The next level shifts the focus from teaching to blended learning providing active learning opportunities (Ellis et al, 2009) such as group work and peer review (Benson et al., 2011). At the highest levels, blended learning is seen as a way to help students build knowledge (Ellis et al., 2009; González, 2009), develop and apply new concepts (Ellis, Steed et al., 2006) and to support specific pedagogy (Yuen et al., 2011). Although not quantified in these studies, it would appear from the literature that most of the activity in blended learning in the tertiary sector is yet to reach the higher levels described here (e.g. Owens, 2012; Nanayakkara & Whiddett, 2005).

With the majority of teachers being enthusiastic about blended learning, barriers to using a blended approach are not, in the main, related to attitudes (Benson et al., 2011). Teachers appreciate the benefits of increased student engagement in learning, enhanced teacher and student interaction as well as the flexibility to incorporate new learning activities and to accomplish learning objectives more successfully (Vaughan, 2007). The main challenges to implementing blended learning identified by teachers included a lack of time to develop blended learning modules, perceptions that students were being fed material, lack of confidence that the technology would work (Benson et al., 2011) and lack of support and resources for course redesign (Vaughan, 2007).

Despite these challenges, the beginnings of pedagogical change relating to blended learning can be seen. Stacey and Wiesenberg (2007) found that online teaching had been influenced by face-to-face teaching experiences with teachers applying 'the best and most appropriate' (p.31) strategies from their face-to-face teaching to the online medium. This included the use of authentic discussion topics and community building tasks. The online teaching experience seems to have had an even greater influence on face-to-face teaching. The more structured online

environment led to more organised, thorough and thoughtful face-to-face teaching, a sense of community was becoming a focus for face-to-face settings and teacher-centred delivery was being replaced by facilitation and guiding. A new level of reflective and innovative teaching practice was thought to be emerging (Stacey & Wiesenberg, 2007). These findings are echoed by McShane (2004) who concluded that teachers had become 'more conscious of their teaching as a result of the decisions they have had to make in combining live and online modes' (p.3).

Much of the literature has approached the face-to-face and online components of a blended learning environment as two separate components but understanding the individual benefits of each mode of delivery and making pedagogical changes in isolation is not sufficient to create a successful blended learning experience. Many researchers have noted that it is how the face-to-face and online learning environments are integrated which is the key to success and also the most problematic (e.g. Garrison & Kanuka, 2004; Gedik, Kirax & Özden, 2012; Glogowska, Young, Lockyer & Moule, 2011; O'Toole & Absalom, 2003).

2.6 Student perceptions and experiences of blended learning

Students are 'generally positive' (Vaughan, 2007, p.84), 'overall positive' (Stacey & Wiesenberg, 2007) or have a 'high degree of satisfaction' (Paecher & Maier, 2010, p.295) about their experiences of blended learning. They are also more enthusiastic about blended learning than their teachers (Jeffrey, Milne, Suddaby & Higgins, 2012; Palmer & Holt, 2009) and have an expectation that their learning will incorporate technologies such as online learning management systems and internet technologies (Chen et al., 2010). Students appreciated the clear and structured approach provided by online aspects of blended courses (Paechter & Maier, 2010) especially where the goals and standards for courses were explicit (Ginns & Ellis, 2007). They perceived time efficiencies due to the flexibility of accessing material at any time and in any place (Paechter & Maier, 2010). In addition, students were positive about the role of online environments in course management, particularly in providing frequent course updates (Ginns & Ellis, 2007) and rapid feedback (Paechter & Maier, 2010).

Students preferred online environments when communication with both peers and teachers was for the distribution of information. However, when communication and interaction was for the development of shared meaning or joint solutions, face-to-face environments were felt to be superior (Paechter & Maier, 2010; Ginns & Ellis, 2007). In terms of learning outcomes, 'whether students achieve higher in blended learning compared to either fully face-to-face or

fully online courses is not clear' (Owston et al., 2013, p.39). The lack of clarity may be due to different studies focussing on different measures of achievement. If achievement is measured by course retention rates or subjective learning gains, blended learning courses may be more successful (Owston et al., 2013). However, if achievement is measured by test scores, then no significant difference is seen between blended, traditional face-to-face or fully online courses (Owston et al., 2013). What is more certain is that students' perceptions of the blended learning environment (Owston et al., 2013) as well as their ability to take responsibility for their learning (Bluic, Ellis, Goodyear & Piggot, 2011) are strongly related to their achievement. High achievers preferred the blended format over face-to-face or online only environments finding blended courses more convenient, more engaging and key concepts easier to learn (Owston et al., 2013). Students with a deep approach to learning were also more likely to receive higher grades in a blended course (Bluic et al., 2011).

Issues that students raised in relation to blended learning included workload. Students did not perceive time in lectures as 'work' but did view time spent online as 'work' (Vaughan, 2007). Therefore, they felt that 'their workload in the two environments made the overall workload heavier than for a usual course' (Gedik et al., 2012, p.113). Time management was also a problem, particularly the requirement to complete online activities between face-to-face sessions (Vaughan, 2007). And, although students appreciated the flexibility of the online part of their courses, they struggled with self-regulation and taking responsibility for their own learning (Paechter & Maier, 2010; Vaughan, 2007). Other barriers in the blended learning environment included course design such as the scheduling and balancing of the two environments, cultural aspects for non-native speakers of English who were uncomfortable with the level of writing skills required when working online, technical issues and the time required to seek technical support (Gedik et al., 2012). Students also commented that the balance between content in the two learning environments was often not right making them 'disjointed and separate' (Glogowska et al., 2011, p.889). Students were also unclear about the relationship between a learning unit as a whole and the online component and also the extent to which the online component supported the face-to-face activities (Ginns & Ellis, 2007). Therefore, the complexities of the blending process and its significance for effective delivery are important (O'Toole & Absalom, 2003).

2.7 Blended learning in undergraduate science

Most of the studies discussed up to this point have been have been part of multi-disciplinary studies with participating students and teachers drawn from across single or multiple organisations. Science based studies of blended learning are fewer, with most being case studies of a single course, a single use of technology or an exploration of blended learning in conjunction with another teaching approach, for example problem-based learning, such that it is hard to separate the results and their significance. More discipline specific studies are needed (Arbaugh, Bangert & Cleveland-Innes, 2010) since the affordances of technology-mediated learning vary between disciplines and therefore, teachers' and students' experiences and perceptions of the blended learning format will also vary. However, the findings of current science studies are relevant to this study.

A blended learning approach to support active learning was trialled in a laboratory-based physiology course (Dantas & Kemm, 2008). Online activities were used to encourage more effective preparation and participation in practical classes. Prior to class, students developed hypotheses and predictions and received automatic or tutor feedback on their submissions. Students were positive about the effectiveness of the course although there was no significant change in exam results.

In psychology, students who attended traditional in-class lectures scored significantly lower than those who viewed the same lectures online prior to taking part in group activities and discussion during their in-class time (Lewis & Harrison, 2012). This 'flipped' classroom approach demonstrates the benefits in using technology to free-up class time for more student-centred activities. A similar result was seen in an exercise physiology class which transitioned from a traditional lecture format to the 'flipped' online lecture format (McFarlin, 2008). Following the blended delivery, students' grades were roughly one grade higher than when the traditional approach was used. The flipped model allows lecturers to 'reconceptualise the teaching and learning dynamic' (Strayer, 2012, p.172) and is an example of a blended learning approach which exploits the affordances of each learning environment. It uses the online environment to introduce students to course content outside of the classroom while using face-to-face environment for interactive, dialogue-based learning where students engage with that content at a deeper level (Strayer, 2012).

A study of geography students' views of the traditional face-to-face and online learning mechanisms (Mitchell & Forer, 2010) revealed that students overwhelmingly thought that

lectures were a good way to learn information. More would choose to attend a lecture or tutorial than receive the same information online as they appreciated the extra detail given in lectures and 'the ability to identify nuances in content emphasis' (Mitchell & Forer, 2010, p.82). Moore and Gilmartin (2010) similarly investigated blended learning in geography undergraduates. Following the redesign of a human geography module to a blended course, they found that the blended learning format had a positive effect on student engagement and learning.

2.8 Blended learning in New Zealand tertiary education

The Ministry of Education in New Zealand defines e-learning as 'learning that is enabled or supported with the use of information and communication technologies' (Ministry of Education [MinEd], 2010a, para. 1). This definition appears to include blended learning since it describes e-learning as 'no longer associated just with distance learning' (MinEd, 2010a, para. 4). The Ministry views its role in tertiary e-learning as to 'assist educators, organisational leaders, students and Government agencies in their decision-making and practice about e-Learning' (MinEd, 2010b, para. 1).

An e-learning advisory group was set up in 2001 and called for a 'coherent national e-learning strategy and greater collaboration in the sector in order to meet diverse learning needs' (New Zealand Council for Educational Research [NZCER], 2004, p.5). In 2004 the interim tertiary e-learning framework was released (MinEd, 2004). However, this was to be New Zealand's only tertiary e-learning strategy as it has since been 'positioned within wider strategies' (Guiney, 2014) such as the pan-sector ICT Strategic Framework for Education (MinEd, 2006), the Digital Strategy (Ministry of Economic Development, 2008) and the ICT Investment Framework (MinEd, 2011). Integrating e-learning policy with wider policy is also found in the US, Finland and Canada (Brown, Anderson & Murray, 2007). Advantages of this approach are greater alignment between policies which position the tertiary sector to realise the full potential of e-learning. Disadvantages, however, include e-learning becoming 'lost' amongst other policies and a potential lack of increased e-learning uptake by the tertiary sector (Brown et al., 2007, p.79).

Although now dated, the most recent reviews of e-learning in the New Zealand tertiary sector provide background for this study: data from universities collected between 2004-2008 show that, at degree level, the majority (approximately 78%) of provision involved some form of e-learning and that this had increased during the time period (Guiney, 2011). The use of web-

supported courses where students were provided with access to optional online resources was the highest and was increasing. Web-enhanced courses where online access of resources was expected and web-based courses where online access of materials and online participation were required were less frequent and showed a small decline (Guiney, 2011). The use of e-learning provision was highest (88.5%) in the natural and physical sciences although the type of e-learning was not specified (Guiney, 2011). During the same period, achievement, measured by completion rates, in courses with and without e-learning was comparable, as was achievement between courses using different types of e-learning (Guiney, 2013). New Zealand tertiary students have been shown to prefer traditionally taught courses more than blended courses, but blended courses more than fully online courses (Jeffrey Atkins, Laurs & Mann, 2006). Jeffrey et al. (2006) also identified 11 learner profiles. Interestingly for blended learning and its focus on student-responsibility for learning and socially constructed knowledge, only 12% of students had a learner profile matching these characteristics.

2.9 The context of this study

Much research has been undertaken on blended learning within the tertiary sector (Halverson et al., 2012). Some of this has suggested that there has been little exploration of the perceptions and experiences of teachers in comparison to those of students (Torrisi-Steele & Drew, 2013; Gerbic, 2011; González, 2009). However, in parallel others claim that there has been little exploration of the perceptions and experiences of students (Ituma, 2011; Tselios, Daskalakis & Papadopoulou, 2011; López-Pérez, Pérez-López & Rodríguez-Ariza, 2011) or from the institutional perspective (Graham et al., 2013; Porter et al., 2014). Perhaps in response to this perception, many studies have focused on either institutional, teacher or student perspectives (e.g. Institutional: Garrison & Vaughan, 2013; Graham et al., 2013; Hardaker & Singh, 2011; Porter et al., 2014; Teacher: Ellis, Steed et al., 2006; Ellis et al., 2009; González, 2009; González, 2012; Owens, 2012; Lawrence & Lentle-Keenan, 2013; Reed, 2014; Student: Gebre, Saroyan & Bracewell, 2012; Gedik et al., 2012; Henderson, Selwyn & Aston, 2015; Lopez-Perez et al., 2011; Osgerby, 2013). A small number of studies have explored multiple perspectives (Jones & Jones, 2005; Vaughan, 2007; Roblyer, McDaniel, Webb, Herman & Witty, 2010; Palmer & Holt, 2009; Eskey & Schulte, 2012; Moskal et al., 2013) but what is lacking is research which simultaneously considers both teacher and student perspectives on blended learning which also considers their disciplinary and organisational context. Furthermore, as Arbaugh et al. (2010) suggest for online studies, many blended learning studies

have attempted to ‘treat course content as a constant’ (Arbaugh et al., 2010, p.38) and seek approaches for blended learning that ‘are applicable regardless of discipline’ (Arbaugh et al., 2010, p.38). Given early research indicates difference between disciplines (Arbaugh et al. 2010) more discipline specific studies are needed. This study is an attempt to begin to fill that gap and it addresses the following research questions:

1. What are undergraduate science lecturer and student perceptions and experiences of blended learning?
2. How do the institutional and disciplinary contexts influence lecturer and student perceptions and experiences?

The study is a case study of blended learning in undergraduate science within a New Zealand University. It uses interviews with university management initially to position the university within the blended learning adoption framework proposed by Graham et al. (2013) and to determine the institution’s current stage of blended learning adoption and implementation. This provides the background context for blended learning and explores the institutional perspectives of blended learning. This macro-level approach is then combined with a micro-level exploration (Hardaker & Singh, 2011) of staff and students’ perspectives and experiences of blended learning specific to their science discipline. The methodology is described in more detail in the next chapter.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter provides the rationale and description of the research design. It outlines the philosophical and theoretical assumptions which have informed the research process. It then discusses the selection and nature of participants, data collection methods and data analysis as well as the ethical considerations, validity and reliability.

3.2 The qualitative research paradigm

Two main methodologies exist in research; quantitative and qualitative. Quantitative methodology is concerned with measuring and 'accurately capturing aspects of the social world that are expressed in numbers – percentages, probabilities, variance ratios' (King & Horrocks, 2010, p.7). It is underpinned by the positivist paradigm (Davidson & Tolich, 1999, p.26) and uses experimental methods and traditional scientific approaches (Cohen, Manion & Morrison, 2011). In contrast, qualitative methodology is concerned with how the social world is experienced and understood (King & Horrocks, 2010). It is underpinned by the interpretive paradigm (Davidson & Tolich, 1999, p.26) and uses broad and holistic methods which allow detailed descriptions of the social world such as settings, processes and relationships.

This study aimed to understand the level of adoption and implementation of blended learning within science in a tertiary education context, the barriers and enablers influencing its uptake and the lived reality of its delivery and outcomes as experienced by staff and students. Therefore, a qualitative research approach has guided this study as it sought to discover lecturers' and students' experiences and views of blended learning and not simply the outcomes of those experiences (Bogdan & Biklen, 1998). This study fell within the interpretive paradigm as it began with individuals and aimed to understand how they interpret the world around them (Cohen et al., 2011). It also acknowledged that the meanings individuals develop are varied and multiple since they are negotiated through the social, 'historical and cultural norms which exist in individuals' lives' (Creswell, 2007, p.21). The study also took inspiration from the phenomenological philosophy as it was interested in 'understanding social phenomena from the actors' own perspectives' and describing the world as experienced by the subjects, with the

assumption that ‘the important reality is what people perceive it to be’ (Kvale & Brinkmann, 2009, p.26).

3.3 A case-study approach

Case study is ‘a strategy for doing research which involves an empirical investigation of a particular contemporary phenomenon within its real life context using multiple sources of evidence’ (Robson, 2002 as cited in Ashley, 2012, p.102). A case may be an individual, institution, instance or event (Ashley, 2012; Stake, 2006; Thomas, 2011). It is defined by the temporal, geographical, individual, organisational or other contextual boundaries that can be drawn around it (Hitchcock & Hughes, 1995 as cited in Cohen et al., 2011). Case study research can be used for a number of purposes including to explore a phenomenon about which not much is known or to describe something in detail (Ashley, 2012). The strength of the case study approach is in its ability to ‘drill down and get at its [the case’s] complexity’ (Ashley, 2012, p.102) and to provide a rich, detailed description of the central phenomenon.

The single-case design (Yin, 1994; Thomas, 2011) of this study is of a university using multiple data sources to inform the study. Data was collected from the institution, lecturers and students in order to consider the interplay between them and how this contributes to the effective use of blended learning in this context. For example, overall organisational teaching plans and policies are often determined at an institutional level, while content of undergraduate science courses are determined at the departmental level. Course teaching strategies and approaches are determined by individual lecturers and experienced by students. Key to choosing a case study approach for this study was the ability of case studies to elucidate what is similar and what is different between the data and, in a phenomenological context, to find out why they are different (Merriam, 1998).

Qualitative case study approaches have been used successfully to study blended learning within tertiary education. For example, Yuen (2011) used a case study of a university in Hong Kong to explore the pedagogical use of ICT in blended learning context and identified four distinct teaching approaches. In New Zealand, Nanayakkara and Whiddett (2005) completed a case study at a tertiary institution and revealed that lack of an institutional strategy, lack of time and lack of training support were the three most critical barriers to the adoption of e-learning by staff.

3.4 Use of the blended learning adoption framework

Graham et al. (2013) developed the blended learning adoption framework to assist institutions to recognise issues and identify markers to gauge their progress in strategically adopting and implementing blended learning. The framework was developed from case studies of universities whose blended learning adoption ranged from early through to mature. It identified three categories of core institutional blended learning issues (Table 1).

The 'strategy' category contained issues related to overall blended learning design within the institution including the institutional definition and purpose of blended learning, the advocacy and policy supporting blended learning and the degree to which it had been implemented. The 'structure' category was concerned with issues relating to the technological, pedagogical and administrative environment and its facilitation of the blended environment. Specifically this included governance, scheduling, models and evaluation practices. The 'support' category identified the degree to which institutional practices supported blended implementation and maintenance and included blended learning design, support services and incentives. Within each category, three stages of adoption and implementation were described awareness/exploration, adoption/early implementation and mature implementation/growth. 'Awareness/exploration' indicated an institution with no blended learning policies but one which demonstrated awareness of, and limited support for, blended learning activities. Institutions at the stage of 'adoption/early implementation' had blended learning strategies and early policies and support mechanisms in place. 'Mature implementation/growth' signified institutions which had well-established policies, systems and support which were integrated into the overall university plans.

The blended learning adoption framework plays a central role in this study as it provides a both a comprehensive yet simple description of the issues which are at the core of institutional blended learning strategies and delivery. In order to fully understand management, lecturer and student perspectives and experiences of blended learning it is critical to understand the blended learning environment in which they operate particularly since perspectives are influenced by both the institutional infrastructure surrounding blended learning (e.g. Nanyakkara et al., 2005) and an individual's own beliefs and conceptions (e.g. Lawrence & Lentle-Keenan, 2013). In this study, the framework was used in two ways: firstly to determine the stage of adoption of blended learning at the university and secondly, the categories and their descriptors were used to identify areas of key importance for blended learning and to form an organising structure for both the interviews with the different participant groups, the analysis of the data and the discussion of the findings.

Table 1: The blended learning adoption framework

Adapted from Graham et al., 2013, p.7

Category	**Stage 1 – Awareness/explorations**	**Stage 2 – Adoption/early implementation**	**Stage 3 – Mature implementation/growth**
Strategy			
Purpose	Individual faculty/administrators informally identify specific BL benefits	Administrators identify purposes to motivate institutional adoption of BL	Administrative refinement of purposes for continued promotion and funding of BL
Advocacy	Advocacy Individual faculty and administrators informally advocate	BL formally approved and advocated by university administrators	Formal BL advocacy by university administrators and departments/colleges
Implementation	Implementation Individual faculty members implementing BL	Administrators target implementation in high impact areas and among willing faculty	Departments/colleges strategically facilitate wide-spread faculty implementation
Definition	No uniform definition of BL proposed	Initial definition of BL formally proposed	Refined definition of BL formally adopted
Policy	No uniform BL policy in place	Tentative policies adopted and communicated to stakeholders, policies revised as needed	Robust policies in place with little need for revision, high level of community awareness
Structure			
Governance	No official approval or implementation system	Emerging structures primarily to regulate and approve BL courses	Robust structures involving academic unit leaders for strategic decision making
Models	No institutional models established	Identifying and exploring BL Models	General BL models encouraged not enforced
Scheduling	No designation of BL courses as such in course registration/catalog system	Efforts to designate BL courses in registration/catalog system	BL designations or modality metadata available in registration/catalog system
Evaluation	No formal evaluations in place addressing BL learning outcomes	Limited institutional evaluations addressing BL learning outcomes	Evaluation data addressing BL learning outcomes systematically reviewed
Support			
Technical	Primary focus on traditional classroom technological support	Increased focus on BL/online technological support for faculty and students	Well established technological support to address BL/ online needs of all stakeholders
Pedagogical	No course development process in place	Experimentation and building of a formal course development process	Robust course development process established and systematically promoted
Incentives	No identified faculty incentive structure for implementation	Exploration of faculty incentive structure for faculty training and course development	Well-established faculty incentive structure for systematic training and implementation

3.5 Case identification, selection and nature of participants

3.5.1 The case

The case study was of a university in New Zealand. The university is located within a large city on two campuses. The five colleges within the university offer undergraduate and postgraduate courses in over 50 disciplines, from accountancy to zoology. The university currently has 547 continuing academic staff, 944 general staff and 11,995 equivalent full-time students. Domestic and undergraduate students make up 89% and 84% of enrolments respectively.

The College of Science at the university comprises seven departments and two research centres. It offers a large range of qualifications in science at both undergraduate and postgraduate level. The Bachelor of Science is a three-year degree that allows students to major in a range of subjects from chemistry, physics and biology through to psychology, management science and linguistics. At the time of this study, 184 staff taught into the undergraduate programmes including some staff from non-science departments and there were 2,454 equivalent full-time students enrolled in an undergraduate science degree. This represents 20.5% of the university's students.

The region where the university is sited suffered a series of major earthquakes in 2010 and 2011 and subsequent aftershocks. Following damage to buildings and infrastructure, the university is now in a period of campus-wide remediation and renewal. The earthquakes also impacted on student numbers, although enrolments are rising again.

3.5.2 Management participants

The management interview participants were three members of university staff whose role, or some aspect of it, related to management of e-learning at the university level, for example, membership of the university e-learning advisory committee. They were identified from information on the university's web site and invited to take part in the study by email.

3.5.3 Lecturer participants

An online survey was administered to all 184 lecturers who taught in the undergraduate Bachelor of Science programmes. They were invited to complete the survey by email.

The three lecturer interview participants were purposefully chosen due to their teaching experience (3 plus years) and their use of blended learning in their undergraduate teaching. They were identified by their head of department or through the university's e-learning unit and were invited to participate by email.

3.5.4 Student participants

Due to university restrictions designed to prevent the over-surveying of students, a large scale survey was not possible. Eighty five 300-level students enrolled in an undergraduate science degree were invited to take part in the study through their lecturer. The students had experienced at least two years of undergraduate science teaching.

Two interview participants were invited to participate by email via three of the university's science student associations. The third was identified by snowballing techniques.

3.6 Data collection approach

Both qualitative methodologies (Bogdan & Biklen, 1998, p.6) and case study research (Creswell, 2007) often use multiple sources of data in recognition that there are many factors influencing a single case and that to capture these 'usually requires more than one tool for data collection and many sources of evidence' (Cohen et al., 2011, p.289). Case studies, therefore, can 'blend numerical and qualitative data' and be considered 'mixed methods research' (Cohen et al., 2011, p.289).

This study as a whole, therefore, was guided by the qualitative interpretive paradigm but employed a mixed methods approach to data collection. The main source of data was qualitative interviews. These were supported by quantitative surveys for the lecturer and student groups (Table 2). An embedded design meant that the quantitative and qualitative data complemented each other and were collected simultaneously (Creswell, 2012). Together, the breadth of the quantitative data and the depth of the qualitative data provided rich description of blended learning in undergraduate science by allowing both 'high conceptual validity' as well as 'an understanding of how widespread a phenomenon is across a population' (Flyvbjerg, 2011, p.314).

A mixed methods approach to data collection has been used successfully in similar studies involving both lecturers and students. Stein, Sheppard and Harris (2011) used a combination

of an email survey and semi-structured interviews to explore New Zealand tertiary educators' conceptions of e-learning and professional development. A similar phenomenographic approach and mixed methods data collection was used by Ellis, Goodyear, Prosser and O'Hara (2006) to investigate students' experiences of learning through face-to-face and online discussion.

Table 2: Data collection methods

Participant Group	**Data collection method**	**Purpose**	**Research questions informed**
Management	Management interviews	To collect data regarding the stage of adoption and implementation of blended learning at the university	Q2
Lecturer	Lecturer interviews	To collect data regarding the lecturers' experience and perceptions of blended learning	Q1, Q2
	Lecturer survey	To collect data regarding the lecturers' experience and perceptions of blended learning	Q1, Q2
Student	Student interviews	To collect data regarding the students' experience and perceptions of blended learning	Q1, Q2
	Student survey	To collect data regarding the students' experience and perceptions of blended learning	Q1, Q2

3.6.1 Qualitative interviews

Qualitative semi-structured interviews were used with all three participant groups to provide a detailed and nuanced perspective about their perceptions and current use of blended learning within tertiary science. The use of interviews reflected my interest in 'elucidating and clarifying participants' views rather than simply labelling or judging them' (Abd-El-Khalick & Lederman, 2000, p.674). Moreover, interviews allow participants to talk freely in their own words so that the researcher can develop insights on how subjects interpret the phenomenon at the centre of the study (Bogdan & Biklen, 1998). The interviews were semi-structured so as to allow sufficient flexibility for the participants to introduce and discuss issues that they perceived important to the topic (Briedenhann, 2007). During the interview

prompts were used for clarification of the information requested and provided. Probes were used to encourage participants to expand on their initial responses (King & Horrocks, 2010).

3.6.2 Quantitative surveys

For the lecturer and student groups, the interviews were supplemented by a quantitative survey. Surveys are useful for addressing the 'how' and 'what' of a study and they were used here to gather 'factual information on attitude and preferences, beliefs and predictions, opinions, behaviour and experiences' (Cohen et al., 2011, p.257). The surveys were exploratory in nature starting with no prior assumptions and aimed to explore relationships and patterns (Cohen et al., 2011) with the purpose of providing a picture of the wider use and perspectives of blended learning than could be obtained from the interviews alone. The survey followed a cross-sectional design which allowed a comparison of the perspectives of lecturers and students (Creswell, 2012) but also employed questions that were specific to each group being surveyed.

3.7 Data collection methods

3.7.1 Management data collection

Interviews were carried out with the three management participants. The interviews were primarily to enable the university to be placed within the blended learning adoption framework created by Graham et al. (2013). Therefore, the interview questions were taken from this study (Appendix A). The interview process, however, was flexible and allowed participants to discuss blended learning issues that were outside of the questions relating to the framework. Interviews were scheduled to last one hour and were recorded.

3.7.2 Lecturer and student data collection

3.7.2.1 Semi-structured interviews

The lecturer interview schedule was developed from the survey aspect of this study and from other published research (Stein et al., 2011; Steel, 2009; Skelton, 2010; Ocak, 2010; Ellis et al., 2009; Nanayakkara & Whiddett, 2005; González, 2012; DeHaan, 2005). The student interview schedule was adapted from the lecturer interview schedule in order to allow a

comparison between perspectives. The schedules for lecturer and student interviews are in Appendices B and C respectively. Interviews were scheduled to last one hour and were audio recorded.

3.7.2.2 Surveys

The lecturer survey was developed from surveys on blended learning or e-learning that were administered by other institutions (Leithbridge College, 2011; Schmidt, 2010) or from published research (Golden, McCrone, Walker & Rudd, 2006). The science specific questions and lists of science skills were adapted from Coil, Wenderoth, Cunningham and Dirks (2010) and Leggett, Kinnear, Boyce and Bennett (2004). The student survey was developed from the lecturer survey in order to address the same issues but also included questions about students' use of the technological devices within lectures. The questions were largely multiple choice or likert scale questions with a smaller number of open-ended questions. The lecturer and student surveys are in Appendices D and E respectively.

The surveys were administered online using Qualtrics software (Version 2014; Qualtrics, 2014). The principles (Dillman et al. 1999 and others as cited in Cohen et al., 2011) for designing online surveys of were followed where possible: participants could only start one survey, incomplete surveys could be re-entered and a submission confirmation was included. The survey provided clear instructions, progress was visible, questions were kept to a single screen where possible and there was no requirement to complete a question before moving on to the next one.

The surveys were piloted by staff and postgraduate students from the Education faculty at the university. Following piloting, questions were rephrased for clarity and administrative aspects of the surveys were improved. Both surveys were open for four months and one email reminder was sent to participants during that period.

3.8 Ethical issues

Ethical principles aim to respect and protect participants in qualitative research (Bogdan & Biklen, 1998) and, therefore, the ethics procedures were tailored for this particular study (Creswell, 2012). To further minimise any risks, the ethical issues were reviewed throughout the study particularly during the researcher's interactions with interview participants (Glesne

& Peshkin, 1993). The risks of the study were minimal and ethical approval was given by the University of Canterbury Educational Research Human Ethics Committee (Ref: 2013/34/ERHEC).

Full disclosure of the study purpose was provided to all participants so deception was not considered an issue. Although anonymity of participants was not possible due to the face-to-face nature of the interview procedure (Cohen et al., 2011), confidentiality was assured by using pseudonyms and crude categories or by deleting all of the identifying names and information within the study (Cohen et al., 2011). Furthermore, no reference was made to the participants by the researcher. The disclosure of sensitive information and resulting stress was not thought to be an issue due to the topic of the study. Therefore, the participants' position and relationships within the institution were not affected (Dearnley, Dunn & Watson, 2006). The potential benefits of participation included improved understanding of the participant's own teaching and learning and contributing to improvements in blended learning teaching and learning in undergraduate science. 'Reciprocity is a characteristic of qualitative research' (Harrison, MacGibbon & Morton, 2001, p.323) and transcripts were provided for member checking. The final results and copies of any publications will also be made available to participants.

Participation in the interviews was via informed written consent which recognises a participant's right to weigh up the risks and benefits of being involved in a study (Cohen et al., 2011). The information provided to participants included the nature and purpose of the study, the interview procedure, confidentiality arrangements, my background as the researcher and the risks and benefits of the study. The consent process also indicated that participation in the study was voluntary, that participants could withdraw at any point without prejudice and had the right to ask questions. Information sheets and consent forms were provided to participants on initial email contact (see Appendix F and G for examples). They were also provided in hard copy and discussed at the start of the interview prior to participants signing the consent form.

Participation in the surveys was anonymous and any identifying information provided in responses was kept confidential. Prior to entering the survey, information about the study similar to that for the interviews was provided. Entering a survey was taken as informed consent.

3.9 Data analysis

The data analysis plan aimed to describe both the perspectives of each individual group but also to 'understand how they are qualified by local conditions, and thus develop more sophisticated descriptions and more powerful explanations' (Miles & Huberman, 1994 as cited in Merriam, 1998, p.195). Separate analyses of the management, lecturer and student data were completed. This was followed by a comparative analysis to identify similarities and differences between teacher and student perspectives and experiences of blended learning and to ascertain the influence of the institutional context on these.

3.9.1 Interview analysis

Both during and immediately following the interviews, researcher notes were made on issues raised, initial interpretations of the participants' responses and emerging themes. Following this, interviews were transcribed verbatim. The transcribed interviews were submitted for member checking where each participant was given the opportunity for verification, correction and comment (Gardner, 2008).

Transcripts were read to gain their general sense and for preliminary exploration. The constant comparative method was then used to develop categories within the data (Merriam, 1998). Portions of text or statements were coded by assigning words or phrases which accurately described their meaning (Creswell, 2012). Codes were data-driven and not developed from preconceived notions (Kvale & Brinkmann, 2009). They included settings/contexts, processes, perspectives, activities, relationship and social structures (Bogdan & Biklen, 1998). Following this, codes were compared, modified and grouped due to similarity or removed due to redundancy. The new, more focused code list was then re-applied to the data. This process was repeated until 'saturation' (Gibbs, 2007 as cited in Kvale & Brinkmann, 2009) of the material when no new insights emerged from further coding. Key themes were then developed by looking for codes that the participants discussed most frequently, codes which had the most evidence to support them, codes that might be expected in relation to the study topic and codes that were unique or surprising in relation to the study topic (Creswell, 2012).

For the management interviews only, the transcripts were also analysed in order to place the university within the blended learning adoption framework created by Graham et al. (2013). Agreement between the participants' responses was recorded and the responses given a short

coding phrase. Occasions where the responses did not agree were noted. The coded responses were then compared to both the framework's category and stage descriptors, the analysis of the case studies used to develop the framework and the analysis of Porter et al. (2014) who applied the framework to a number of institutions.

3.9.2 Survey analysis

The response rate for both the lecturer (20.1%) and student (9.4%) survey was low and the survey data was not analysed statistically. Descriptive statistics were used to illustrate the responses provided.

3.10 Reliability and validity

This study did not set out to either prove or disprove a hypothesis (Bogdan & Biklen, 1998) but it did aim to produce valid and trustworthy knowledge (Merriam, 1998) of blended learning in undergraduate science. It put aside *a priori* assumptions, was open to new interpretations and relied on the data to produce these interpretations so that the themes developed were plausible and accurate (Merriam, 1998). The idea of reliability and validity in research originated in relation to quantitative research and their applicability to the qualitative case study has been described as 'far less clear' (Thomas, 2011, p.63). However, they are important to discuss.

Validity refers to the degree to which a study investigates what it is intended to investigate (Kvale & Brinkmann, 2009) or to which the research findings match reality (Merriam, 1998). Validity was addressed in this study by minimising sources of bias (Cohen et al., 2011). Bias in the content of interview questions was reduced by using questions from previous successful studies and piloting prior to data collection. My own influence on data interpretation (Yin, 1994) was minimised by remaining aware of the assumptions, worldview and theoretical orientations that I brought to the study (Merriam, 1998) throughout its completion. Validity was further addressed by providing a precise description of what people said (Davidson & Tolich, 1999) since interviews which use the participants' own words are less abstract than other data collection methods (LeCompte & Preissle, 1993 as cited in Merriam, 1998). Triangulation of data from multiple sources and multiple participants about the same topic (Davidson & Tolich, 1999) was used to confirm emerging findings. It also

supported the construction of ‘plausible explanations’ (Mathison, 1988 as cited in Merriam, 1998, p.204) by pointing to contradictions and tensions in the data (Ashley, 2012). Sampling was not an issue for the lecturer survey as the survey was sent to all the lecturers who taught into the undergraduate science courses. However, since only a portion of the student population was surveyed additional care was taken with the conclusions that have been drawn from the survey data. Finally, member checking of the interview transcripts also supported the study’s validity (Merriam, 1998; Silverman, 2000).

Reliability refers to the degree to which, by following the study methodology on a different occasion, the same or different observers could arrive at the same findings and conclusions (Kvale & Brinkmann, 2009). In other words, that the ‘results are consistent with the data collected’ (Merriam, 1998, p.206). The goal of reliability is to minimise the errors and biases in a study (Yin, 1994). In this study the inclusion of the theory underpinning the study, the rationale behind the data analysis plan and careful documentation and description of how the findings were arrived at (Silverman, 2000; Yin, 1994) improve its reliability. The efforts made to acknowledge the researcher’s position, member checking and the use of triangulation are also relevant to improving reliability.

3.11 Limitations

The limitations of this study included the bias of participants and those of the researcher, whether the participants interpreted the questions as was intended and the survey response rates. This research also represents the participants’ perspectives at the present time and these may change over time, informed by their experiences with blended learning. They will also vary between individuals and between classes. The limitations were acknowledged and have been addressed as described above. The limitations affect the generalisability of the results but as this is not a central feature of case studies, this did not adversely affect the conclusions drawn.

CHAPTER FOUR

MANAGEMENT PERSPECTIVES

4.1 Introduction

This chapter describes the findings from the management interviews, firstly in relation to positioning the university within the blended learning adoption framework and then in relation to the additional themes that were developed. Extracts from the management interview transcripts have been used to highlight key points. The management interview participants are referred to as M1, M2 and M3.

4.2 Description of management participants

The management interview participants were three members of university staff whose role, or some aspect of it, related to management of e-learning at the university level.

4.3 Analysis in relation to the blended learning adoption framework

The management interview transcripts were coded and then compared to the blended learning adoption framework's categories, subthemes and stage descriptors as well as the analysis of the case studies used to develop the framework (Graham et al., 2013). The findings are described below using the framework's category and subthemes as an organising structure.

4.3.1 Strategy

The 'strategy' category comprised issues relating to the overall design of blended learning including the existence of an organisational definition of blended learning, the form and level of advocacy for blended learning, the degree of implementation, whether the organisation had identified purposes of blended learning and the extent to which there were policies surrounding it (Graham et al., 2013).

4.3.1.1 Purpose

Institutional purposes and motivations for adopting blended learning were clearly identified. The main reasons given were flexibility of provision which enabled access for more students and making teaching more effective. At the time of this study, increasing student retention was seen as more important than increasing new enrolments for this university. Another reason for adopting blended learning was to enhance how the university was viewed by external stakeholders and also to respond to the requirements of these stakeholders which, for example in relation to the accreditation of some courses, 'have turned from constraints to push' (M2).

One participant saw a purpose for blended learning specific to this university's context; as a means to continue providing teaching and learning when the physical university was closed to staff and students:

> after the earthquakes…[the university] became very, very conscious of the whole idea of academic resilience…if things go down and the servers are up and running, as happened during the earthquakes, then you can pretty much continue (M3)

An inconsistency in the motivations of staff and university management was raised by one participant who saw more of a focus on learning from teachers while, in general, 'the higher up the more it is motivated by money' (M1). This participant did, however, acknowledge that 'although it sounds like a criticism…that's their job'.

4.3.1.2 Advocacy

The university had no formal policy, approval or implementation process for blended learning courses at the institutional level. No participant mentioned a strong management level advocacy for blended learning but one suggested that 'the drive was also coming from the top' (M2). However, discussion around 'how does this…fit with our overall strategy' and 'what are the resources for this?' (M2) was said to be ongoing. Overall, participants felt that

> the strongest drive comes from the faculty on the ground….supported by the staff engaged in e-learning and its support in some way (M2)

Participants agreed that the university was not communicating its vision for blended learning well but indicated that it was increasing its focus on the role of technology in learning by

recently forming an institutional level e-learning advisory group as a sub-committee of the university's learning and teaching committee.

4.3.1.3 Implementation

Blended learning at the university was considered to be implemented by individuals using 'a very mixed approach' (M2). Teachers could choose whether they adopt a blended learning approach and do so using a range of models. Pedagogical support was available to staff designing blended courses through e-learning advisors although 'not all lecturers work with them' (M3).

Some areas of the university were seen to be more advanced in their e-learning implementation. In the College of Education, all courses were expected to have guidance, a learning management system (LMS) presence and to use its gradebook facility (M2). These developments were felt to be a result of the experience and expertise of the individual staff in this particular College:

> …to some extent that was stimulated by the fact that [they] have a significant distance mode…so [they] bring all that history to it (M2)

4.3.1.4 Definition

The participants agreed that the university had not adopted an institutional definition of blended learning. One suggested that there were 'probably a whole number of definitions on campus as far as blended learning goes' (M3). Overall, definitions were thought to 'tend to the simplistic' (M2) but the participants felt that there were common elements to the definitions being used:

> …the sort of thread that runs through all of the definitions would be the idea of some form of mix, blend in terms of face-to-face and online that would really be it to a large extent (M3)

4.3.1.5 Policy

There was no institutional policy specifically relating to blended learning. Participants indicated that an e-learning plan incorporating blended learning was drafted but was

‘integrated’ (M1) into the university’s overall teaching and learning plan. The participants were supportive of this:

> It’s great separating off e-learning from learning because you want to accentuate it…but at the end of the day, they belong together (M3)

However, participants indicated that a separate university level e-learning strategy (as opposed to plan) had now been requested. This would have a more operational focus on ‘what we need to do, when and where’ (M2).

4.3.2 Structure

The ‘structure’ category of the blended learning adoption framework (Graham et al., 2013) included issues relating to the technological, pedagogical and administrative framework facilitating the blended learning environment. This included the governance process for the approval of blended learning courses, the models being used to support their design, the scheduling structures for timetabling and course catalogue designations and the use of institutional level evaluations of blended learning (Graham et al., 2013).

4.3.2.1 Governance

The present blended learning approval process was described as ‘ad hoc’ (M3). New teaching programmes required university level approval and so were appraised by e-learning support staff. The introduction of new courses within existing programmes, however, required only college level approval and so e-learning support staff did not necessarily have any input. Moreover, changing an existing course to a blended format did not require any approval and could be done at any time by individual lecturers. The need for a consistent approach was raised. This would mean that

> blended learning follows the exact same processes as any application for a new course or new programme (M3)

4.3.2.2 Models

The university did not follow a particular model for developing blended learning courses. Participants commented that individual teachers designed their blended courses in a variety of

ways and that most often this included some use of the university's LMS. Again, technical and pedagogical support staff were available to assist but were not required to be consulted.

4.3.2.3 Scheduling

Within the university's course catalogue, distance courses could be identified but there was no official designation to separate traditional and blended courses:

> I don't think the quality of communication around blended learning is at the point where it would be easy for a student to know before they actually entered the university (M3)

Some courses include information about their format within the course description. This was 'written by faculty' (M2) but there was no requirement or consistent way of doing this.

The current timetabling process also considered traditional and blended courses in the same way. One participant noted that the classroom designated by the timetabling process could affect blended courses: 'if you are in your average classroom it is very difficult' (M2). The same participant also described how courses following alternative formats or timings to the standard university calendar were often 'forgotten' (M2). Staff teaching these courses had to remind computer support services (ICTS) to ensure access to necessary resources and classrooms.

4.3.2.4 Evaluation

One participant described a university wide e-learning benchmarking exercise using the e-learning Maturity Model (eMM; Marshall, 2010) that was completed in 2009. Due to the participants selected, however, there was a perception that the results were not representative. Following the interruption caused by the earthquakes in 2010-2011, this participant expected a second eMM benchmarking exercise to take place in 2014 which would provide 'baseline data we can measure against' (M3). The benchmarking was seen as marking a shift in the university's view of blended learning evaluation:

> …we could measure the effectiveness of blended learning by looking at the number of courses that have a Learn site or a moodle site…to adopting the view that what we should be looking at is the quality of blended learning that was taking place and not the number of moodle sites (M3)

Despite no university level evaluation, the participants felt that blended learning was evaluated to some extent by the university's standard course surveys and by a survey of the distance courses in the College of Education.

4.3.3 Support

The 'support' category considered issues relating to the manner and extent to which the organisation facilitates the implementation and maintenance of its blended learning course design. This incorporates the availability of technical and pedagogical support as well as the use of faculty incentives (Graham et al., 2013).

4.3.3.1 Technical support

Participants described how the university uses a Moodle-based LMS as a platform to support blended learning and has also introduced lecture capture through Echo360. They noted that technical support for blended learning related technologies was available through electronic self-help and the university's Information and Technology Services (ITS) and audio-visual staff. One participant discussed how changes to where blended learning technical support staff were based could influence the service that was provided:

> ….like the Moodle programmer [previously based with the e-learning advisors] going off into ITS. Could be good, could be bad but the priority in ITS will be seen very differently (M2)

Participants were aware of potential infrastructure issues that might arise with the expansion of blended learning. These included the availability of space and processes for archiving material, the use of cloud services, support for new devices and technologies, the long term capability of the wireless network and working within a managed IT environment.

4.3.3.2 Pedagogical support

Participants discussed the dedicated e-learning staff that provided pedagogical support to lecturers and their development of a range of support services. These included electronic self-help, one-on-one consultations and 'brown bag lunch' sessions. They were trying to move away from the traditional workshop approach which was 'the least effective way of doing it

[professional development]' (M3). It was indicated that the key issue with the pedagogical support was the 'limited pool of [e]learning advisors' (M1) who were 'pretty much running at capacity' (M3). Maximising the limited resources was the driver behind support services being redesigned. For example, telephone and email enquiries have been replaced by an electronic job logging system which is a 'far more cost-effective, resource-effective solution' (M3).

A formal application process for blended learning courses aiming to make 'the blended aspect part and parcel of every day course design' (M3) was described. A 'multi-disciplinary design team' (M3) approach was proposed. This would include liaison librarians and e-learning support staff who would assist lecturers to design their blended courses.

The lack of support for students participating in blended learning courses was acknowledged. Participants were uncertain about the services currently provided but felt that it currently fell to the student learning skills centre. However, one participant commented that 'their focus is...numeracy, literacy, it's not blended learning' (M3).

A lack of centralised student support had produced ad hoc solutions including student 'e-mentors' (M2) in the College of Education. Suggestions for improvements to student support included online self-help before and after starting at the university and compulsory orientation sessions for new students.

4.3.3.3 Incentives

The university was aware of the importance of providing staff with incentives to increase the implementation of blended learning:

> What are the hurdles…to implementing blended learning? The first one, right at the top of the list, is staff incentives (M3)

However, no formal incentives are currently in place. The workload model, for example, currently viewed distance, blended and classroom-based courses the same and, in one participant's view, 'quite incorrectly so' (M3). However, participants noted that incentives were currently being discussed including 'providing staff with time off for design of blended courses' (M3) and making teaching part of the 'professional appraisal of academic staff' (M3). Participants considered the university's teaching and learning grants to be an incentive but they did acknowledge that these were not specific to blended learning projects.

4.4 Identification of management themes

The management interview transcripts were analysed a second time using the constant comparative method. This identified four management themes relating to blended learning at this university. These are described below.

4.4.1 Fit with overall institutional strategy

> ...it's quite symptomatic of the problem of blended learning, how it fits into the bigger picture...not only at [the university] but universally (M3)

Participants were uncertain about how blended learning fitted into the university's overall strategy but it was noted that this was a universal problem. However, for this university, there was a more pressing need to understand the fit and purpose of blended learning within the institutional strategy as the university is in the process of rebuilding physical spaces following a series of earthquakes:

> We're rebuilding now even more and some of the infrastructure's a bit loose…sometimes that's helpful because being a bit loose means that change should be easier (M2)

One participant raised the need to consider the overarching student experience as more courses adopt a blended approach with less classroom time:

> …because if students aren't with you, where are they?....there's all these things that need to be thought through (M2)

4.4.2 Adequate resourcing

> It [the university] is actively trying to implement blended learning but is not putting its strategic resources to that end very successfully (M2)

The issue of adequate resourcing for blended learning was raised a number of times by participants. Resources were most often raised in relation to the number and availability of e-learning support staff who were seen as crucial to the development of quality blended learning courses but were currently 'a limited pool' (M1) and 'incredibly thinly spread' (M2). As well as current resourcing issues, participants felt that competing demands on university finances meant future resources specific to blended learning were difficult to secure.

Participants indicated cloud computing, data storage, better wi-fi networks and the managed computing environment as resources that would need to be addressed in the future.

4.4.3 Visibility of blended learning

> We need to take a grip and figure out what it is about that we are going to talk about as our vision for blended learning and shout about it (M2)

There was tension between making blended learning more visible in order to improve adoption and implementation and making blended learning part of normal practice. Increasing the visibility of blended learning was seen as a requirement from one perspective. to ensure that the required resources were made available. However, management participants also thought that blended learning needed to be seen as 'part and parcel of normal practice' (M3). This was evident in the integration of the e-learning plan into the teaching and learning plan which they felt was appropriate, noting that 'at the end of the day, they belong together' (M3) and 'it is all part of teaching and learning' (M1).

4.4.4 A change of pace and a positive future

> The momentum for blended learning has picked up considerably in the last two years. Very much so (M3)

The participants gave a sense that blended learning had become more of a priority for the university and that it was poised to put in place the policies and structures and to further develop the support systems required to implement blended learning more widely. The participants' general outlook for blended learning at the university was positive and they envisaged 'enormous possibilities' (M2).

CHAPTER FIVE

LECTURER PERSPECTIVES

5.1 Introduction

In this chapter, findings from the lecturer aspect of this study are presented. The results of the lecturer survey are described and a rich description of the lecturer interviews is provided. Themes that were developed from the data are described. Extracts from the lecturer interview transcripts have been used to highlight key points. The participants are referred to as L1, L2 and L3.

5.2 Lecturer survey analysis

Thirty seven responses were received from the 185 undergraduate science lecturers invited to participate giving a response rate of 20.11%. Due to the low response rate, the survey data were not analysed statistically. Instead descriptive statistics were used. The number of responses to each question (n) is given. The number of responses differed between questions and between statements within the same question as none of the questions were compulsory. Therefore, percentage figures (based on raw data and rounded to nearest 1%) are given to allow comparison. Percentages may total more than 100% for questions where multiple responses were possible.

5.2.1 Description of respondents

Survey respondents represented all departments and research centres within the College of Science. The mean length of teaching experience was 17.57 years (±11.54 years; range: 3-38 years). The spread of experience was good with 41% respondents having taught for less than 10 years, 19% for 11-20 years and 41% for more than 20 years.

5.2.2 Use and preference for different teaching methods

The majority of lecturers (77%; n=35; figure 1) described their teaching as ‘technology enhanced’ which was face-to-face instruction with supplementary online instructional

material such as resources or reading material. Fewer described their teaching as ‘blended’ (14%) or ‘face-to-face’ (9%). In the last year, lecturers had taught using entirely face-to-face, entirely online, blended, video conference or webinar methods. Face-to-face (69%; n=35; figure 1) and blended (86%,) course formats were used most often. Twenty three lecturers (36%) had taught using multiple methods. The majority (70%) of these had used both face-to-face and blended methods. A smaller number of lecturers had taught using three or four of the teaching methods listed.

Of those who had used a blended approach in the last year, more than half (54%; n=35) had taught all of their courses in a blended format and 29% had taught at least some of their courses using a blended approach. Only 14% of lecturers had not used blended learning in any of their courses. It should be noted that one lecturer indicated that they had not taught in the last year, even though no lecturers gave this response to the same statement in a previous question.

Lecturers had an almost equal preference for teaching face-to-face (57%; n=35; figure 1) and blended courses (66%). Almost a third (29%) indicated a preference for more than one teaching method. For all of these the preference was for both face-to-face and blended courses. No lecturers preferred to teach entirely online or video conference-based courses and two did not have a preferred teaching method.

In an open response question, lecturers overwhelmingly (67%; n=30) cited lecturer-student interaction as a reason for preferring a face-to-face environment. The benefits included being able to add their own ‘expression and ‘drama’ to make points in the classroom’, to gauge student understanding by observing facial expressions and other cues and the immediacy of the face-to-face environment allowing ‘clearing up of misperceptions or expanding concepts’. Some lecturers also expressed satisfaction or ‘joy’ when they could see that students had understood something. The online environment was generally felt to ‘complement and re-enforce[s]’ the learning taking place in the face-to-face environment but not replace it, even when using synchronous video conferencing as it ‘does not provide the ambience needed for students (in two different locations) to feel like ‘one class’’. The online environment was seen as useful to provide access to information (23%), where lecturers ‘don’t add any value’. Only a few lecturers (13%) mentioned the learning benefits of the online environment. These included flexible delivery, the ability to address different learning styles, enabling students to ‘learn at their own speed’ and anonymity which encouraged participation. Lecturers were concerned that online learning reduced student engagement and

that students lacked effective online learning skills. Two science specific comments noted the importance of face-to-face experiences in science education, for example laboratory and field work.

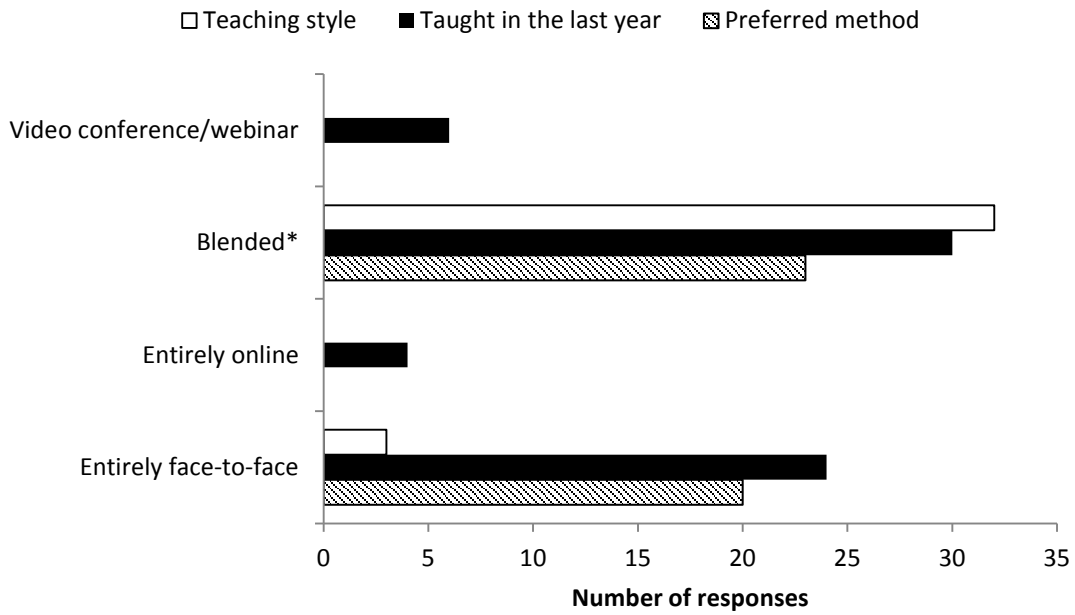

Figure 1: Lecturer teaching style, use and preference. n=35. Multiple answers could be selected for some questions. *Blended includes technology enhanced.

5.2.3 Use of e-learning tools in teaching

Using the responses 'all the time', 'frequently', 'occasionally' and 'never', lecturers reported their use of e-learning tools for a number of teaching related activities including lesson preparation, researching teaching materials, classroom instruction, communication and student testing and feedback (n=31-34; figure 2). Responses of 'frequently' and 'occasionally' were combined due to the low number of responses. For most of the activities listed, at least twice as many lecturers had used e-learning tools either frequently or occasionally (range: 52%-73%) than those who used e-learning tools all of the time or never. The activities for which the highest number of lecturers never used e-learning tools were to 'prepare schemes of work' (55%) and 'to test learners understanding' (54%). The activities for which the highest number of lecturers used e-learning tools all the time were 'make course materials available to learners' (76%) and 'research and access teaching materials' (54%). For all other activities, the majority of lecturers used e-learning tools frequently or occasionally.

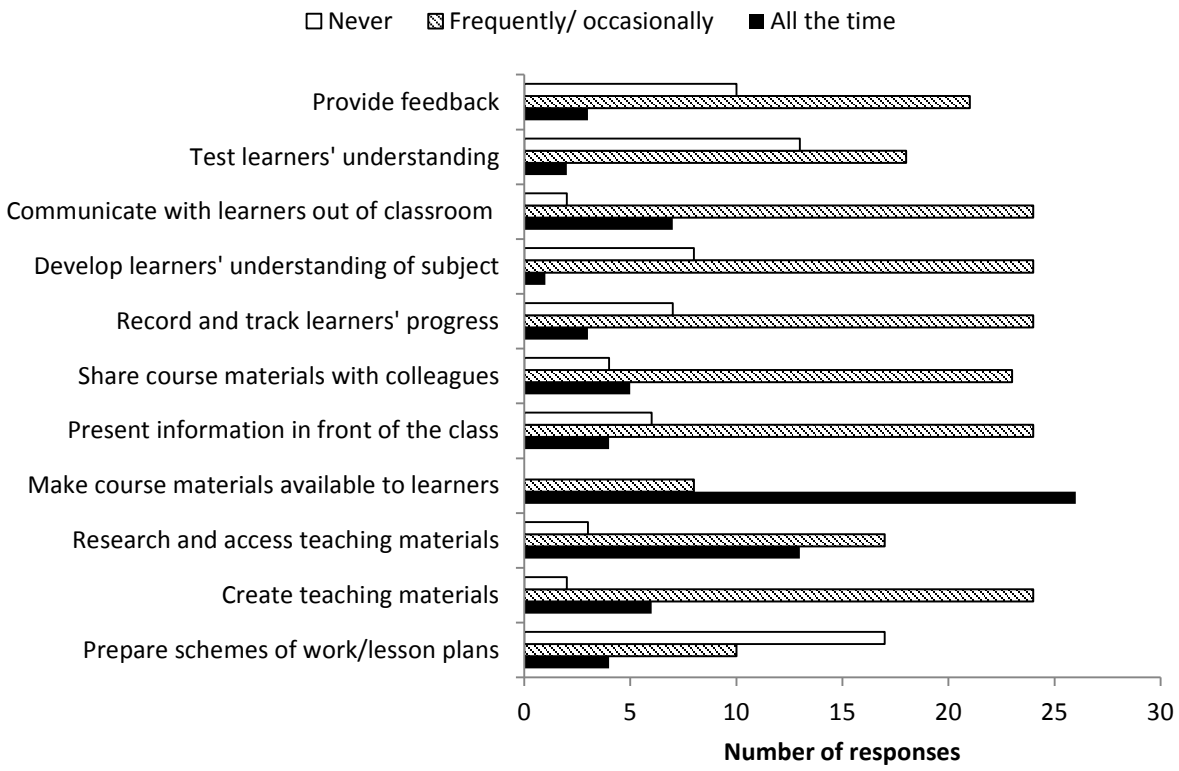

Figure 2: Lecturer use of e-learning tools for teaching-related activities. n=31-34.

5.2.4 Influence of blended learning

For this question, potential responses were ‘strongly agree’, ‘agree’, ‘uncertain’, ‘disagree’ and ‘strongly disagree’. Due to the low number of responses of ‘strongly agree’ and ‘agree’ were combined, as were responses of ‘disagree’ and ‘strongly disagree’. Lecturers were unsure how blended learning impacted wider learning issues such as student attendance, retention, motivation, employability, achievement and lecturer record keeping and course management (n=33; figure 3). Over 30% and up to 70% of lecturers answered ‘uncertain’ for all statements except ‘makes course management easier’ (15%). When ‘uncertain’ responses were excluded, lecturers agreed that blended learning ‘creates a more enjoyable learning experience’, ‘facilitates better record keeping’ and ‘makes course management easier’. They disagreed that blended learning ‘improves attendance’, ‘makes students more employable’ or ‘improves student retention’ and were divided about whether blended learning ‘makes students more motivated’ and ‘facilitates higher overall grades’ with approximately equal numbers agreeing and disagreeing with these statements.

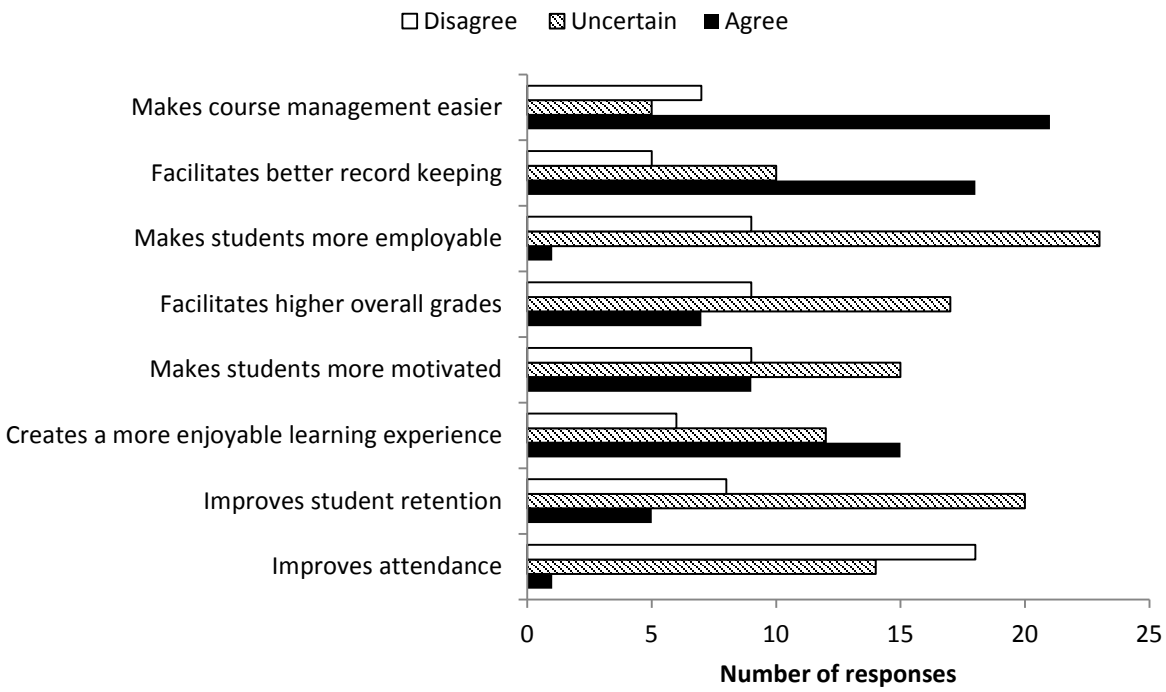

Figure 3: Lecturer perspectives on the wider influence of blended learning. n = 33.

5.2.5 Challenges for teaching and learning in undergraduate science

An open response question asked lecturers what they considered to be the major challenges for teaching and learning in undergraduate science. Only a small number (7%; n=27) mentioned a lack of teaching skills or time to develop resources but the majority saw the main challenges as being student-centred. Over a third (37%) of responses commented on the effect that poor student engagement and motivation had on learning. Other challenges were students' lack of content knowledge and independent learning skills on entering tertiary study (19%) and reduced attendance (19%). One lecturer (4%) felt reduced attendance also affected lecturers themselves: '…when only half the class attend, then WE are less motivated to make a good effort' (emphasis original). The only comments specific to science again noted the need to continue to develop students' 'hands-on skills' (19%). For 7% lecturers problems with undergraduate teaching were attributed to the university 'becoming a business' which was 'trying to get as many enrolments as possible'. Online learning was seen to be exacerbating the challenges lecturers faced (27%): 'providing online materials is essential, but is also likely part of the problem'.

5.2.6 Use of e-learning tools in undergraduate science teaching and learning

In an open response question, lecturers provided examples where e-learning tools had supported their teaching. Over half (66%) referred using e-learning tools or the university's learning management system to provide access to supplementary reading material and recorded lectures. However, in only three instances was the use of the online learning environment used to enhance teaching: by facilitating a flipped classroom model or allowing commentary to be added to reading material in order to increase students' understanding. The next most common use of e-learning tools was to provide opportunities for quizzes and other 'self-testing' (15%). Specific to science, two lecturers had used remote experiments or simulations to assist students to visualise difficult scientific concepts.

Lecturers were asked whether they thought e-learning tools could support various aspects of teaching in undergraduate science such as visualization of unobservable items, identifying misconceptions, providing authentic learning experiences and building students understanding of concepts (n=29; figure 4). Responses were 'already use', 'can envisage a use', 'don't know' and 'can't envisage a use'. For each of the statements, less than 30% (range: 3%-31%) of lecturers did not know whether e-learning tools could be useful to provide support. At least one lecturer (range: 3–62%) was already employing e-learning tools to support each of the activities listed. The highest numbers of lecturers currently used e-learning tools for 'delivering scientific content' (62%) and 'modelling/simulation' (37%). The lowest numbers used them to 'provide access to equipment and experiments not possible in UC laboratories' (3%) and 'improving students' understanding of the nature of science' (7%). For all activities except one, even those where current use of e-learning tools was low, more lecturers could envisage a use of e-learning tools than those who could not. The exception was 'improve student attitudes to science' where more lecturers could not envisage a use for e-learning tools.

Lecturers were then asked whether they thought e-learning tools could support students to develop science skills such as data interpretation, ability to construct an argument, problem solving, testing hypotheses and working collaboratively (n=29–30; figure 5). Responses were 'already use', 'can envisage a use', 'don't know' and 'can't envisage a use'. Similar to above, for each skill listed fewer than a third (range: <1-31%) of lecturers did not know whether e-learning tools would be useful. The highest numbers of lecturers currently used e-learning tools to help students in 'conducting an effective literature search' (52%) and 'creating a bibliography' (48%). No lecturers currently used them to support 'ability to

design an experiment' or 'being able to infer plausible reasons for a failed experiment'. Lecturers were less positive about the use of e-learning tools to support the development of science skills: for 15 out of the 23 skills listed more lecturers could envisage a use for e-learning tools than those who could not. However, for six out of the 23 skills listed, more lecturers could not envisage a use for e-learning tools. For the remaining three skills lecturers were divided about the potential for e-learning tools with approximately the same number able to see a use for e-learning tools as the number who could not.

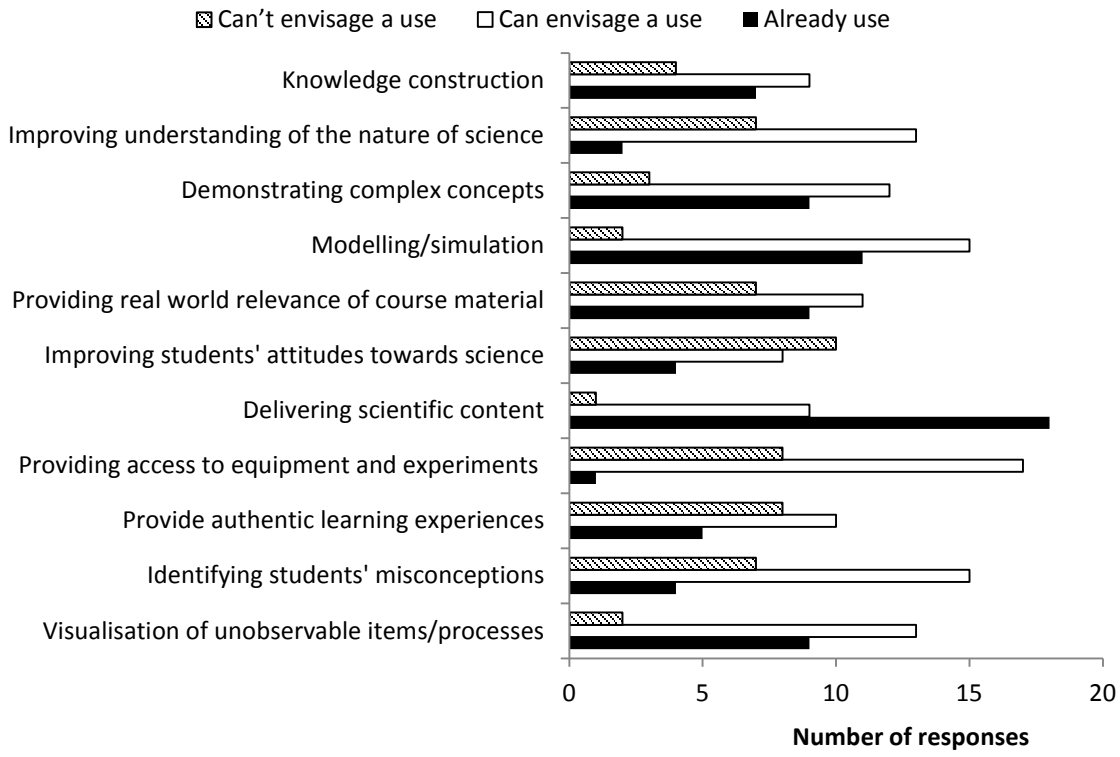

Figure 4: Lecturer perspectives on the use of e-learning tools to support learning in science. 'Don't know' responses have been omitted for clarity. n=29.

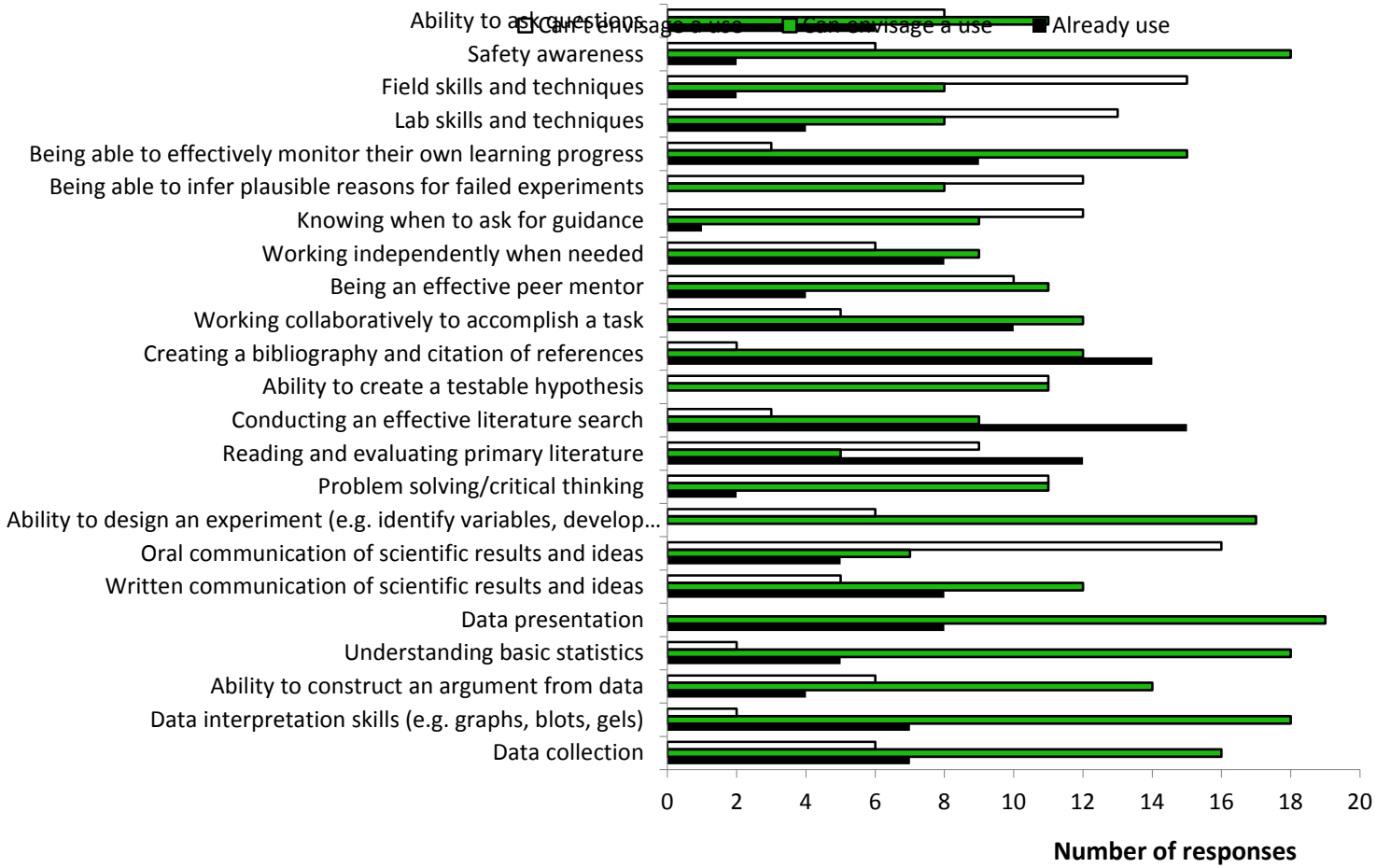

Figure 5: Lecturer perspectives on the use of e-learning tools for science skill development. 'Don't know' responses have been omitted for clarity. n=29-30.

5.2.7 Lecturers' perceptions of students' perspectives of e-learning tools

Using the responses 'all the time', 'frequently', 'occasionally' and 'never', lecturers reported how they though their students used e-learning tools. Responses of 'frequently' and 'occasionally' were combined. More lecturers (range: 57–96%; n=27-28) thought that students were making use of e-learning tools at least occasionally. They thought that students already used e-learning tools to 'contact lecturer with queries' (96%), 'submit assignments' (93%) and 'catch up on missed lectures' (96%). Fewer lecturers thought that students used e-learning tools to 'support learning during laboratories' (18%), support learning during tutorials' (11%) or 'engage with subject matter in the classroom' (11%).

Lecturer perspectives of students' attitudes towards online learning produced some of the strongest results of the survey (figure 6). For this question, potential responses were 'strongly agree', 'agree', 'uncertain', 'disagree' and 'strongly disagree'. Responses of 'strongly agree' and 'agree' were combined, as were responses of 'disagree' and 'strongly disagree'. The number of lecturers answering 'uncertain' was high for some of the statements (range: 4-48%; n=27). Excluding 'uncertain' responses, lecturers unanimously agreed that students expected to use learning tools in their learning, wanted to be able to access material anywhere, were confident to contact a lecturer by email and preferred to attend face-to-face lectures, tutorial and laboratory classes as opposed to online versions. Lecturers were divided over the statement 'students know how to use e-learning tools successfully'. Lecturers agreed that students owned a variety of technologies they currently used to support their learning but were less certain whether students owned technologies that were not currently being used.

5.2.8 Institutional influences on blended learning

For this question, potential responses were 'strongly agree', 'agree', 'uncertain', 'disagree' and 'strongly disagree'. Responses of 'strongly agree' and 'agree' were combined, as were responses of 'disagree' and 'strongly disagree'. Lecturers (48%; n = 29) agreed that the university had an e-learning strategy and vision but fewer (17%) thought that the strategy was clearly communicated. Lecturers perceived an expectation from senior management (76%), the College of Science (72%) and

individual departments (86%) that e-learning was used in teaching. Fewer, however, thought that their department 'promoted good practice and innovation in e-learning' (48%), that 'e-learning was incorporated into curriculum planning' (41%) or that there were strong structures in place to help them develop e-learning (52%). Despite this, 72% of lecturers could 'identify opportunities to use e-learning in my subject'.

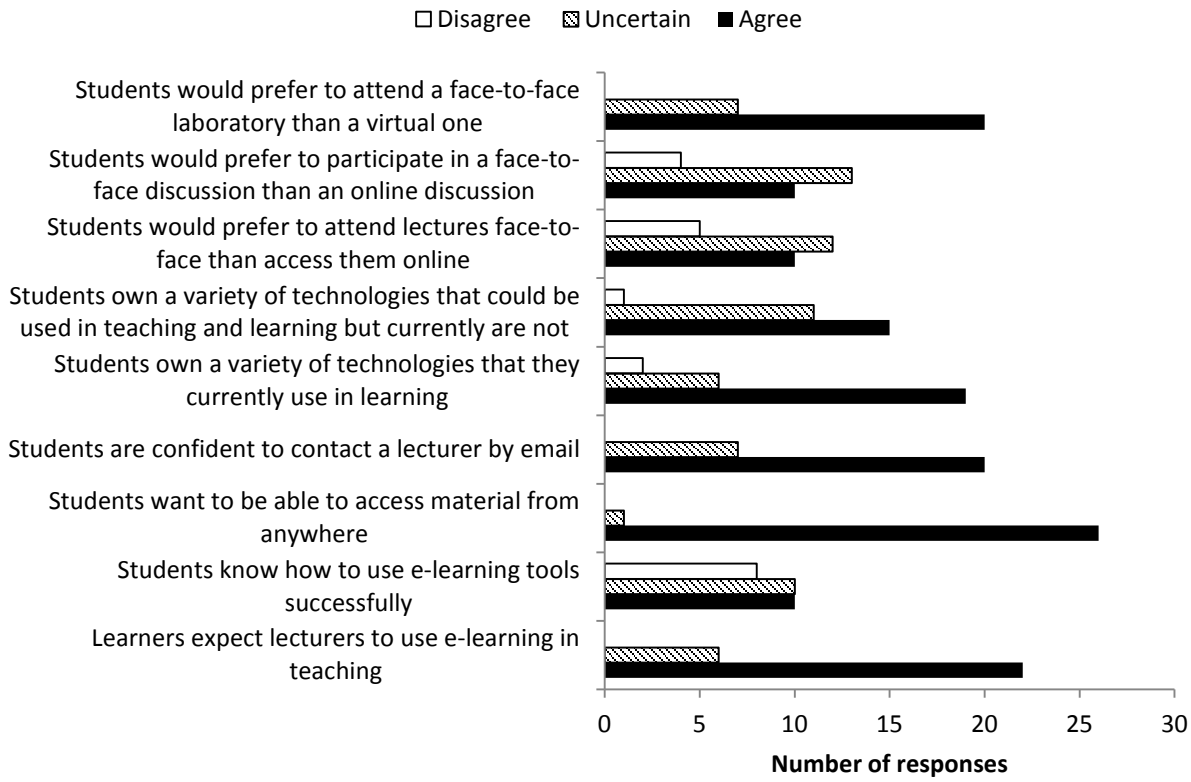

Figure 6: Lecturer perspectives of students' attitudes towards online learning. n=27.

5.2.9 Additional comments

Around half of the lecturers added additional comments. These mainly re-iterated comments made earlier. New comments included questioning whether blended learning pedagogies were 'effective…practice' and suggesting that blended learning was being 'pushed' without research evidence to show that it improves learning. One lecturer suggested that 'in a few years, a number of universities will be advertising that their institutions provide face-to-face lectures, labs and tutorial for their students' possibly indicating that they viewed blended learning approaches as nothing more than a passing trend.

5.3 Lecturer interview analysis

5.3.1 Description of participants

The lecturers were two males and one female who taught undergraduate science courses in evolutionary biology, biochemistry and chemistry. All were experienced lecturers having taught for more than nine years (range: 9-29 years).

5.3.2 Teaching styles

All three lecturers identified their teaching style as involving active learning and incorporating a range of approaches. They all altered their teaching style and level of interaction with students according to the level they were teaching:

> 100 level [first year] courses are probably allowed to be more passive more of the time than they are at higher levels… (L2)

Changes in teaching style were due to large class sizes in first and second year courses and the diversity of students within them which ranged from 'students who excelled at NCEA to students who have never done biology and are in their forties' (L3). Two lecturers felt that their teaching was targeted to particular students within their classes and both differentiated students by their level of engagement and motivation not their academic ability:

> …the students who excel are probably going to excel regardless of what I do…the students who are not engaged there is nothing I can say or do that will actually engage them…most of the time I am teaching to that group in the middle so I can shift them up a wee bit… (L3)

One viewed this approach as 'a defect' (L2) because they felt that they should be more effective with lower achieving students.

5.3.3 Definition and use of blended learning

When asked to define 'blended learning', none of the lecturers specifically mentioned the use of technology, instead referring to blended learning as the use of a range of teaching approaches and tools:

> I think it means you are using multiple modes of delivery to engage multiple types of thinking…in some kind of coordinated cohesive whole (L1)

One lecturer referred to the term 'blended learning' as a 'buzz word' (L1). When probed, all agreed that a blended learning could include the use of technology but they did not view this as essential:

> not just electronic, it could also be manual kinds of tools [describes a card-based learning game]…it's a combination of all those tools at once all the way to the more traditional monologue information delivery (L2)

When asked how long they had used a blended approach in their teaching, the lecturers gave varied responses which again illustrated that a blended approach did not necessarily include the use of technology. For example, one lecturer felt that they had always used a blended approach and one thought that they had only really used a blended approach since the university introduced a learning management system (LMS). Two described themselves as early adopters of the different LMS that have been used within the university.

The examples of blended learning from their teaching that the lecturers shared did include the use of technology. Two used a flipped classroom model where at least some of the face-to-face lectures were replaced by interactive learning sessions. The reduced lecture time was offset by either recorded lectures or online support material.

> a lot of factual information is actually outside the classroom and that we spend the class face-to-face time actually being more thoughtful (L3)

For these lecturers, this was when blended learning was most effective in courses; transforming the face-to-face interaction between students and teachers:

> ...where the classroom doesn't change but you introduce e-learning, you haven't done anything (L2)

The third example was the use of 'slowmation' software in which students used cell phones to create a narrated, animated film based on a scientific research paper. The lecturers had also used re-useable learning objects, a virtual laboratory, pre-lecture quizzes to prepare students for classes, post-lecture quizzes to test students' understanding and online peer assessment.

5.3.4 Planning blended learning

When planning their teaching, all three lecturers were clear that 'the technology is not driving things' (L1) and that pedagogy influenced their course design:

> …it's not just the medium you use but the way you use it (L1)

The lecturers tailored their teaching to the motivations, interests, diversity and ability characteristics of each student cohort. Starting with the learning outcomes for the course they looked for relevant content, contexts and case studies that would support knowledge development whilst also being of interest to the students concerned. Only then did they consider technology:

> I think about what it is I want the students to know at the end…then I think what is the best way to achieve that particular skill base or knowledge set…then it will be 'okay, what part can technology play in that?' (L3)

Lecturers commented on the need to be aware of the pedagogical implications of using technology in teaching as it could alter learning:

> ...you've got to be sufficiently reflective about the implications of the different media that you use. Try to at least identify the new pedagogical challenges that arise because of that (L1)

Caution was suggested with overusing a particular approach as for students, there 'is a fine between familiarity and getting bored' (L3). Using too many different approaches within one course was also avoided:

> …you want to get them [students] engaged in the material but you don't want to overwhelm them (L3)

When adopting a blended approach lecturers had started with simpler uses of technology such as pre-lecture quizzes and had built upon their successes. A flexible approach was also recommended due to the rapidly changing technological landscape: 'things come and go...you embrace what works at the time' (L3).

5.3.5 Challenges of learning and teaching in undergraduate science

The lecturers agreed that students found science difficult to learn. The quantity, depth and breadth of content and the amount of new terminology that this created was seen as a challenge for students and meant that using innovative approaches was more difficult. Visualising time and distance scales such as 'femtosecond activity in chemistry all the way to billions of years in the age of the cosmos' (L1) required abstraction and analogy which was a further cognitive challenge. Other issues were the amount of background theoretical understanding needed to be able to engage critically with science and the involvement of maths knowledge which students disliked. These issues were compounded by the interdisciplinary nature of science:

> Biochemistry is, like all interdisciplinary subjects, a problem because you need to have working knowledge in chemistry, you need to have working knowledge in biology and you need to have working knowledge in biochemistry and then you need to put biochemistry in the context of everything else (L1)

One lecturer struggled to understand what interested current students. Their own motivation in science was in understanding how things worked but their students seemed more interested in being able to use sophisticated science technologies such as gene sequencers without wanting to know how they worked:

> …they don't seem to be interested in the black box. I think a large part of the motivation for me was the black box and for them it's the outcome in the absence of the black box (L2)

The context of undergraduate science also presented challenges of its own. Lecturers felt that the team teaching approach in undergraduate science courses made trying to implement a blended learning approach more difficult since team teaching meant getting 'buy-in from your colleagues' (L3). Some courses tried to find a solution acceptable to all in the team and opted for partial implementation of a chosen approach but other courses were taught with each lecturer using their own approach:

> Most scientific course delivery is fragmented into different teaching styles (L1)

The lecturers recognised that the diversification of the student cohort meant that they were simultaneously teaching students who would become scientists as well as those

who would follow other career paths. For one, a blended approach addressed this problem as it offered different learning environments which would appeal to different learners and access to different media created multiple opportunities for students to develop their working understanding of science.

5.3.6 The benefits of a blended approach in undergraduate science

By offering a wider range of learning environments and activities, blended learning was seen as a way to enable access for more students, including those with disabilities. Blended learning was seen as a way to motivate students as it incorporated technologies and interfaces that students were familiar with and could engage with it easily. However, this presented challenges for one who was unfamiliar with current technologies:

> I can't make a judgment about whether that [Facebook] is a relevant technology to adopt for my teaching (L1)

For one lecturer who used a flipped classroom, blended learning was also able to facilitate more effective use of the face-to-face environment by allowing time for interactive learning activities such as problem-solving which developed the higher order thinking skills needed in science.

Lecturers also used the blended learning environment to help 'scaffold' (L1) students' learning. They had used an online tutorial package to allow students to learn at their own pace and to get instant feedback on their progress and regular quizzes. These were used:

> ...to try and force students to work in real time because again one of the problems we face is that students go 'oh, I'll mug up for the final exam next term' (L1)

Such activities were also felt to encourage students to become more responsible for their own learning. Online activities such as recorded lectures could also help structure students' self-learning time which one lecturer thought they used ineffectively:

> Unstructured learning time doesn't work… if they are watching me for an hour…that takes an hour that they would otherwise be misusing as their self-learning time (L2)

Blended learning also improved course management by making it easy to track what material and content had been delivered, to quickly revisit course material or correct mistakes. One lecturer also saw time efficiencies through reusable learning objects; setting up online activities was initially time consuming but would save them time in future years.

All the lecturers agreed that showing students the relevance of science was important aspect and that technology made this easier as they could 'pull in [something] that they've seen on TV or in a commercial or some sort of political statement….' (L3).

5.3.7 The influence of institutional factors

When asked whether they thought university had blended learning strategy or vision, the lecturers' responses ranged from 'no' (L3) and 'it might do' (L1) to 'I think it does…but it's a really modest one at best' (L2). All agreed, however, that any vision was poorly communicated. Lecturers agreed that not having a blended learning strategy made it 'a challenge for the institution to work out its priorities and then reward those priorities' (L1). For example, all the lecturers felt conflict between the teaching and research aspects of their roles and that a strategy would help promote the value of teaching within the university.

There was some conflict in the lecturers' views on how blended learning should be implemented. They were critical of the lack of a blended learning strategy which had led to departments implementing their own strategies, support mechanisms and evaluation processes. This created a 'patchwork environment' which was likely to 'fail dismally' (L2). The fact that limited numbers of lecturers chose interactive blended teaching methods over the traditional passive model made blended courses 'islands' (L2) of experience for students which students were uncomfortable with:

> …it has to be a uniform cultural change because otherwise the students experience an island and they will resent an island just because it is an island…an island of experience (L2)

However, they were also critical of an institutional-led approach to blended learning. One described how an institution having 'a' vision was dangerous because it's '*a.*..singular…vision and one-size fits all' (L1) when clearly blended learning was differentially effective and relevant in different types of teaching environments:

> I would not welcome an environment in which I was told what to teach…[I] fundamentally disagree that crowd teaching is the way to go (L2)

One lecturer thought that they were using active and blended learning successfully with second and third year students but were currently not doing so with large first year classes. This lecturer saw the need to use blended learning from the start of students' tertiary education to frame their expectations of teaching and learning:

> I think once we can start doing it [team-based learning] at first year, that's when you'll see the real cultural shift…if we redesign those courses in such a way that that's how they are done then the flow on is just obvious (L3)

The fact that the institution did not have 'any effective means to evaluate any of our successes as lecturers' (L2) was raised as a concern and had led to them using their own ad hoc ways of evaluating the effectiveness of different approaches. Another issue was a lack of strong research evidence to support blended learning claims:

> I've never really seen a study…to be assured that the outcome of their learning is any better than the outcome of our learning (L2)

A number of comments were made about adequate resourcing and support systems being necessary for successful blended learning implementation. All of the lecturers thought that the support they received for course development from the university's e-learning advisors had been effective. All could, however, also see room for improvement particularly when compared to the level of support available in other New Zealand and international universities:

> …they've got half a dozen [flexible learning advisors]…here you've got [one] to service two colleges (L3)

One lecturer explained how the limited availability of support sometimes meant that 'you end up teaching people a lot of things yourself' (L3). However, they did

appreciate any informal opportunities to share effective teaching practice both within their departments and across the wider university.

Some frustration was felt, however, that although the university relied on the creativity of academic staff to develop effective courses, some institutional systems and policies prevented them from developing their skills further. The lecturers focused on how lack of time was an issue for their professional development and one was frustrated that study leave was not able to be used for teaching-related activities.

Two lecturers suggested that support for low level administrative tasks such as loading content onto and managing the learning management system would be welcomed. The third suggested a team approach to course design where academic staff could work with support staff with a range of expertise:

> My job is to talk with you [support staff] and identify which media would be useful, which techniques could be really good and then to feed you content and context but you can do all the implementations because I…don't have the time to do that (L1)

The influence of technical support and infrastructure was raised less frequently. Ensuring that the various technology platforms and associated software packages were compatible was noted by one lecturer and another requested better technical support for the more complex, dedicated computer laboratories as at present staff often relied on each other's expertise if problems arose with these facilities.

The lecturers on the whole felt that staff at the university were enthusiastic about their teaching. They also agreed that most lecturers' use of blended learning was 'basic' (L1). They felt that many lecturers did not embrace blended learning or new approaches as it was easier to follow traditional approaches:

> …there really is a push to those things that are most in common and the things that have the most in common are passive experiences (L2)

One lecturer suggested that lecturers being hired for their research expertise and not for their teaching style or ability was not helpful in changing the current situation.

At some point, all of the lecturers made reference to the university's current financial situation which they thought would affect the infrastructure and resources available for blended learning. One, however, saw this as a positive:

> …you're on a dated campus that is even more cash strapped than your normal university…but we're also in a position of potential opportunity here… (L3)

The same lecturer discussed how redesigning teaching spaces which were more appropriate to interactive teaching and blended learning was a key opportunity of the rebuild work at the university. However, with the changes in infrastructure moving at pace, it was felt that guidelines for the redevelopment of spaces would be beneficial.

5.3.8 The influence of student factors

The lecturers felt that different students liked and disliked the blended approach but that the ones who hated it were 'not necessarily the bad students' (L1). The highest achieving students were thought to dislike collaborative, team-based approaches as they preferred to work independently. The lecturers linked students' dislike of blended learning with their expectations of tertiary study. The lecturers' thought that students' viewed tertiary learning as a passive experience, referred to by one as the 'TV experience' (L2):

> I think it is a cultural expectation that adults go to university and in university you sit studiously listening to Socrates and writing things down. They want that because that's also how they see themselves as being adults (L2)

Alternative approaches to this passive expectation were therefore met with resistance from some students. From one lecturer's experience the resistance was not due to reduced success but was entirely due to the teaching methodology itself. Those who were able to engage with blended learning enjoyed the course, but those who could not or would not engage did not. This was described this as a 'cultural limitation' (L2) of blended learning.

In contrast to this view, one lecturer suggested that students had 'higher expectations than we're delivering on' (L3) because they had come from high schools where teachers were using more innovative pedagogies. This lecturer suggested better connections between tertiary and high school staff would support lecturers to develop their teaching and also facilitate students' transition to tertiary study. Another key to increasing students' level of comfort with different teaching approaches was not to

adopt these wholesale from other institutions, particularly overseas institutions, but to tailor them for New Zealand students. Once students were familiar with blended learning, it was suggested that they might actually encourage the wider adoption of blended learning as academic staff were more likely to act on requests from students to make changes to their courses.

Students appeared to like online lectures as they effectively relieved them from having to attend lectures. One lecturer saw this as a problem created by lecturers who recorded their face-to-face lectures and put them online as this effectively made the face-to-face lectures 'redundant' (L2). Other aspects of students' learning skills and study habits were also seen as barriers to their successful engagement with blended learning.

One of the lecturers felt that students relied on lecturers to provide motivation and interest for their learning whereas they felt that student self-motivation was essential at tertiary level. Key to this was the ability for students to see the relevance of something they found disinteresting but which they would be 'able to use [it] for something I do find interesting' (L2). Lecturers who continued to provide all the motivation for students were not thought to be doing them any favours in the long run:

> …at some point they have to be able to interest themselves and if I continue to be the one to put emphasis on making it interesting then I'm probably undermining their own personal development (L2)

The lecturers felt that students were unable to take responsibility for their own learning:

> I personally think that when students become more comfortable with being in charge of their own learning, that e-learning will become a really good way for them to do it [learn science] (L2)

One lecturer commented that research evidence had shown that student maturity levels had decreased over time and this created added difficulty with blended learning methods, particularly those using interactive approaches. Students did not like speaking in front of peers or discussing online, lacked the study skills to make effective use of their self-study time and were felt to be unable to filter out from the information provided what would help them learn effectively. The lecturers agreed

that students were competent in being able to manipulate technology but not to use it effectively for learning:

> I think they all have the ability to click the buttons and navigate these sites… do they have the skills to use e-learning materials in a way that makes them learn? That I don't think they have, no (L2)

5.4 Identification of lecturer themes

The themes outlined below represent topics that were frequently referred to during the lecturer interviews or unusual findings. The themes draw on data collected from both the lecturer survey and the interviews.

5.4.1 Pedagogy first

> I think it's not enough just to do some clever thing that develops some skills. It's really important that you do it in the overall context of the pedagogical aims of the course... (L1)

Pedagogy was at the heart of the decisions that lecturers made about the structure and teaching approaches that they used in their courses. However, the majority still used a transmission approach suggesting that their understanding of effective pedagogy may be lacking. Only a few had a more student-centred view and had used more mature blended approaches such as the flipped classroom. All, however, made compromises around pedagogy due to the influences of the wider university environment.

5.4.2 Student culture and expectations

> I'm going to study really hard at the end…I'm gonna [sic] flog myself for two weeks and that is what it is to be a student (L2)

Lecturers felt that students' perceptions of tertiary study were of the passive, traditional model. Blended learning, therefore, particularly blended models which incorporated participatory learning, was not what students expected and they were resistant to such approaches.

5.4.3 The influence of science as a discipline

> I've got to take you to a world where you see the world on this [atomic] scale and we have to think by analogy on that scale to what we know...and then we need all this abstract terminology...we need descriptors of atoms and bonding... (L1)

The adoption and implementation of blended learning was influenced by science as a discipline both due to the nature of the material being delivered as well as the wider context of science teaching and learning. This impacted on lecturers' use of blended teaching techniques.

5.4.4 The 'island effect'

> …if we try to change…[to innovative approaches]…it has to be a uniform cultural change because otherwise the students experience an island and they will resent an island just because it is an island…an island of experience (L2)

The implementation of blended learning by individual staff at the university has created what was described as the 'island effect' where the isolation of these courses and their alternative approach was a challenge for students and, therefore, for staff.

CHAPTER SIX

STUDENT PERSPECTIVES

6.1 Introduction

In this chapter, findings from the student component of this study are presented. The chapter describes the results of the student survey and provides a rich description of the student interviews. Themes that were developed from the data are described. Extracts from the student interview transcripts have been used to highlight key points. The participants are referred to as S1, S2 and S3.

6.2 Student survey analysis

Eight responses were received from the 85 students invited to participate representing a response rate of 9.4%. Five were studying towards a Bachelor's degree in geography. This is not a representative sample of science undergraduate students at the university. Therefore, the results have been considered with caution. Due to the low response rate, the survey data were not analysed statistically. Instead descriptive statistics were used. The number of responses to each question (n) is given. The number of responses differed between questions and between statements within the same question as none of the questions were compulsory. Therefore, percentage figures (based on raw data and rounded to nearest 1%) are given to allow comparison. Percentages may total more than 100% for questions where multiple responses were possible.

6.2.1 Description of respondents

The respondents were all third year undergraduate students completing Bachelor's degrees in biological sciences (13%), geography (63%), physics (13%) and geology (13%).

6.2.2 Experience and preference for different teaching methods

In the last year, students had experienced all of the teaching methods listed: entirely face-to-face, entirely online, blended and video conference (n=8; figure 7). All had been part of a course which used an entirely face-to-face approach. Approximately two thirds of the students had experienced entirely online courses (63%) or video conferencing methods (63%). Blended learning had been experienced by the lowest number of students (50%).

Two students (25%; n=8) thought that all of their courses had included blended learning and five (63%) thought that at least some of their courses had included blended learning. Only one said none of their courses included blended learning. However, it should be noted that four students indicated that they had not experienced blended learning methods in the previous question.

Students preferred face-to-face (63%; n=8; figure 7) and blended (63%) courses equally. Only one student (25%) preferred to be taught entirely online and no students preferred to be taught via video conferencing methods.

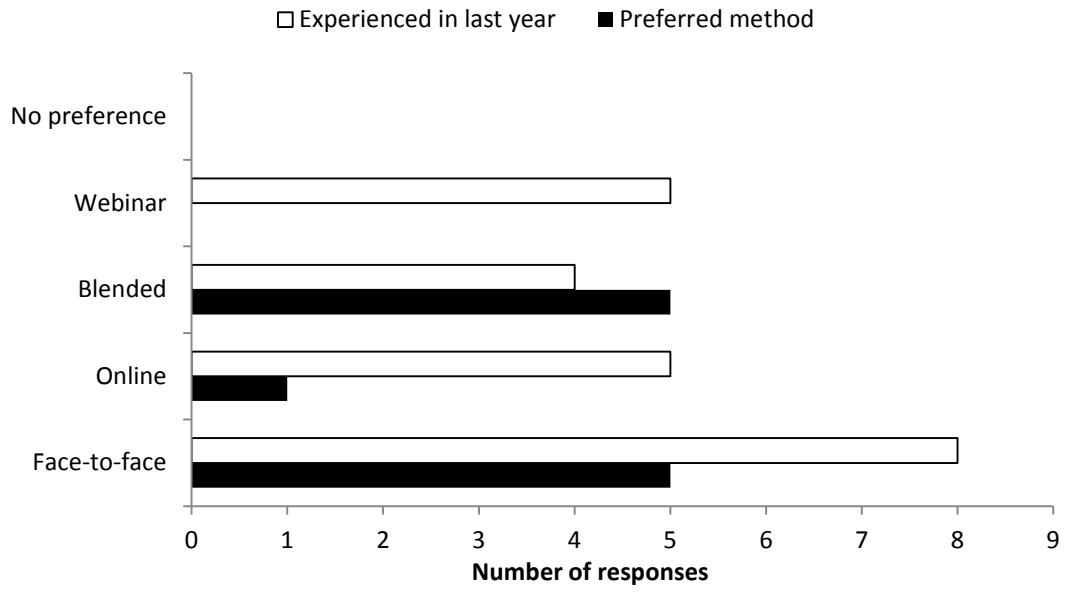

Figure 7: Student experience of and preference for different teaching methods. n=8; multiple answers could be selected for some questions.

In an open response question, students indicated that they preferred the face-to-face learning environment because it enabled teacher-student interaction (n=8). A quarter (25%) of students thought the face-to-face environment was more enjoyable and increased concentration since when in a lecture 'you are unable to push pause and check Facebook etc'. The students who discussed teacher-student interaction welcomed the opportunity to 'ask questions direct to the lecturer' and to 'build[ing] better connections with the lecturer'. It also enabled them to ask for support and improved their understanding of topics being presented. The students reported positive aspects of the online environment including the availability of online resources which extended the lecture material, the ability to review recorded lectures and the use of online quizzes to test understanding.

6.2.3 Use and perspectives on e-learning tools in learning

Using the responses 'all the time', 'frequently', 'occasionally' and 'never', students reported their use of e-learning tools for a number of learning related activities including researching topics, organising and submitting work, engaging with the lecturer and their peers (n=8; figure 8). Responses of 'frequently' and 'occasionally' were combined for analysis. At least one student used e-learning tools at least occasionally for all of the activities listed (range: 13–50%). For most of the activities listed, more students (range: 50–88%) used e-learning tools either frequently or occasionally than those who used learning tools all the time or never. The activity for which the highest number of students never used e-learning tools were to 'create presentations' (50%). A quarter of students had never used e-learning tools for direct learning activities, to contact a lecturer or to organise work. The activities for which the highest number of students used e-learning tools all the time were 'track your own progress' (50%) and 'reinforce knowledge' (50%) and 'work independently' (50%). For all other activities, the majority of students used e-learning tools frequently or occasionally.

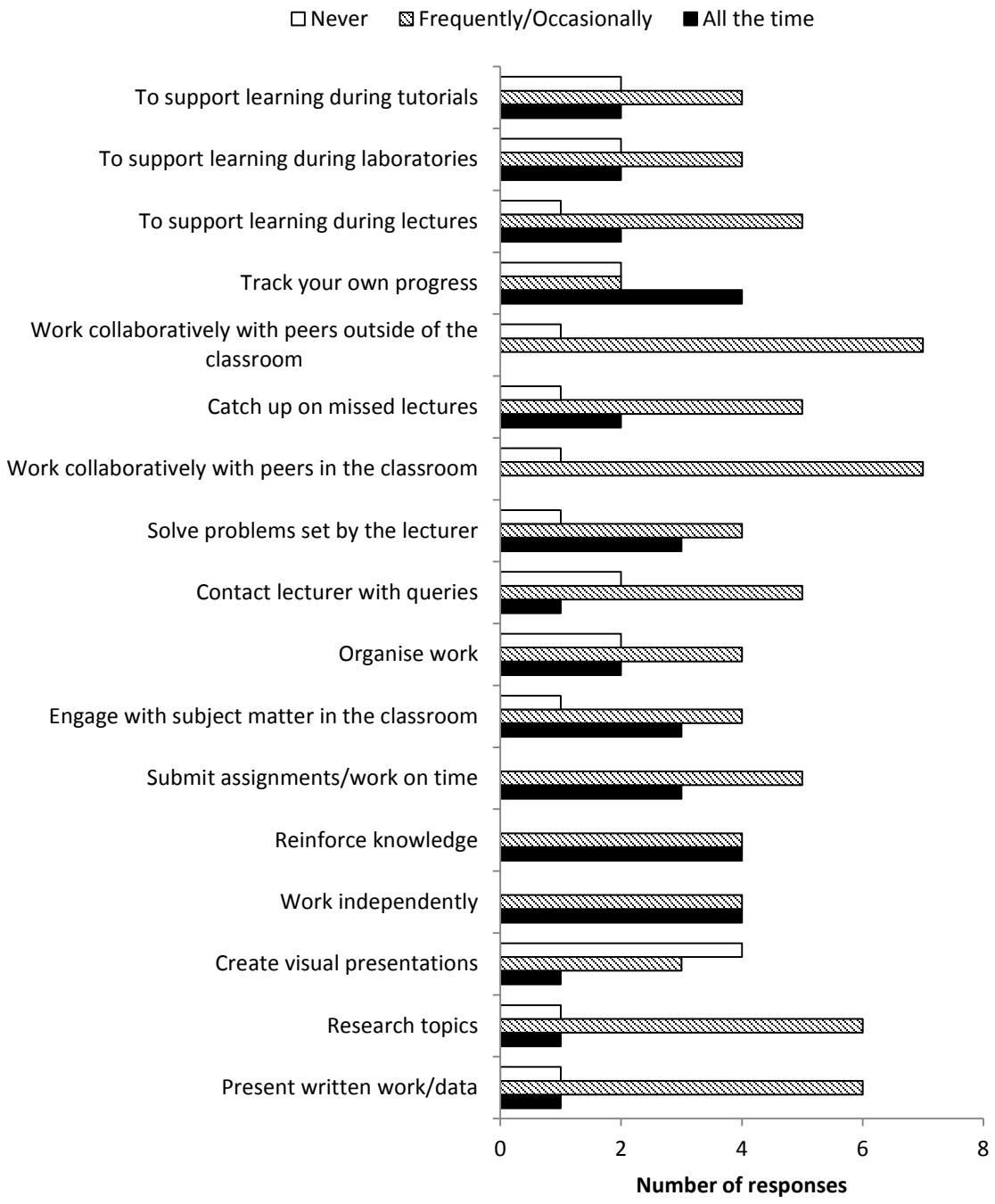

Figure 8: Student use of e-learning tools. n = 8.

6.2.4 Expectations of blended learning

For this question, potential responses were ‘strongly agree’, ‘agree’, ‘uncertain’, ‘disagree’ and ‘strongly disagree’. For analysis, due to the low number of responses of ‘strongly agree’ and ‘agree’ were combined, as were responses of ‘disagree’ and ‘strongly disagree’. When asked about their expectations for e-learning use in their courses, their e-learning skills and technology ownership, more students agreed (range: 63–100%; n=8; figure 9) with the statements than disagreed or were uncertain. The students had high expectations around the use of e-learning tools in their courses, with around three quarters agreeing that they expected lecturers to use e-learning in their teaching. They were, however, divided about the statement ‘I expected my university courses to include more e-learning’ with approximately equal numbers of students agreeing (38%) and disagreeing (50%). Students agreed that they wanted to ‘access course material materials from anywhere’ (100%) and the majority (88%) were ‘confident to contact a lecturer by email’ and would prefer face-to-face lectures, tutorials and laboratories than online equivalents.

6.2.5 Influence of blended learning

For this question, potential responses were ‘strongly agree’, ‘agree’, ‘uncertain’, ‘disagree’ and ‘strongly disagree’. For analysis, responses of ‘strongly agree’ and ‘agree’ were combined, as were responses of ‘disagree’ and ‘strongly disagree’.

The students were positive about whether blended learning could influence wider educational issues such as student attendance, retention and employability with more students agreeing (range: 50-88%; n=8; figure 10) than disagreeing or uncertain with all of the statements except one. The exception was the statement ‘improves attendance’ where responses were fairly evenly divided. The highest number of students agreed that blended learning ‘facilitates better record keeping’ (88%). Over half (63%) agreed that blended learning ‘makes management of studying easier’, ‘facilitates higher grades’, ‘makes students more motivated’ and ‘creates a more enjoyable learning experience’.

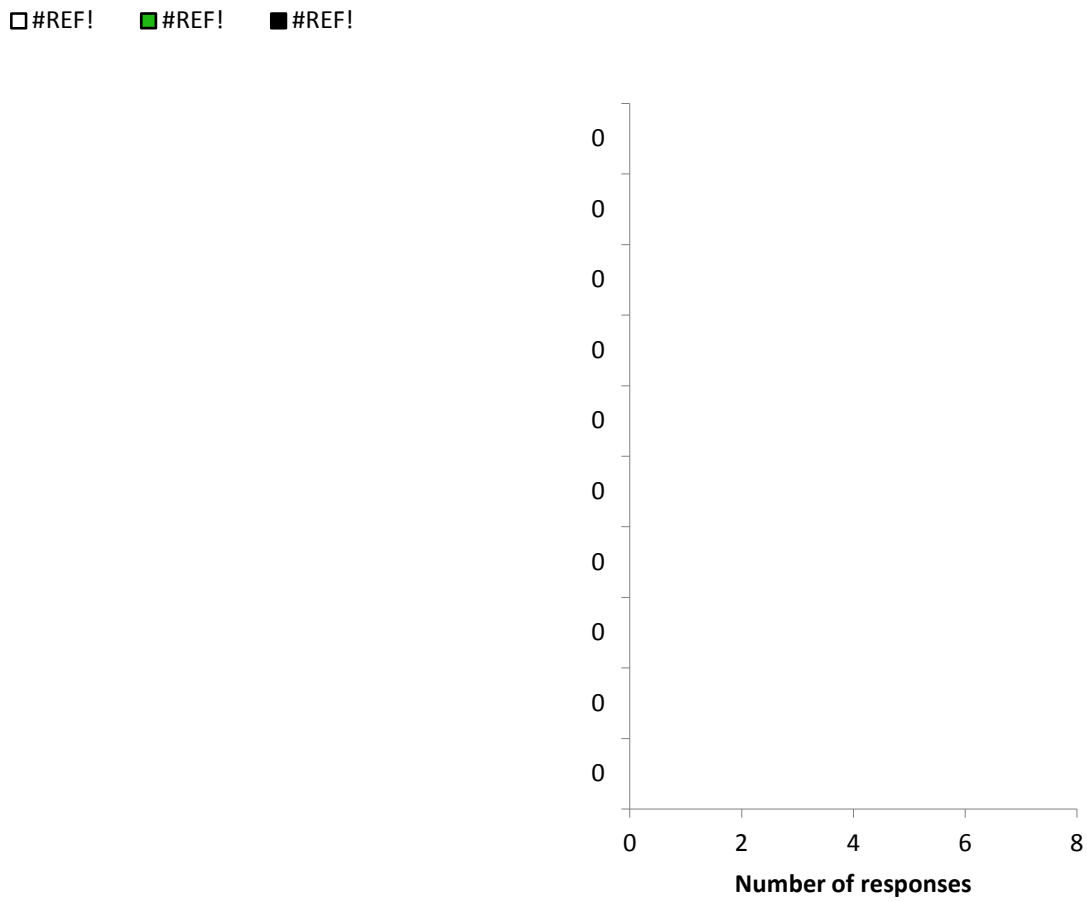

Figure 9: Student expectations of e-learning. n = 8.

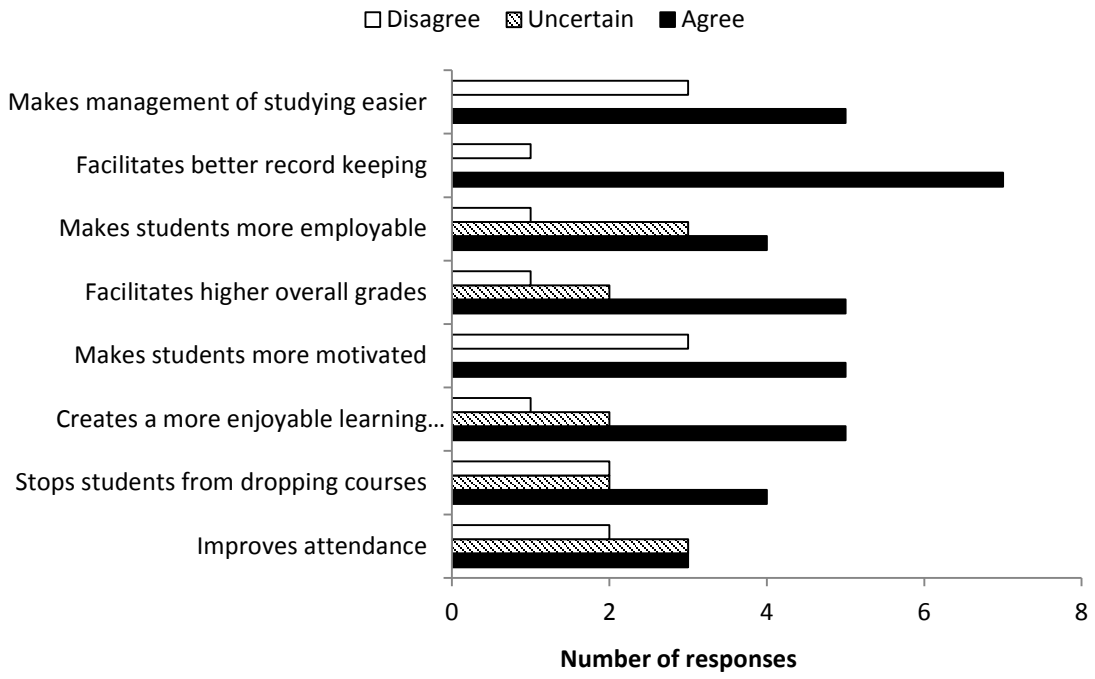

Figure 10: Student perspectives on the wider influence of blended learning. n=8.

6.2.6 Challenges for learning in undergraduate science

In an open response question asking what they found difficult about learning in science, 50% of the students responded that they had most difficulty with the 'challenging' content, 'learning new ideas' and understanding 'new concepts'. One (12%) mentioned inconsistency between courses and departments, particularly that some did not use the learning management system at all. Another (12%) commented that the teaching methods often did not suit their 'visual' learning style.

6.2.7 Use of e-learning tools in undergraduate science teaching and learning

In an open response question, students provided examples where e-learning tools had supported learning in their courses. Half (50%) of the students had used the university's learning management system to download lecture notes and slides, watch recorded lectures and organise their study. This had helped them to 'explain concepts', 'reinforce[d] what they were studying' and 'gave me a better grasp on a subject'. The fifth student had used the internet for research.

Students' views on whether e-learning tools could support various aspects of learning in undergraduate science such as visualization of unobservable items, identifying misconceptions and building understanding of concepts were investigated. Responses were 'already use', 'can envisage a use', 'don't know' and 'can't envisage a use'. The students were very positive about the use of e-learning tools to support their learning. For all of the activities listed, over 85% (range: 86–100%; n=7; figure 11) of the students indicated that they or their lecturers were already using e-learning tools or that they could envisage a use for them in supporting this activity. The highest use of e-learning tools was for 'visualisation of unobservable item/process' (43%) and 'providing real world relevance' (43%). The students had not experienced e-learning tools being used to 'identify misconceptions', 'provide access to equipment or experiments', 'improving attitudes to science', improving understanding of the nature of science' or 'knowledge construction'. However, even though they had not experienced the use of e-learning tools in these contexts, at least 43% (range: 43-100%) of the students could envisage a use for e-learning tools for each activity listed.

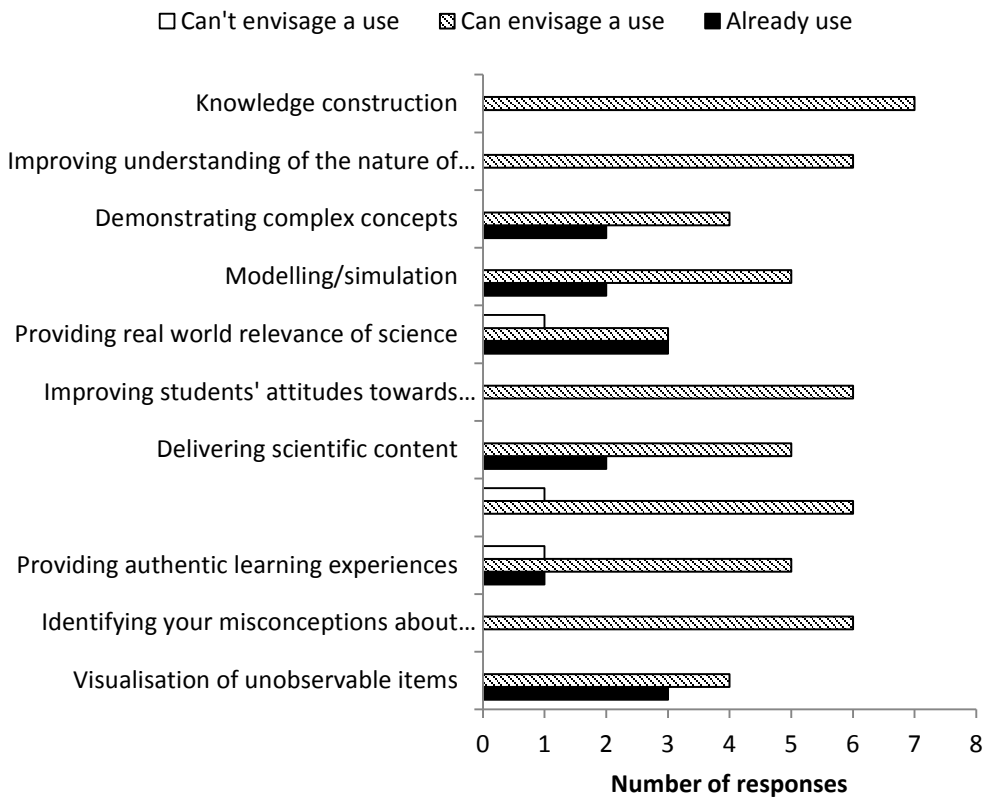

Figure 11: Student perspectives on the use of e-learning tools to support learning in science. 'Don't know' responses have been omitted for clarity. n=7.

Students were asked whether e-learning tools could support the development of various science skills such as data interpretation, ability to construct an argument and problem solving. Responses were 'already use', 'can envisage a use', 'don't know' and 'can't envisage a use'. Only for three items did one or two students (n=6; figure 12) indicate that they did not know whether e-learning tools could be used to support students' development of these skills. The highest numbers of students currently used e-learning tools for 'data interpretation' (67%) and to 'work independently' (67%). Students had not used e-learning tools for six of the skills listed. Students were less positive about the use of e-learning tools to support the development of science skills: for 18 out of the 23 science skills listed more students (range: 66 – 100%) more students could envisage role for e-learning tool than those who could not but for three of the skills listed, more students could not envisage a role for e-learning tools. All of the students were positive about the potential for e-learning tools to support' problem solving/critical thinking' even though they did not currently use e-learning tools for this activity.

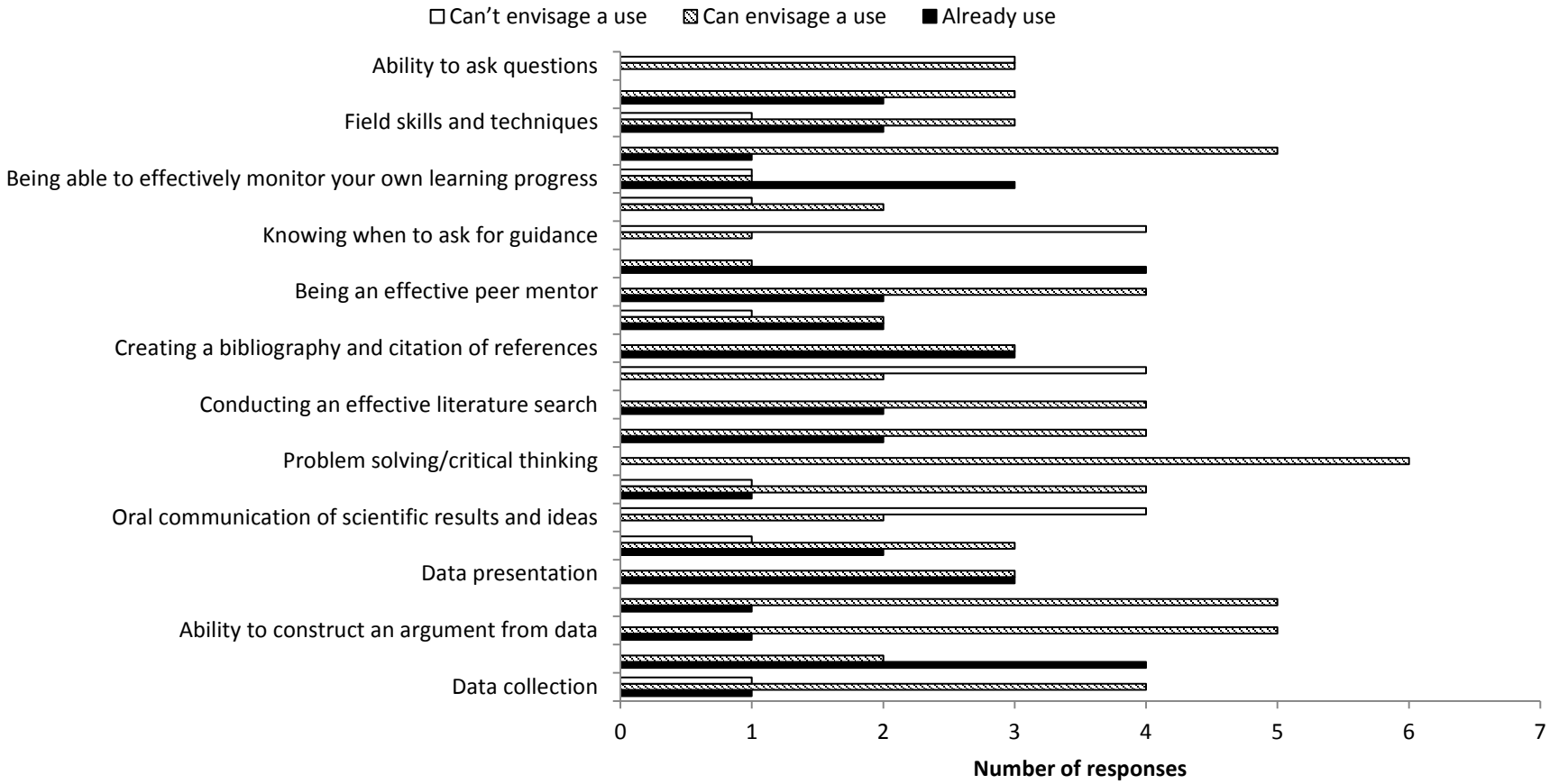

Figure 12: Student perspectives on the use of e-learning tools for science skill development. 'Don't know' responses have been omitted for clarity. n=6.

6.2.8 Student device ownership and use

More students owned a laptop than any other device (83%; n=5). Half (50%) of students owned a tablet computer and a smart phone. For all the devices more students either already used the device or were happy to use this device in their learning (range: 83–100%) than were unhappy to do so. In the last week, all (100%; n=6) of the students had taken a smart phone and most had taken a laptop (67%) into a lecture or laboratory session. Fewer had taken a tablet computer (33%).

At least one student had used their devices for each of the activities listed (range: 17–100%; n=6). The most frequent study-related activities that the devices were used for were 'internet access' (100%) and to 'read a document' (100%). The majority (83%) had 'read or sent a study-related email' but only 50% of the students had used their device to 'participate in a learning activity'. The only non-study activity for which students had used their devices was 'to read or send an instant message'. All of the students had done this. All of the students had accessed the internet during a lecture or laboratory. Just over 80% of the students (n = 6) had accessed the university's learning management system. Other popular uses included Google (67%), Facebook (33%) and Wikipedia (17%).

6.3 Student interview analysis

6.3.1 Description of student participants

The students were two males and one female. One had graduated with a Bachelor of Science (Hons) within the last 18 months and was continuing with postgraduate study at the university. One had just completed the requirements for a Bachelor of Science (Hons) and the third was in their third year of undergraduate study. The students represented a range of science disciplines: biology, geography and physics.

6.3.2 Perceptions and realities of university study

Prior to studying at the university, the students had all envisioned learning at tertiary level to be 'predominantly lecture based' (S1) supplemented by tutorials and laboratory-based activities. The learning experience would be passive:

> I suppose the…perception is that you sit in a room, people talk at you and somehow you absorb the knowledge and repeat it back (S2)

Tutorials were envisioned to involve more active learning through ‘discussion’ (S1) as were laboratory activities which would involve ‘actually poking things and playing with chemicals’ (S2). The students all agreed that when they started at the university, their expectations were largely proved correct. Variations between courses were noted as were changes in later years of study, although one student attributed these to changes that were necessary as a result of the earthquakes. Two of the students had experienced lectures previously; one took a university course whilst at high school and the other had sat in a couple of lectures with an older student. The third had developed some idea of what to expect from an older friend studying at the university.

6.3.3 Learning styles

When asked how they preferred to learn and to be taught, the students gave different responses. One preferred lectures but also enjoyed discussion-based, small group tutorials. Another student enjoyed a mixture of learning experiences but preferred lectures as they felt that hearing scientific information delivered in combination with visual material was more useful than simply reading it. In contrast, although the third student attended lectures they felt that ‘the lecture format fails me’ (S3). Describing themselves as an ‘independent’ (S3) learner, this student attended lectures but used the time to work independently on the course material:

> …because I’m bad at time managing, what I do is I go to lectures and while the lecturer is speaking I’ll write my notes or work on a problem related to the course and I’ll just not listen to the lecturer all that much…just listening to a lecturer doesn’t do it for me… (S3)

The students also suggested that students disliked participation in lectures, left their study until the last minute and that some students only did ‘what we needed to do’ (S1) and were unwilling to put in additional effort to gain higher grades. One student suggested that assignments in small chunks with deadlines was useful to keep their work on track and another thought that the pressure of knowing they could be asked to participate in a lecture made students more likely to adequately prepare for lectures.

All of the students had experienced and enjoyed discussion activities in small group settings. One thought this:

> … made it a lot more interesting and entertaining…better to have it [science content] explained by a peer rather than a lecturer (S2)

Another suggested this format 'works well because of the social impetus it puts into the course' (S3). However, participation was voluntary which meant 'classmates would just sit there…be really quiet' (S1). Whilst small group discussion was an accepted part of tutorials, answering a question in a lecture, was seen by all the students as undesirable and made them uncomfortable:

> …the awkward pauses are so long and everyone kind of shuffles and it's clear that no-one is going to answer and all they're doing is looking down at their desk and trying not to draw attention to themselves (S3)

One student suggested that this type of participation was more difficult for students who had come to university directly from high school as opposed to those who had had 'even the shortest amount of experience outside of an education setting' (S1).

6.3.4 Difficulties with learning science

Gaps in prior knowledge, recall of factual information and disorganised course material were the students' key challenges in science. Reliance on prior knowledge was an issue for understanding complex science models, particularly in second and third year:

> occasionally you would just find yourself lost with a piece of information where you just didn't have that knowledge…it may have been something that was discussed in an earlier year that you'd missed out on (S1)

The responsibility of catching up was left to the student as 'that is your job as a student' (S1). One student struggled with the requirement to 'remember this specific fact or this particular number' (S2). They preferred learning experiences that allowed them to demonstrate wider scientific understanding such as 'here's a concept, understand and explain the concept, then apply it' (S2). Another discussed the challenge of managing the large volume of material that was provided in their science courses which, coming from multiple sources, was often 'all over the place' (S3). However, navigating disorganised course material may have helped them 'to learn stuff, in a good way' (S3).

6.3.5 Blended learning definition

When asked what the term' blended learning' meant to them, the students were uncertain with one commenting, 'very little' (S3). All described blended learning as being a combination of different teaching and learning methods:

> …to me it's a combination of…lecturers telling you things and students learning for themselves and working in groups to find things out and teaching each other (S2)

None specifically included the use of technology in their definitions but when prompted agreed that the use of technology would fit within blended learning:

> …I think…the way the world works everything is on computer (S2)

When one student elaborated on their definition of blended learning, they described its purpose as aiming to 'capture most learning styles' (S1) and to 'slice things up a lot more and deliver smaller packages in terms of knowledge' (S1).

6.3.6 Experiences of blended learning

The students' experiences of online activities were mostly limited to recorded lectures, lecture notes and quizzes. One was unable to recall being engaged in any online activities other than these and in their experience the online learning environment was largely used as a means to support the management and administration of large courses:

> …it's such a large course that everything is very industrialised…you download things off [the LMS]…you upload things to [the LMS] (S3)

This student felt that physics, being skills-based, was a difficult discipline in which to incorporate online learning. Mastering these skills 'usually looks like a person sitting at a desk with writing implements' (S3).

Another student described a blended learning course that was developed, in part, to allow the course to continue following the earthquakes. The course had three elements: face-to-face and some podcasted lectures, online tutorials and an online gaming exercise. The student found the approach useful as each of the three elements provided different ways to engage with the course material. The lectures 'delivered your theoretical base' (S1), the tutorials

provided ‘practical models…the number crunching stuff’ (S1) and the gaming exercise was ‘trying to take it that little bit further into that real world exercise-type thing’ (S1). This model enabled the student to:

> …piece together your learning so that, even though…there’s that same thing being taught three times, because the third time that you have done it, you feel like you really know it (S1)

A team-based learning experience was described by the third student as an example of blended learning but it did not appear to include a specific online element. The course replaced one lecture with a group-based discussion session which the student had found beneficial. The same student had also used Slowmation software to create an animation explaining the concept within a scientific journal article. The student enjoyed the creative aspect of this activity but felt that it improved and refined their science communication skills more than their understanding of the science content of the article.

6.3.7 Perspectives on learning with technology

When asked whether the uses of technology that they had experienced within their courses helped them learn, the students had varying opinions. One was very positive and discussed a number of advantages including the online environment being ‘less lecturer driven’ (S1) and being particularly motivated by the online gaming exercise which tested their theoretical knowledge in an authentic exercise. Another benefit of working in the online environment with their peers was that it provided more immediate feedback on their learning than the lecturer feedback which was given on a limited number of occasions during the course:

> …you are all bouncing knowledge off each other and that’s quite good to see where you are placed in terms of the rest of the class…seeing areas where you are dropping the ball in terms of your knowledge…or areas where you are exceeding (S1)

Being in paid employment, this student appreciated the flexibility of online learning activities: ‘being able to watch lectures whenever I wanted…was quite good‘ (S1).

Another student admitted that they were ‘not very good on computers’ (S2) and when discussing a course that they had enjoyed which did not include much technology concluded ‘maybe that’s why I enjoyed it…it was a bit more old fashioned’ (S2). This student also found that using technology could make learning harder:

> …sometimes it can get really confusing when you are trying to tackle the technology as well as the course (S2)

Despite this they were also positive about the use of technology in their courses including lecturers' use of electronic presentations and animations and opportunities to use interactive software to practice science skills.

The third student had not experienced the use of technology within their courses beyond using the learning management system to access recorded lectures, download materials and complete online quizzes. They did not equate these activities with learning:

> I had to do online quizzes…you had to solve a problem and type the answer into the box…which wasn't really an online learning experience it was more of a filling out an online form experience (S3)

Two students were able to distinguish between courses that used technology well and those who used it poorly and described how this affected their learning. One reported that 'some courses definitely use it [technology] very well and they do motivate you to go further' (S1) but when technology was not used well courses 'become a very boring, must complete this exercise type of environment' (S1). Particularly criticised were courses which included online exercises that could be completed by other means:

> …still kind of paper-based but your teacher has become an internet resource in a paper-base rather than an engaging e-resource (S3)

'Ugly web pages' (S3) with poor presentation, dead links and information from previous courses that had not been updated were also a frustration and sent a message to students about the value of the online aspect of a course:

> '…it made me feel like…this wasn't a very important environment because it wasn't looked after by the lecturer because it was such a mess' (S3)

The students' opinions on whether using technology improved their learning outcomes were similarly varied. One thought that using technology improved their 'knowledge retention' especially where theory was linked to practical examples or activities. The second thought that technology 'sometimes' helped them to learn but that they also felt 'handicapped' (S2) by their low technological skills. The third student commented that technology had helped them learn 'pre-university' (S3). The students reported being distracted when using

technology during their independent study time, particularly when viewing long recorded lectures because it was easy to 'click on a tab and go and look at something else' (S3).

6.3.8 Student technology ownership and use

Two of the three students interviewed owned both a smart phone and laptop. One of these two also owned a tablet. These students had taken all of these devices to lectures and tutorials. One had switched from taking a laptop to a phone in the later years of their study as they felt that the smaller classes made it 'rude…to have a big old laptop on the desk' (S3). The other had used their own devices to make notes, record lectures and search the internet for information to improve understanding of the lecture material. This student had also used their smart phone and related apps for a variety of tasks: 'geo-tagging… [measuring] noise levels, walking distances, speeds…taking photos to merge together…mapping software' (S1). The third student, however, did not own any of these devices although they did have a cell phone. This student made hand written notes during lectures and felt that having a laptop or other device in a lecture 'would not make any difference' (S2). If they were required to use a particular programme it would be installed on the university computers. Otherwise they thought '…people can just use pen and paper…' (S2).

The students all agreed that students used their own devices in lectures for a variety of purposes, both course-related and otherwise. Students looked up words and concepts using Wikipedia but also viewed Facebook, watched things on the internet and sent and received text messages when bored. The students were sometimes distracted by others using technology during lectures but overall felt that it was not really a problem and was an obvious side effect of technology use:

> 'It's probably one of the harder things is to use technology as a teaching tool and not get distracted by all that other stuff you can do on it' (S1)

One student welcomed the idea of using their own devices more, one was neither positive nor negative and one said

> 'I can see it may happen….to be honest I'm not keen on it…' (S2)

One student recognised that the fact that not all students had access to these devices was a reason why their use was limited. A further limiting factor was lecturers' knowledge of the availability of technology and how they could effectively incorporate it into their teaching.

6.3.9 Skills, issues and support for students in blended learning courses

The students were all confident that they had the skills necessary to use e-learning tools successfully within a blended learning environment. Where a course required the use of a specific piece of software, the students felt that this was generally well explained and taught by their lecturers who did not make assumptions about the students' prior knowledge of such systems. More basic technological knowledge such as changing passwords, getting access to the university networks and wi-fi systems and navigating the learning management system, however, was self taught by 'trial and error' (S1) or ad hoc during courses. One student noted that 'more generalised support is lacking' (S1) and that support could be provided in a more co-ordinated way. For example, information on how to access free or student licensed software available through the university was provided in their later years of study but would have been appreciated earlier on.

The students had not encountered many issues with using technology, although all made comments about the network which had 'dead patches' (S1), slowed when overloaded, particularly when an entire tutorial or lab class was trying to work online or just 'died' (S3). For basic technological issues such as problems with passwords, printing issues and accessing systems, the students had used the help function on the LMS or contacted tech support via the library. None of the students had experienced any major issues that they were not able to solve via these routes. However, if more major problems had arisen the students thought that there was likely to be an IT department that they could contact. Finally, for pedagogical issues related to using technology for learning, the students would have initially contacted their lecturer for support and guidance although, to date, none had needed to do this.

6.4 Identification of student themes

The themes outlined below represent topics that were frequently referred to in the data or unusual findings. The themes draw largely on data collected from the student interviews.

Due to the low sample size in the survey, no themes have been developed solely from the survey data.

6.4.1 Perspectives on blended learning are influenced by experience with technology

> To be honest I'm not really keen on it [technology]. I don't intend to buy a tablet or a smart phone or anything unless I absolutely had to…I think it could become a bit of an issue if the university says you have to have it because this is how we are going to teach but not everyone wants it or has access to it (S2)

The students all had different skill levels and experiences of technology both personally and in relation to their learning and these influenced their perspectives on blended learning. Those students with more personal experience of technology, and more importantly who had experienced more innovative uses of technology in their blended courses, had greater ability to envisage uses for technology in learning and were more enthusiastic about increasing the use of technology in their courses.

6.4.2 Discomfort with interactive teaching methods

> …peer pressure is a kind of an interesting element…you have to take it [a learning activity] more seriously because you know that other people are going to see you and that they might think you're dumb if you get the answer wrong (S3)

The students were uncomfortable with teaching methods which required them to participate during learning activities yet they were aware such experiences supported their learning. The students felt more comfortable participating in small groups than making individual comments to the whole class.

6.4.3 Students' attitudes are affected by lecturer behaviours

> …when you do a course where the material is all over the place and the person has not prepared their lectures because they are doing a bumbling job….you feel as a student a kind of lethargy on the lecturer's part and so you are not so keen to engage in this (S3)

The student preferred lecturers who demonstrated passion for their subject and were organised in their teaching. The students were more prepared to engage with a lecturer when

they perceived that they the lecturers themselves had put some effort into their teaching and delivery.

6.4.4 Blended learning requires new study habits to be developed and supported

> …as it stands students have to sit down at their computers and watch a video which is really hard to do because you can just open a new tab and just go and look at something else… (S3)

Blended learning required the students to adapt and develop their study habits. This included working steadily throughout a course, learning to participate in classes and managing course material delivered both face-to-face and online. Students were confident that they had the technological skills necessary to be successful in blended courses and did not see support for learning skills as necessary. Existing support structures were focussed around technological skills.

CHAPTER SEVEN

DISCUSSION

7.1 Introduction

In this chapter, the findings from the management, lecturer and student aspects of the study are discussed with reference to the current research literature. A general discussion of the findings for each group is followed by a discussion of the key themes developed from the data.

7.2 Management discussion

7.2.1 Position within the blended learning adoption framework

The case studies examined by Graham et al. (2013) were all found to be at the same stage of adoption of blended learning for each of the three implementation categories but the authors noted that 'this may not be true of all institutions' (p.8). The university at the centre of this case study demonstrated different rates of adoption in different categories. The support category was more advanced (stage 2 - adoption/early implementation) than either of the strategy or structure categories which were both at the same stage of adoption (stage 1- awareness/exploration). Placing the university mostly at the stage of awareness and exploration of blended learning with some areas moving to adoption and early implementation was consistent with the views of the management participants:

> [The university] is probably now just getting over that very difficult chasm between the first 10%...of early adopters and the…early mainstream (M3)

For each category in the blended learning adoption framework, the stage of blended learning adoption and implementation is discussed below.

7.2.1.1 Strategy - Stage 1

In terms of issues relating to strategy, the university was at stage 1 (awareness/exploration) of the blended learning adoption framework of Graham et al. (2013). Management at the university had identified purposes for blended learning which were consistent with those in

the literature, for example enhanced pedagogy (Garrison & Kanuka, 2004), increased flexibility and access (Vaughan, 2007) and increased engagement (Garrison & Vaughan, 2013). These aligned with the institution's vision and goals and such alignment has been suggested as a central factor in the successful scaling up of blended learning (Vaughan, 2007; Owston, 2013; Moskal et al., 2013). The university had not formally adopted blended learning or produced an accepted definition of blended learning. It had, however, identified context specific purposes for blended learning in relation to the resilience required when circumstances make the physical university unavailable for face-to-face teaching and the recovery process following such events. This puts the university in a strong position since Moskal et al. (2013) have argued that using individual contexts to frame blended learning 'plays a vital role for construction of a workable definition' (p.15).

A wide range of ideas about what constitutes blended learning exist within the university in this study and teachers have implemented blended learning in their own ways, for their own reasons. Garrison and Vaughan (2013) have suggested that this is common in tertiary institutions. To date, this university has relied on the early adopters to implement blended learning (Garrison & Vaughan, 2013) and the failure to 'provide systems and environments that result in wider adoption of successful ideas' (Marshall, 2011, p.189) has limited its wider use. In consensus with recent research, management in this study suggested that in order to move from the stage of early adoption by individuals to wider implementation a more directed effort was required including stronger support mechanisms, professional development (Marshall, 2012), greater focus on preparing students for blended learning (Taylor & Newton, 2013) and institutional leadership (Moskal et al., 2013).

Management in this study acknowledged that there was an absence of strong management advocacy for blended learning which is an issue since this is has been suggested as the key to adequate resourcing (Taylor & Newton, 2013) and blended learning sustainability (Garrison & Vaughan, 2013). However, institutional advocacy for blended learning was poised to become stronger with the development of a university e-learning strategy which would focus on operational matters. The development of the strategy had been devolved to the e-learning advisory group which includes management, lecturers, students and representatives from the technical and pedagogical support units. This was a positive step since faculty have been said to be 'suspicious of top-down influences on teaching' (Moskal et al., 2013), feel that it excludes them from the design making process (Kotter and Schlesinger, 2008 as cited in Bohle Carbonell, Dailey-Herbert & Gijselaers, 2013) and are resistant to the standardisation

of blended courses which do not respond to the unique needs of their discipline (Gibbert, Probst & Davenport, 2011 as cited in Bohle Carbonell et al., 2013). In another study, engaging all stakeholders in the strategy development process identified tensions between them and resulted in a 'more realistic strategy' (Johnson & Smyth, 2011, p.211).

This university was keen to increase the use of blended approaches but did not have a specific blended or e-learning policy or implementation strategy. This was integrated into the overall learning and teaching policy under the belief that e-learning objectives, as described in the policy, 'are best when coherent with...strategic learning and teaching priorities'. The benefits of having a blended learning policy are clear. However, not having one could be signalling a move from an initial emphasis on technical infrastructure where an independent strategy might have been beneficial, to a focus on good teaching and learning practice (Anderson et al., 2006 as cited in Rosenberg, 2007). In its policy approach, therefore, the university may be signalling a new maturity in its blended learning implementation.

7.2.1.2 Structure - Stage 1

In terms of issues relating to structure, the university was at stage 1 (awareness/exploration) of the blended learning adoption framework of Graham et al. (2014). The university did not have a consistent governance process to approve or guide the implementations of blended learning and faculty used an ad hoc course design process. Bohle Carbonell (2013) suggested that this is common in universities, particularly where blended learning implementation is approached from the bottom up and left to individual staff.

Management in this study, however, questioned the continuation of this approach, instead advocating for all courses to be approved by the same process which would include appraisal by e-learning support staff. They suggested approval should be at the institutional level. However, Porter et al. (2014) found that many universities in the process of moving from early adoption to implementation had devolved this authority to the department level. This was thought to help promote acceptance at all levels of the institution (Niemic & Otte, 2010) and to allow individual departments to ensure that their blended learning courses were the most effective for their discipline (Gibbert, Probst & Davenport, 2011 as cited in Bohle Carbonell et al., 2013). In conjunction with this, the university had proposed the introduction of a team-based course design process. However, although management expressed a desire to formalise the course design process there were no indications that this would be restricted to

a specific model. Allowing such flexibility retains the freedom for academic staff to be creative in their teaching methods (Mackeogh & Fox, 2009) and to maintain control of their teaching. It also allows them to feel that they can influence direction and outcomes of blended learning (Hardaker & Singh, 2011) which is important in any implementation plan.

The university catalogue currently distinguished between courses which are taught on campus and those which were taught by distance methods but no official designation was given to those which use a blended format. Students, therefore, may be unaware of the teaching methods which will be used until they actually start a course. Management did not express any real concern about this approach but greater consideration of this issue may be required. Nearly all of the institutions moving from adoption to implementation of blended learning that were investigated by Porter et al. (2014) recommended that courses be designated as blended in the course catalogue.

Blended learning courses at the university were timetabled as for classroom-based courses meaning space may not be being maximised. The largest cost savings from blended learning are proposed to be gained from a model which reduces seat-time thereby reducing space requirements and associated operating costs (Vaughan, 2007). However, since blended learning courses at the university largely used the online environment to supplement rather than replace face-to-face sessions the space requirements of blended courses were not currently being reduced. Therefore, although cost efficiencies were not raised as important at this point in time for this university, they may be a future consideration and timetabling would need to be addressed.

The university recognised that improving the quality of blended learning was more important than its previous focus on simply increasing the number of blended courses. However, no formal institutional level blended learning evaluation process was place. Management felt that the current course survey tools, although not designed specifically for this purpose, allowed blended courses to be evaluated to some extent. A specific evaluation process should be considered since a key aspect of initiatives aiming to change pedagogical approaches and influence student learning should be ‘central data collection procedures to monitor success and inform policy on faculty development and support’ (Owston, 2013, p.2). Moskal et al. (2013) cautioned that if such data is not collected, answers to questions about student learning and staff and student satisfaction with their blended learning experiences would be ‘decided by anecdote’ (p.18).

7.2.1.3 Support - Stage 2

In terms of issues relating to support, the university was at stage 2 (adoption/early implementation) of the blended learning adoption framework of Graham et al. (2013). The existing technical infrastructure at the university was robust enough to allow blended courses to be designed and delivered by individual teachers on an ad hoc basis. A platform for blended learning through a Moodle-based learning management system and support for staff using other technologies such a lecture capture systems are provided. The technological support systems in place at this university were in line with those in the literature (e.g. Porter et al., 2014): online self-help including videos, a live helpdesk, email, instant messaging, a support request logging system and dedicated computer lab technicians. Multiple options for accessing support such as this demonstrates a higher level of system maturity (Moskal et al., 2013).

Management were also able to anticipate potential technological issues with the expansion of blended learning across the campus including the need for greater data storage and archiving capacity, the use of cloud computing and the long term capability of the wireless network. Problems with technological infrastructure have been cited as a barrier to the adoption of blended learning (e.g. Mahdizadeh, Biemans & Mulder, 2008; McConnell & Zhao, 2006 as cited in Stein et al., 2011). Ensuring that technological infrastructure is reliable and robust is a continuous, dynamic exercise requiring forward thinking and a scalability plan to ensure that systems are able to cope with the increasing load, increasing data storage demands and the rapid evolution of technology (Moskal et al., 2013; Palmer & Holt, 2009). While the university had shown awareness of these issues, a plan is needed to mitigate them (Porter et al., 2014).

Pedagogical support, which has long been identified as a 'most pressing issue' (Rosenberg, 2007, p.2), was perhaps the most developed aspect of the blended learning environment at the university. Not only were support systems in place they were being refined to better meet the professional development needs of staff using blended approaches. Institutions have struggled with the most effective and efficient way to provide this support (Taylor & Newton, 2013) and management in this study recognised that although the workshop based model of professional development is perhaps the most common in higher education it may also be the least effective approach (see also Taylor & Newton, 2013). Therefore, the university's e-learning unit had introduced a variety of options for staff beginning or advancing their blended teaching methods. These included one-on-one sessions with an advisor, electronic

self-help, a job-logging system, informal sharing sessions and drop-in lunch sessions. Adopting a more flexible model integrates formal and informal learning opportunities (Taylor & Newton, 2013) and recognises the value of peer-based learning by creating opportunities for 'natural, everyday collaborative interactions' between staff (Stein et al., 2010, p.161). Management were cognisant that the limiting factor for improvements to pedagogical support was the limited pool of e-learning advisors. Perhaps with this in mind, the university was exploring a team-based course design process which would bring together technological, pedagogical and information system knowledge to support academic staff who are developing blended courses. Such an approach has also been advocated in other studies (e.g. Taylor & Newton, 2013; Garrison & Vaughan, 2013).

Despite the university's positive and mature approach to staff pedagogical support, similar support for students, however, was lacking. Student support is advocated by a number of studies (e.g. Strayer, 2012; Dias & Diniz, 2014; Torrisi-Steel & Drew, 2013) and may be most important for low achievers who may not be as well equipped to cope with the blended environment (Owston et al., 2013) Therefore, this was a clear area which requires a more co-ordinated institutional focus. Management suggestions for student-focused pedagogical support included more online self-help and orientation sessions for new students. Students in Taylor and Newton's (2013) study agreed with these suggestions but also requested guidance on how the online resources and face-to-face session were integrated and wanted practice sessions for using different technologies.

Management recognised that incentives for staff to adopt a blended approach were a key factor in expanding the use of blended learning but no formal incentive scheme was in place. Incentives may not be important at the university's current stage of blended learning adoption since early adopters do not need incentives but they may be required for continued momentum amongst other staff who may be 'less enthusiastic' (Porter et al., 2014, p.194). Acknowledging that a lack of time was a key issue for faculty (see also Oh & Parks, 2009; Blake, 2009; Ocak, 2010), the university had begun to discuss whether workload models should distinguish between blended and face-to-face courses and whether time release to allow staff to develop blended courses could be provided. Management also suggested that greater recognition of teaching performance in promotion criteria was needed which concurs with Rosenberg's (2007) request for 'parity of esteem between teaching and research' (Rosenberg, 2007, p.9).

7.3 Management themes

7.3.1 Fit with overall institutional strategy

Management participants were uncertain about the exact fit of blended learning with overall university strategy and the extent to which it was considered a priority. Although the purposes for blended learning aligned with the goals and vision of the university in this study none of the key strategy documents, with the exception of the Learning and Teaching Plan, made specific mention of blended learning. In management's view, this made widespread blended learning implementation a challenge by making adequate investment of resources difficult (Moskal et al., 2013). However, research has suggested that not only should the purposes of blended learning align with institutional goals and priorities (Owston, 2013), the institutional goals for blended learning must align with those of faculty and students since blended learning is ultimately about their teaching and learning (Moskal et al., 2013). The importance of this was demonstrated by 'the brief history of online learning [which] is littered with the carcasses of initiatives in which gaps in understanding between administration and faculty were never satisfactorily resolved' (Moskal et al., 2013, p. 17).

The university in this study was in an unprecedented period of change following the recent earthquakes. Management saw opportunities to capitalise on this to bring about more cohesion between overall institutional goals and blended learning. For example, the university was building and remediated teaching and learning spaces and, if done appropriately, their redesign could support the interactive learning approaches at the heart of quality blended learning. Next generation learning spaces should be student-centred rather than teacher-centred (Wilson & Randall, 2012) and should be designed to facilitate small group work (Baepler et al., 2014). Research supports managements' view about the benefits of such spaces: a six year study found that not only did students in active learning classrooms outperform those in a traditional classroom, they also rated the active classroom highly on a number of other important attributes including engagement, enrichment and confidence (Baepler et al., 2014).

However, there was concern from management that the emphasis on buildings and infrastructure was not being matched by an equivalent emphasis on teaching and learning. Management were also aware of academic staff concerns that their teaching might be expected to be driven by the new teaching spaces. There was a sense that management thought this would be a positive thing. However, they were also aware that top-down

implementation and enforced changes to teaching were not welcomed by staff (Hardaker & Singh, 2011) and that if staff felt excluded from the decision making process they could refrain from action or as Hardaker and Singh put it, 'exercise[ing] their ability 'to do otherwise'' (p.230).

One management participant expressed concern about how the university would manage the overall student experience in a landscape where blended learning and, therefore, independent learning and learning off campus were increasing. Ellis and Goodyear (2010 as cited in Guiney, 2012, p.112) agreed that 'e-learning needs to be understood in relation to the whole of the student experience of learning at both course and degree level' (p.112). Student satisfaction with their university experience is thought to ensure both student retention (Roberts & Styron, 2010) and enhance the institution's reputation (Twigg, 2003). Therefore, with students having reported feeling lost, overwhelmed and alienated by technology-enabled learning (Taylor & Newton, 2013), this is indeed a key concern for any institution.

7.3.2 Adequate resourcing

Management at the university wanted to widen the use of blended learning within their organisation but they did not believe that this was being backed up by the strategic use of the university resources. Poon (2013) compelled institutions to be 'realistic about the investment of time, effort, and resources that are required for development and implementation' (p.282) and to be mindful that the necessary resources are not limited to technological infrastructure but also include the human resources needed both to develop blended learning initiatives and to provide faculty and student support services and training.

However, when committing resources to blended learning, caution should be exercised particularly in the early stages. A number of successful blended learning initiatives have involved institutions initially offering increased resources in the form of incentives, staff time and additional support staff (Garrison & Vaughan, 2013; Bohle Carbonell, 2013). This approach may create unrealistic expectations from faculty and if unsustainable, can have a negative impact on blended learning growth. This was demonstrated at a Canadian university where teachers were offered an initial funding grant to support the redesign of their courses to a blended format but very few continued to offer the blended format once the grant was finished (Garrison & Vaughan, 2013).

7.3.3 Visibility of blended learning

Management responses suggested tension between making blended learning more visible within the university to secure sufficient resources and institutional support and making it less visible so it would be seen as part of normal practice. A number of studies have advocated for strong institutional leadership with respect to blended learning (e.g. Moskal et al., 2013; Graham et al., 2013; Taylor & Newton, 2013). Ad hoc, bottom-up adoption of blended learning by enthusiastic faculty is common in universities (Garrison & Vaughan, 2013) but implementation has stalled when the policies and systems needed for wider adoption are not in place (Marshall, 2011). Therefore, raising the profile of blended learning at the institutional level provides a 'voice and influence on institutional policies and systems that an entirely informal self-organising community may not have had' (Russell, 2009, p.13). This is important with respect to gathering sufficient infrastructure and support for blended learning at the implementation stage to ensure that the key policy and infrastructure changes are instigated (Bohle Carbonell, 2013).

However, making blended learning seen as part of normal practice may increase its acceptance among academic staff. Edmondson (2008 as cited in Bohle Carbonell, 2013) agreed that only when faculty are able to 'perceive it [blended learning] as 'their way of working' will it become the new organisational routine' (p.30). Thus a more subtle approach with faculty may be an appropriate strategy. This is supported by research which suggested that faculty are resistant to changes being imposed on them (Bohle Carbonell, 2013) due to feelings of loss of control over their teaching (Mackeogh & Fox, 2009).

7.3.4 A change of pace and a positive future

As its position within the blended learning adoption framework indicated, management at the university in this study felt that the institution was poised to put infrastructure, policies and practices in place which would support the wider adoption of blended learning including the redesign of teaching spaces and the development of an e-learning strategy. A study of 11 institutions transitioning from the awareness/exploration phase of blended learning adoption framework to the adoption/early implementation phase provided recommendations for institutions' strategy, structure and support decisions during that transition (Porter et al., 2014). These included developing blended learning advocates at multiple levels within the institution, defining a blended learning structure that was flexible enough to allow adopters

the freedom to make pedagogical decisions, adequately developing infrastructure as well as technical and pedagogical training, ensuring support was ongoing and providing support for blended learning students. The wider research literature similarly agreed that these are key enablers of blended learning implementation (e.g. Graham et al., 2013; Moskal et al., 2013; Benson et al., 2011; Nanayakarra & Whiddett, 2005).

The findings of this study have shown that university level discussion of a number of these issues such as incentives, workload, blended learning course design and approval processes and student support were either in progress or were recognised as warranted. Therefore, this supports the management view that their adoption of blended learning was gaining pace.

7.4 Lecturer discussion

7.4.1 Nature and use of blended learning

In the last year, the use of blended learning at the university was high with the majority of lecturers using a blended approach in their teaching and more courses being taught using a blended approach than any other delivery method. This is in line with observations that blended learning is gaining in popularity in higher education (Torrisi-Steele & Drew, 2013) and could become the 'new traditional model' (Ross & Gage, 2006 as cited in Graham et al., 2013).

Most lecturers described their use of blended learning as 'technology-enhanced' since they largely used face-to-face instruction and incorporated the online environment only to make supplementary make course material available to students. Such use of learning technology has been described as expository use (unidirectional transmission of content to students) and is distinguished from active use (students use technology to individually explore information and solve problems) and interactive use (technology mediates human interaction and knowledge emerges from this interaction; Means, Toyama, Murphy, Bakia and Jones, 2009 as cited in Castaňo-Muňoz, Duart & Sancho-Vinuesa, 2014). Students were shown to have improved academic achievement when they used technology for interactive learning rather than individual learning (expository and active categories combined). Therefore, individual use of learning technology was not 'an effective strategy of improving learning' (Castaňo-Muňoz et al., 2014, p.157). In line with the findings of Owens (2012), therefore, although the number of blended courses at the university in this study was growing, the types of blend that were being used mean that the online environment was rarely used effectively to support

learning. The university, however, is not unusual in this respect with a number of studies reporting findings that the most common student experience of blended learning was the provision of supplementary online resources (Torrisi-Steele & Drew, 2013; Nanayakkara & Whiddett, 2005; Benson et al., 2011; Sharpe, Benfield, Roberts & Francis, 2006).

A small number of lecturers in this study, however, were engaged in more student-centred blended learning practices where they used the online environment to address different learning styles, to enable interactive face-to-face teaching approaches and to allow students to learn at their own pace. Owens' (2012) study also reported that only a few staff used blended learning environments to support specific student-centred pedagogies and Nanayakkara and Whiddett (2005) similarly described 'pockets of excellence' (p.82) within respect to blended learning practice.

Specific to science, the current use of e-learning tools to support various aspects of learning in science such as visualization of unobservable items and identifying misconceptions or the development of science process skills such as data interpretation and hypothesis testing was low. In this study the online learning environment was used most frequently by lecturers to deliver scientific content or modelling and simulation exercises. In terms of skill development technology was used most often to support students conducting a literature search or creating a bibliography. Overall, therefore, many lecturers were uncertain about the role of e-learning tools specifically in relation to science teaching and learning. However, others were generally positive about e-learning tools and were able to envisage a role for them in science education.

No other study has investigated overall blended learning use by science faculty in this way. Individual studies targeting a single aspect of learning in science have, however, demonstrated that blended learning can be effective in supporting, for example, understanding of difficult scientific concepts and problem solving (He et al., 2012), understanding of the relevance of science (Wolter, Lundeberg & Bergland, 2013) and development of laboratory skills (Crandall et al., 2015). Therefore, blended learning has the potential to be used in more ways than it is currently used by the lecturers in this study.

7.4.2 Perspectives on blended learning

Survey respondents in this study were directed to consider blended learning as the integration of face-to-face and online learning environments. During the interviews, however, when

asked about their understanding of the term ‘blended learning’, it became clear that lecturers did not necessarily include the use of technology in their conceptions of blended learning. Instead they took a wider view, considering blended learning as incorporating a range of teaching methods and tools or media in order to address a range of learning styles. The lecturers did not view their use of blended learning as ‘new’; they had used such approaches throughout their careers but more recently this had begun to include the use of technology. A similar view of blended learning as more than just the incorporation of technology into teaching was also held by staff in the study of Benson et al. (2011). Their conclusion that blended learning was not ‘uniformly understood by staff’ (p.147) could also be drawn here. Following the discussion of blended learning definitions, all participants understood that, in the context of this study, blended learning was taken to mean the integration of face-to-face and online learning environments.

As in other studies (e.g. Reed, 2014; Stein et al., 2011) lecturers were on the whole positive about blended learning. They showed equal preference for both blended and face-to-face teaching methods and were able to see uses for the online environment to support both general and science specific aspects of learning as well as scientific skill development, even if they did not currently use e-learning tools for these activities. However, they were less positive about the influence of the online learning environment on other factors affecting student learning. Two issues that were raised on multiple occasions were that online learning reduced student engagement and attendance at face-to-face lectures. The literature, however, has generally reported that blended learning increases student engagement (Torrisi-Steele & Drew, 2013; González, 2012; Owens, 2012). Student engagement in this study was perhaps perceived differently being linked to students’ study behaviours (for example their presence in classes) rather than their ‘cognitive investment in, active participation in and emotional commitment to their learning’ (Chapman, 2003 as cited in Zepke, Leach & Butler, 2014, p.387). For example, lecturers commented that students lacked the learning skills to work independently or invest quality time when learning online. In this case, research would be in agreement (e.g. Taylor & Newton, 2013; González, 2012). An interesting, related finding in this study was that lecturers felt that a blended environment makes learning more enjoyable even though they disagreed that it makes students more motivated or facilitated higher grades – both of which have been linked to student blended course satisfaction (Owston et al., 2013). With respect to online lectures reducing attendance, a study of health and life sciences faculty (Reed, 2014) also revealed that faculty felt that they negatively impacted on class

attendance. However, a number of studies have demonstrated that this is in fact not the case (Osgerby, 2013; Toppin, 2010 as cited in Reed, 2014). The more important question is whether students' learning is improved.

Lecturers were uncertain about the wider influence of blended learning in tertiary education such as its role in student retention or employability or its wider role in science education such as improving students' attitudes to science or their understanding of the nature of science. A less explored aspect of the blended learning literature, staff perceptions of the wider role of blended learning is an area which could benefit from further discussion amongst staff and research since it influences their conceptions of blended learning and, as discussed later, this has been linked to more effective use of blended environments. Although small in number, studies have suggested that a blended approach has a role to play in developing this aspect of scientific thinking (Mackinven, 2011). For example, Duda and Garrett (2008) demonstrated that the use of a blog within an undergraduate physics lab allowed students to see the real-world relevance of physics and maintained their positive attitude towards the subject while the attitudes of those not involved in the blog deteriorated. In addition, discussions of news articles using Facebook improved the understanding of the nature of science in high school science students (Huang, Wu, She & Lin, 2014).

7.4.3 Barriers to blended learning adoption

The main barriers to using blended learning raised in this study were consistent with those frequently reported in the literature: a lack of time, a lack of technical skills and a failure to see any pay off in lecturers' courses.

The increased time commitment required to design and teach blended courses has been regarded as the 'number one challenge' for faculty (Vaughan, 2007, p.87). A lack of time has been reported in many studies (e.g. Nanayakkara & Whiddett, 2005; Benson et al., 2011; Owens, 2012) including one by Reed (2014) where over 60% of health and life sciences staff indicated a lack of time was preventing them from engaging with blended learning to a greater level. Furthermore, Garrison and Vaughan (2013) commented that 'it is unrealistic to ask most faculty members to participate in these activities [blended learning initiatives] without release time and/or resources such as a teaching assistant' (p.26). Although there has been no quantification of actual hours involved in blended learning, faculty perceived that it

increased their workload and like the lecturers in this study, felt that this was not taken into consideration by university workload models (Tynan, Ryan & Lamont-Mills, 2015).

Tertiary teaching staff also commonly claim a lack of technical skills and confidence with technology: Nanayakkara and Whiddett (2005) found that 60% of their respondents felt that they lacked the knowledge to develop and deliver content in a blended environment despite many having attended professional development training. Staff in Reed's (2014) study ranked a lack of skills as the second most important barrier to their use of blended learning. Reed's (2014) study also showed that the number of staff identifying a lack of skills aligned closely to the number of staff identifying a need for greater support and training. In contrast, in this study more lecturers identified a lack of technical skills as a barrier to their adoption of blended learning than those who identified a lack of support for developing these skills. A similar but more pronounced pattern was seen for instructional design skills and instructional design support. This suggests that it was not a lack of support which is preventing lecturers in this study from developing their blended learning skills but something else, possibly a lack of time.

A failure to see any pay off in their courses was also discouraging lecturers in this study from adopting blended learning methods which agrees with research suggesting that 'most academic staff seek some form of positive impact from embracing technology supporting learning and teaching' (Benson et al., 2011, p.150). A bad experience has prevented teachers engaging meaningfully with e-learning resources - even if they had done so in the past (González, 2012). One lecturer in this study identified with this; having previously used a flipped approach and experienced such strong student resistance to it, they were considering returning to a traditional lecture format. It would be interesting to understand more about how the lecturers in this study perceive and measure 'pay off in their courses' and whether they were considering it from the perspective of improved student learning outcomes and satisfaction or more from increased efficiencies and comfort with their own practice.

Some of the lecturers indicated that the evaluation tools employed by this university were designed for face-to-face courses and therefore unsuitable for assessing blended approaches. This forced them to develop their own ad hoc evaluation methods. Effective evaluation mechanisms during the implementation of blended learning are thought to be of critical importance (Graham et al., 2013). Furthermore, the ability to determine whether changes in practice have positive effects on student experiences and achievement also encourages teachers to reflect on and subsequently improve their practice (Scott, 2014).

Barriers to blended learning adoption such as financial incentives or greater recognition for teaching that are frequently cited in the literature (e.g. Nanayakkara & Whiddett, 2005; Reed, 2014; Rosenberg, 2007) were not viewed by lecturers in this study to be significant barriers to their use of blended learning. Although not indicating it as a barrier as such, the interviewed lecturers in this study did discuss how multiple pressures on their time and the emphasis on research in terms of recognition and promotion made prioritising their teaching more difficult.

Most significantly for this study, a number of lecturers commented that they were unable to see how technology supported the teaching approaches needed for their science subject. They also questioned whether research evidence had definitively shown that blended learning improved learning outcomes for students. Harwood (2004) wrote that 'it is a surprise for....science faculty to discover that there is a solid research body in education...some science faculty believe that there is little or no body of knowledge and that they need to develop their own' (p.61). However, whilst there is a growing body of research on blended learning in general, there is some support for the lecturers' views as there is a lack of in-depth research on science specific blended learning approaches. Most science-based studies have tended to be descriptive or have involved the evaluation of a single blended learning technique as it is introduced into a single or small number of courses (e.g. de Fátima Wardenski, Espíndola, Struchiner & Gianella, 2013; Dantas & Kemm, 2008; Lewis & Harrison, 2012). Despite this, conclusions from research where discipline has been considered do provide evidence for the need to consider subject matter when evaluating the suitability of teaching approaches involving the use of technology. For example, Arbaugh et al. (2010) presented findings suggesting that the Community of Inquiry framework may be more suitable for applied rather than pure, hard disciplines since its assumption of a 'constructivist approach to teaching and learning may not align with the cumulative, instructor oriented approaches particularly associated with hard, pure disciplines' (p.43). Therefore, in-depth discipline specific blended learning studies are warranted.

7.5 Lecturer themes

7.5.1 Pedagogy first

Encouragingly for the adoption of blended learning at this university, lecturers already placed strong emphasis on good pedagogy and it underpinned their course design. However,

whilst pedagogy was clearly important to all lecturers their attitude towards and their use of the online environment within blended courses clearly differed. Most saw pedagogy as more important than the need for technology and as no substitute for face-to-face teaching, which tended to limit their use of technology to information sharing. This was described as the 'bolt-on' perspective by Benson et al. (2011, p. 151). Survey respondents voicing this view also indicated that although the online environment could complement and re-enforce the learning taking place in the face-to-face environment it could not replace it. Yuen (2011) concluded that the belief that learning only happened in the face-to-face environment was associated with using online learning environments to 'enhanc[e] course management' (p.3). For the lecturers in this study, their attraction to the face-to-face lecture environment was that it allowed lecturer-student interaction, enabling them to add expression to their lecture delivery or to receive immediate feedback to gauge student understanding. The enduring 'centrality of the lecture' (McConnell & Zhao, 2006 as cited in Stein et al., 2011, p.148) even in teachers' conceptions of e-learning demonstrated how the face-to-face lecture is 'deeply embedded in how university teachers conceptualise good educational environments' (p.148). Furthermore, lectures may also be seen by lecturers as a symbol of their role and authority (McShane, 2004) which blended learning challenges.

Interestingly, the 'bolt-on' lecturers in this study discussed aspects of what they considered to be good pedagogy largely in reference to either the traditional lecture environment or the online environment. They did not seem to think that a particular pedagogical approach could to be facilitated by both the face-to-face learning environment and the online learning environment or a combination of the two. Therefore, although student-lecturer interaction was seen as the key advantage of the face-to-face environment, the general view was that the online environment was unable to support quality interaction even through the use of tools such as synchronous video conferencing. This is in contrast to the findings of Lawrence and Lentle-Keenan (2013) who noted that 'communicating and connecting with students…were than main pedagogical drivers for teachers to use technology' (p.19) and also to the blended learning research evidence which has demonstrated, for example, that 'the most significant positive outcome [for students] was the quantity and quality of interaction with both fellow students and the instructor' (Garrison et al., 2013, p.26). Therefore, for some lecturers in this study there seemed to be a missing link between their perceptions of effective pedagogy and the ability of blended learning environments to enable these pedagogies that support collaborative learning.

In contrast, the interviewed lecturers outlined how their planning began with the learning outcomes or skills to be developed during a course, then the contexts that would be relevant and interesting to their students. Only after this did they consider the learning environments which would best support their chosen approach and how the face-to-face and online elements of the course could be integrated. These lecturers were described in Benson et al.'s (2011) study as 'purely pedagogic' (p.151); happy to embrace technology but only if it supported the pedagogies they felt were optimal in a given situation. For example, two lecturers had purposefully developed blended courses that would enhance lecturer-student interaction and learning beyond that of the traditional lecture. They used online pre-recorded lectures to free up lecture time for more student-centred learning such as team-based and problem-solving learning activities. Research would support this approach: students in flipped classrooms have been shown to do better in their final exams (Williams, Brosi & O'Dowd, 2013; Lewis & Harrison, 2012; McFarlin, 2008), and also to rate the courses highly (Williams et al., 2013). This increased success has been attributed to the self-paced nature of blended learning, enabling student control of the learning process (Lewis & Harrison, 2012) and 'interaction that is not typically possible in a large classroom setting' (McFarlin, 2008, p.90). Furthermore, the social interaction in a flipped physics classroom was thought to contribute to improvements in students' conceptual understanding (Dori & Belcher, 2005 as cited in Baepler et al., 2014).

Understanding such differential useage of blended learning following its initial adoption is complex and an area prime for further research. Despite research (see Torrisi-Steele & Drew, 2013 for review) indicating that effective practices in blended learning are constructivist and student-centred, 'university lecturers have generally failed to develop teaching practices that promote interactive practices in online learning environment'(Owens, 2012, p. 395). In agreement with this, the lecturers in this study were similarly concerned with ensuring that their teaching approaches were based on good pedagogy but the majority were still using traditional, teacher-centred teaching methods and were not exploiting the full potential of the online environment. Research has suggested that teachers' pedagogical beliefs and conceptions are linked to both their adoption of blended learning and the effectiveness of the blend they choose (e.g. Ellis et al., 2009; González, 2009, 2012; Benson et al., 2011; Owens, 2012). Those with teacher-centred views of teaching conceived online learning as a means to support transmission of information to students while those with student-centred views conceived it as a means to engage students in tasks that would support their learning

(González, 2009, Torrisi-Steele & Drew, 2013; Owens, 2012). This was demonstrated in a New Zealand study which identified 'teaching beliefs, experience and practice' as overarching influences on the uptake of web-based technology for teaching in tertiary institutions (Lawrence & Lentle-Keenan, 2013). However, Owens (2012) discovered that 'lecturers may profess to hold particular...beliefs but fail to enact these beliefs in their online teaching practice' (p.393). Relevant to this study, the biggest difference between beliefs and practice was for 'interactive teaching'. Although lecturers rated interactive teaching as essential for learning, their practice showed that facilitating student interaction online was the 'thing they were least likely to do' (Owens, 2012, p.395). Widespread adoption of blended learning, therefore, requires 'a shift in tutor culture' (Luchoomum et al., 2010, p. 27 as cited in Torrisi-Steele & Drew, 2013) which was also suggested by lecturers in this study. This might be achieved through professional development: Salter (2006, as cited in Torrisi-Steele & Drew, 2013) wrote that in the absence of professional development, the introduction of technology does little more than 'replicate existing practice in an online environment' (p.717).

Lecturers in this study discussed feeling compromised in their chosen teaching methodologies by the wider university environment. A significant factor was the lack of teaching spaces more suited to interactive learning activities. Large lecture halls with fixed seating in rows are found to make peer collaboration awkward (Baepler et al., 2014). Innovative and creative 'next generation teaching spaces' (Wilson & Randall, 2012, p.1) which support the flexibility and student-centred teaching approaches are needed. As well as supporting staff already using blended or interactive teaching approaches, the introduction of next generation learning spaces was suggested by one lecturer in this study as potential encouragement for other lecturers to trial new teaching methodologies. Wilson and Randall (2012) agreed with this, finding that participants teaching in student-centred teaching rooms had increased self-reflection about their teaching which made them recognise that a widening number of teaching approaches were now possible and had prompted them to consider re-designing their subjects to better utilise the rooms.

7.5.2 Student culture and expectations

Lecturers thought that students expected to use technology in their learning and that they wanted to be able to access learning material from anywhere. This aligns with current

research: students have been shown to appreciate the flexibility of delivery that a blended format offers both in terms of anytime access but also in terms of choosing the pace of their learning (Taylor & Newton, 2013; Kim, 2012). Lecturers in this study also thought that students used technology more often for administrative activities such as locating resources than to directly support learning. This was confirmed by Henderson et al. (2015) who concluded that students used technology to support the 'logistics' (p.9) of university study such as accessing resources, course information and schedules and submitting assignments rather than using technology for activities 'directly related to learning *per se*' (p.9). However, given that the majority of lecturers in this and other studies used a model of blended learning which incorporates the online environment only as a resource repository this was not unexpected.

Many lecturers in this study agreed that students preferred face-to-face lectures to online ones. They were, however, less certain about students' preference for face-to-face or online tutorials and labs. Hood (2013) found that psychology students' intentions to attend face-to-face or online lectures is positively associated with their intentions to attend tutorials delivered in the same format, suggesting a preference for one mode of access. This was supported by a study of students' use of optional learning resources (live lectures, online lectures and a study support centre) which showed that students were more likely to be heavy users of one type of resource (Inglis, Palipana, Trenholm & Ward, 2012).

However, despite agreeing that students expected to use technology in their tertiary studies and that they owned and used a variety of devices for a variety of tasks within their learning, lecturers in this study also viewed the major challenges of using a blended approach as being student-related. They suggested that students lacked responsibility for their own learning, expected lecturers to provide motivation and interest in their courses, resisted active participation during discussions and would prefer to work hard only in preparation for a final exam. This is unusual since student-related factors are not commonly cited as a barrier to blended learning. A few studies have made brief mention of student characteristics such as ability and willingness to use technology (González, 2012) or student practice and culture (Yuen, 2011) but without further elaboration. This is supported by Wright, Sunal and Day (2004) who noted 'students are ranked less often as a barrier' (p.41). In this study, however, lecturers perceived a lack of student motivation, low engagement, reduced attendance and poor learning skills as key issues. The sense that these issues were preventing lecturers in this study from trying new blended approaches was supported by a study exploring the

origins of student resistance. This suggested that student resistance should be viewed as 'student barriers' (Seidel & Tanner, 2013, p.590) with respect to its impact on teachers trying to adopt more innovative teaching approaches and that it should be considered alongside more traditional barriers such as lack of training and lack of time.

Student engagement is an enduring and complex issue in tertiary education (Kuh, 2009 as cited in Zepke et al., 2014; Zepke et al., 2014). It is thought to be influenced not only by student factors such as motivation, competency and autonomy but also by teacher factors such as being welcoming, supportive and facilitating interaction (Zepke et al., 2014). Therefore, although student engagement is cited by lecturers in this study as an issue for their teaching, they too have a role to play in ensuring the learning environment facilitates student engagement (Parkinson et al., 2011). Faculty, however, may be unaware of the importance of their behaviour to students (Zepke et al., 2014). Blended learning with its focus on active learning, student-teacher interaction, collaboration (Zepke et al., 2014) is proposed as the ideal learning environment to promote engagement (Garrison & Kanuka, 2004; Vaughan, 2007) and studies have demonstrated its positive impact in this respect (e.g. Owston et al., 2013; Gebre et al., 2013). However, if teachers are using ineffective blends (Owens, 2012) whilst continuing traditional face-to-face lectures, then effective student engagement may suffer.

With the exception of contacting a lecturer by email, lecturers surveyed in this study were divided about whether students had the necessary skills to use learn effectively with technology. The interviews revealed that although lecturers felt that students had the technological skills and familiarity to be able to navigate the learning management system and to 'click buttons' but they lacked the learning skills to use e-learning materials and activities in a way that supports or enables them to learn. A similar conclusion has been drawn in other studies (e.g. Henderson et al., 2015) and research advises caution with overestimating students' technological abilities since one study reported that some did have difficulty navigating technology and admitted feeling alienated or overwhelmed by it (Taylor & Newton, 2013). The literature further suggests that support is needed, for example, to reduce students' reliance on teacher-led learning (Torrisi-Steele & Drew, 2012) and to learn the meta-cognitive skills required to succeed in blended environments (Lust, Vandewaetere, Ceulemans, Elen & Clarebout, 2011 as cited in Torrisi-Steele & Drew, 2012).

Lecturers who used active learning tasks as part of their blended approach found that students were resistant to taking part in such tasks particularly those involving collaboration

with their peers. In one flipped classroom described in this study, student dissatisfaction with the course was high. This was not the result of poor student achievement but was directed at the learning environment itself. Missildine, Fountain, Summers and Gosselin (2013) and Lancaster, McQueeney and Van Amburg (2011) reported similar findings: that blended learning approaches involving interactive classroom activities 'can result in improved learning but not necessarily improved student satisfaction' (Missildine et al., 2013, p.597). Dissatisfaction with these courses was attributed, in part, to students' unfamiliarity with the learning approach (Lancaster et al., 2011) or due to them not 'perceiv[ing] the value of interactive learning approaches' (Missildine et al., 2013, p.599). In this study, a large part of the student resistance to interactive learning tasks was attributed to their unwillingness to participate in collaborative, large face-to-face discussions. This aligns with the findings of Strayer (2012) who described students as having a 'love/hate relationship with activity in the classroom' (p.188).

Students' perceptions and expectations of tertiary study were suggested by lecturers in this study to be the root cause of many student-related challenges. Resistance arose when teaching and learning approaches did not conform to their expectations. Strayer (2012) again drew similar conclusions; 'students in the inverted [blended] classroom likely felt that...the learning environment was not meeting their expectations' (p.180). It is known that student expectations of tertiary study are important (Alves & Rapoos, 2007 as cited in Zepke et al., 2014). They are also 'unrealistic' (Darlaston-Jones et al., 2003 as cited in Zepke et al., 2014). Although not specific to blended learning, an Australian survey revealed that 60% of students felt unprepared for university study and in the US it was found that 'a serious mismatch existed between students learning habits and the habits expected of them at university' (McCarthy & Kuh, 2006 as cited in Brinkworth, McCann, Matthews & Nordstrom, 2009, p.158). For lecturers in this study, students' expectations of tertiary study were of the traditional passive model. Blended learning, therefore, is not what students expected from their university courses and even more so blended learning which used student-centred teaching approaches and demanded participation. Key to a successful transition into undergraduate study is the ability of students to develop autonomy and to take more responsibility for their own learning than they expected (Nicholson, Putwain, Connors & Hornby-Atkinson, 2013). This requires lecturers to convey this shift and to rapidly put supports in place to enable it to happen (Brinkworth et al., 2009). Developing students' expectations prior to entering university via blended learning modules has been shown to

give high school students a better understanding of the personal and academic skills needed to learn effectively at tertiary level and 'helped debunk conventions of dusty lecture theatres' (Harnisch & Taylor-Murison, 2012, p.408).

As more students arrive at universities with effective learning experiences using 'blended' approaches to learning, these students are more likely to demand collaborative e-learning opportunities. That is, they will have higher expectations of participation in e-learning. Lecturers mentioned in their interviews that some students arrived at this university with having experienced a greater range of uses of technology to support their learning than was provided in their undergraduate courses.

7.5.3 The influence of science as a discipline

Lecturers' current use of e-learning tools for science-related teaching and learning and science process skill development was lower than their use of such tools for course administration and management-related activities. However, many could see the potential for such tools in undergraduate science education. Both students and teachers are found to consider learning generic process science skills such as data interpretation, experimental design and scientific writing skills important (Leggett et al., 2004). Lecturers in this study, however, were uncertain as to the role of e-learning tools in supporting such science skill development; they were thought to be helpful to assist students to create literature searches and bibliography/references but less so for the development of core skills such as problem solving, critical thinking and designing hypotheses and experiments. Again there are individual studies documenting the successful integration of technology to assist students to learn science process skills, e.g. scientific report writing (Neuman & Hood, 2009) but there is a lack of tertiary level science-specific research in this area. However, the potential for blended learning to support science skill development has been suggested in studies conducted in other disciplines and education levels, for example supporting critical thinking (Shen, 2010), evaluation skills (Wegerif, 2002) and data analysis (Brunsell & Horejsi, 2011).

A key finding for this study, therefore, is that science as a discipline influences the adoption and implementation of blended learning. As recognised by the lecturers in this study, science content is 'inherently complex, highly abstract' (Tibbell & Rundgren, 2010, p.25) with the additional complications of domain specific language and issues with visualisation (Tibbell & Rundgren, 2010). As suggested by one lecturer in this study, the problem was amplified in

interdisciplinary subjects, for example molecular biology and biochemistry, which involve knowledge of, and blur the boundaries between, the traditionally separate subjects of chemistry, biology and physics (Tibbell & Rundgren, 2010). To further complicate matters, science undergraduates also need to acquire science process skills. These are often not explicitly taught but are connected to understanding science content, scientific ways of thinking and academic success (Coil et al., 2010).

Research, however, has suggested that technology also has affordances which support teaching and learning in science because of its inherent complexity and that blended learning offers lecturer opportunities to include innovative pedagogies and technologies in their teaching. For example, the molecular sciences involve 'complex, interacting, aperceptual substances and processes' (Rundgren & Tibbell, 2010) and the learning of key concepts is often supported by 2D visual representations and models. Technology, however, enables the development of 3D models and visualisations which can be manipulated and animated. The combination of 2D diagrams and 3D animations has been shown to reduce students' misinterpretations and support them to achieve multiple learning goals (Rundgren & Tibbell, 2010) particularly conceptual understanding. Extending this, an experience almost entirely specific to undergraduate science learning is involvement laboratory sessions where students' experience 'hands-on' science. Lecturers in this study frequently raised concern that such hands-on activities must be retained within science courses. Some studies have demonstrated that technology-enabled laboratory experiences can be as or more effective that real ones, for example virtual laboratory activities (Finkelstein et al., 2005), remote access to experimental equipment (Pratap & Salah, 2004) and in the development of field skills (Ramasundaram, Grunwald, Mangeot, Comerford & Bliss, 2005). However, the combination of virtual and hands-on laboratory activities has also been demonstrated to be effective: students who experienced a virtual DNA gel-electrophoresis activity prior to a hands-on version were able to first learn basic skills and concepts before applying them for knowledge synthesis in the more complicated hands-on version (Toth et al., 2014). Similar success was seen when students used virtual laboratory activities to prepare for hands-on histology labs (Lovell & Vignare, 2009) and physiology labs (Dantas & Kemm, 2008). Therefore, extending the blended experience to pre-learning skills and concepts prior to laboratory activities and tutorials (He et al., 2012) may also benefit student learning whilst maintaining the hands-on science experience necessary to develop relevant practical skills and reinforce conceptual understanding.

7.5.4 The ‘island effect’

The implementation of blended learning by individual staff at the university has created a patchwork environment in which courses taking a blended or innovative approach are in the minority amongst courses which largely still follow a traditional model of delivery. Effectively this has created what one lecturer described as the ‘island effect’ where the isolation of such courses and their alternative approach presents a challenge for students. Issues of inconsistency between blended courses has previously been raised by students (Sharpe, Benfield & Francis, 2006) and have been reported as a result of various institutional attempts at obtaining sustainable blended learning adoption (Newton, 2003 as cited in Sharpe, Benfield & Francis, 2006). However, the consequences of such patchy implementation from the perspective of teachers and students appears not to have been fully investigated.

This study revealed that a number of factors contributed to the development of the island effect: the combination of the absence of blended learning strategy and the resulting ad hoc, bottom-up approach to blended learning adoption and implementation in this university meant that lecturers were able to choose the extent to which they use adopt blended learning approaches. Blended learning in the absence of overarching university strategy has led to institutions relying on the early adopters (Garrison & Vaughan, 2013) and produced what Nanayakkara and Whiddett (2005) described as ‘random acts of progress’ (p.182). Furthermore, Graham et al. (2013) have suggested that universities who have not officially adopted a blended learning approach are not likely to know the extent to which blended learning has been adopted institution wide’ (p.4). The ‘island effect’ demonstrates the risk in this strategy and suggests that sufficient momentum of adoption and implementation is required to provide at least some consistency of experience for students. Otherwise the early adopters may decide not to continue with their blended courses and would be less likely to develop further innovations in using these approaches as well.

The science model of large, team-taught undergraduate science courses in large lecture theatres was also a contributing factor to the ‘island effect’. Large class sizes, of up to 200 students, were mainly an issue in first year and are known to have their associated challenges: low attendance, lack of student preparedness, low engagement and little opportunity of active learning or feedback (Walker, Cotner, Baepler & Decker, 2008). The seating arrangement in large traditional lecture theatres is also not conducive to interactive

learning (Baepler et al., 2014). It is not surprising, therefore, that lecturers in this study who believed in more interactive, student-centred teaching approaches made compromises with their first year courses and felt forced to adopt more traditional approaches. Furthermore, lecturers were also aware that this created a knock-on issue in subsequent years because students' expectations of tertiary learning and teaching were developed during their first year. Following a more traditional delivery style in first year, therefore, meant that when the students moved into smaller classes in second and third year courses which included interactive and problem-solving sessions they were unprepared and unwilling to engage. The first year of undergraduate study is recognised as 'an important period in determining students' commitment to learning' (Huon et al., 2007 as cited in López-Pérez, Pérez-López, Rodriguez-Ariza & Argente-Linares, 2013, p. 626) and supporting their transition from high school is a key focus for universities (Harnisch & Taylor-Murison, 2012). It has been recently demonstrated, however, that a blended approach can be effective in large science lecture classes either by using the online environment to prepare students for lectures (Moravec, Williams, Aquilar-Rocar, & O'Dowd, 2010) or using a flipped classroom approach that split the large classes into smaller groups which participated in an interactive learning session on a rotational basis (Mackenzie et al., 2013).

The team teaching approach taken in many undergraduate science courses at this university requires some level of consensus on a teaching approach between the multiple lecturers in the course. This resulted in a partial blended approach being adopted for the sections where lecturers were willing. If there was no agreement on approach, this potentially created further fragmentation of the teaching and resulted in blended 'islands' within courses. In this study, 'team teaching' was described as the sequential teaching of different sections of a course by different lecturers. The majority of research into team teaching or co-teaching has mainly been studied in the context of student teachers co-teach with an experienced teacher, interdisciplinary teams of lecturers, such as scientists and social scientists or artists or has involved teachers being co-present during a course. There are very few that have related to a blended learning environment within a single course. However, there are findings relevant to this study: studies have shown that co-teaching is an effective means to develop the skills of student teachers (Henderson, Beach & Famiano, 2006) and one suggested that team teaching (co-present) in health subjects may be effective for professional development due to the reflective interactions taking place between the teachers in the team and the impact of these on practice (Crow & Smith, 2005).

The cultural expectations of students (see section 5.6.2, this chapter) were a significant contributor to the 'island effect' described in this study. Lecturers, however, also recognised that their own culture combined with a lack of incentives for blended learning had a role to play in perpetuating students' expectations: the most common teaching approach in undergraduate science at university was still the passive, traditional model. However, by continuing to follow this model, lecturers were adapting to student expectations and failing to help students adapt to what might be more effective teaching methods. The largely limited use of technology and the online learning environment even though termed 'blended learning' did not change this model. Nor did the use of recorded lectures which were simply a repeat of face-to-face lectures. One lecturer commented that these blended models failed to make the most effective use of the face-to-face contact time between lecturers and students – which both highly valued. For them, only when face-to-face aspect of blended courses were used for more active learning activities would the dominant model change to one of interactive, collaborative learning. Then students would become more comfortable with blended learning and able to engage with it fully. This was echoed by McKenzie et al. (2013) who wrote: 'online delivery is particularly suited to content dissemination...the power of face-to-face is...build[ing] upon prior knowledge...it seems logical to use online learning to prepare all the students for the valuable face-to-face opportunity' (p. 116).

7.6 Student discussion

7.6.1 Nature and use of blended learning

In the last year, the number of students in this study who had experienced blended learning in their courses was less than those who had experienced fully face-to-face or online courses. This is in contrast to reports that blended courses are becoming the most common with tertiary education (Torrisi-Steele & Drew, 2013). However, students in this study may have been confused about different course formats.

The students currently used e-learning tools frequently and for a wide range of tasks including administrative tasks such as submitting assignments, organising their learning and finding information as well as learning oriented tasks such as reinforcing knowledge and watching recorded lectures. As well as using e-learning tools to work independently, high numbers of students also used them for collaboration both inside and outside of the classroom. Research has suggested that students' use technology more frequently to allow

them to manage their university experience than to support their learning (Henderson, et al., 2015). It would be useful to explore, therefore, how students were using e-learning tools for these tasks. For example, when using e-learning tools to 'work collaboratively with peers outside the classroom' the students could have been using the tools just to co-ordinate the collaboration as was found by Osgerby (2013) or they could have been using them to support the knowledge building processes of the collaboration.

In line with Staples (2004), whose student participants described science as 'a vast body of knowledge' and 'a challenge' (p.363), students in this study reported that they found learning in science difficult because of the volume of content and difficulty of understanding new concepts but also because teaching did not always match their learning style. Specific to science, the students were positive about a role for e-learning tools to support both learning in science and the development of scientific skills and reported that they, or their lecturers, currently used e-learning tools for a number of activities associated with science learning and skill development. Although the frequency of this was low, the majority of students could envisage a greater role for e-learning tools. This is a unique finding as although students' views on the importance of science learning and skills have been investigated (Leggett et al., 2004), the use of e-learning tools to support their development has not been explored.

Cochrane and Bateman (2010) reported that 'the majority of our students now own at least a camera phone capable of mobile blogging, recording and uploading video to *YouTube*, email, and browsing the Internet' (Cochrane & Bateman, 2010, p.1). Students in this study also owned a number of devices including smart phones and tablets. They used these during lectures for both course related activities such as taking notes, recording lectures and looking up science vocabulary as well as non-course related activities such as sending text messages, looking at Facebook or watching online videos. Most use of devices during lectures was personal use and one student was frustrated that there was not more use of computers and smart phones in formal learning activities but thought this might be a matter of equity. Witjmans, van Rens and van Muijlwijk-Koezen (2014) demonstrated that use of students' own devices in large chemistry lectures can increase interaction. As well as using smart phones, laptops and tablets to complete quizzes before lectures, students also used them in class to engage in multiple choice 'polling' questions, to answer open ended questions which only the lecturer could see but could then incorporate into their lecture and to download 3D visualisations of molecules for in-class activities. The students were positive about the

approach, particularly valuing the anonymity of participation and that it made then think about things they had not themselves thought relevant (Witjmans et al., 2014).

7.6.2 Perspectives on blended learning

Survey respondents in this study were directed to consider blended learning as the integration of face-to-face and online learning environments. During the interviews, however, it became clear that students were uncertain as to what the term 'blended learning' meant. They described blended learning as being a combination of different teaching and learning methods. None specifically included mention of technology but when prompted it seemed that, for them, it went without saying that technology was included.

Students in this study showed equal preference for blended and face-to-face teaching methods. Other studies report more definite preferences: Waha and Davis (2014) found a lower preference for the blended learning environment (17%) while Walker et al. (2008) found that their students showed a 'strong preference' (Walker et al., 2008, p.365) for the blended approach. In agreement with previous research (e.g. Owston et al., 2013; Osgerby, 2013; Waha & Davis, 2014), the students in this study preferred face-to-face learning because of the opportunities it provided for student-teacher interaction, particularly allowing them to ask questions directly to their lecturer. They also agreed with studies which have suggested that the benefits of the online aspect of blended courses are the availability of resources (Dias & Diniz, 2014), recorded lectures (Henderson et al., 2015) and formative quizzes (Osgerby, 2013).

Students in this study wanted to be able to access course materials from anywhere which is a key affordance of a blended learning environment (Vaughan, 2007). However, the majority still preferred to attend face-to-face lectures, tutorials and labs rather than the online equivalents. Students in Battye and Carter's (2009 as cited in Owston et al., 2013) study also demonstrated a preference for attending face-to-face tutorials. Osgerby (2013) concluded that the face-to-face environment remained essential to students, particularly where they perceived a subject to be difficult. Given that students in this study viewed learning in science as challenging, it would be interesting to explore whether this was linked to their preference for face-to-face learning.

Students in this study were on the whole positive about the ability of blended learning to influence their learning which again aligns with research findings (e.g. Osgerby, 2013). The

students agreed that blended learning environments made the management of their study easier but were slightly less positive about its ability to improve course outcomes, increase motivation and make the learning experience more enjoyable. Interestingly, Owston et al. (2013) discovered that high achieving students were more likely to be satisfied with their blended courses than low achieving students. Students in this study responded to the survey independently and no achievement data was recorded.

7.7 Student themes

7.7.1 Perspectives on blended learning are influenced by experience with technology

The students in this study all had different skill levels and experiences of technology both personally and in relation to their learning and these influenced their perspectives of blended learning. Whilst the concept of 'digital natives' (Prensky, 2001) has been rightly criticised according to Henderson et al. (2015), the belief that current students are more digitally adept than previous cohorts continues. The majority of students, including those in this study, may be more comfortable with technology in their daily lives and use it to interface with the world. However, this study has shown that there are still students who do not own a computer, tablet or smart phone. These students still preferred to learn using more traditional pen and paper-based methods. Students in other studies reported similar preferences for pen and paper (Gorra et al., 2010). They also preferred to print and read material rather than read from a screen (Foasberg, 2014). In support of this choice of strategy, it has been suggested that students who wrote notes by hand or read in print format retained more of the material than those who typed their notes or read on a screen (Mueller & Oppenheimer, 2014; Foasberg, 2014)

In this study, students with low technology skills and experience described how they struggled with online or computer-based tasks as they must also learn to use the technology itself before they can actually complete the learning task. A student in Strayer's (2012) study similarly reported that they 'not only had to make sense of the assignment itself [but also] figure out how to use computers…to solve the problem' (p.191). Osgerby (2013) also revealed that some students were overwhelmed by continuous computer use in their studies. The use of technology in science learning has been advocated as a way to reduce cognitive load allowing the working memory to be focused on the learning activity (Ng, 2011). However, this is only once a student has become skilled in working with a particular

technology. For students with lower technological skills, at least initially, technology may create cognitive overload making it more difficult to concentrate on the learning task.

Students' ability to envisage the role that technology and blended learning could play in their learning was, in this study, also related to their previous experiences with technology in learning. Those whose experience was limited to the use of the learning management system as a resource repository or for assignment submission had more difficulty imagining more innovative uses for technology or seeing how this might relate to the kind of skills and knowledge required their discipline. Those whose experience of technology in their learning extended beyond this, for example to online gaming or smart phone apps, wanted to see technology incorporated into more courses and could see the benefits of technology and blended learning. It has long been known that students' behaviour and experiences are shaped by their institutional and educational contexts (Henderson et al., 2015). Henderson et al. (2015) argued that this could be extended to student use of technology: 'students' uses of digital technologies (and perceptions of 'what works' best) are clearly being shaped by the university contexts within which students are situated as much as they are being driven by individual 'choice' and agency, or even by some supposed 'affordance' of the digital technology' (p.11). As in their study, the lack of more interactive teaching approaches or creative and innovative uses of technology for co-generating knowledge experienced by students in this study suggests that certain forms of blended learning practice dominate within undergraduate science.

7.7.2 Discomfort with interactive teaching methods

The students in this study were uncomfortable with teaching methods which required them to participate during learning activities, describing them as 'intimidating' and a form of 'threat-based learning'. They attributed the unease with participation largely to social issues such as not wishing to appear stupid in front of their peers. Investigating similar student passivity in large undergraduate mathematics lectures in New Zealand, Yoon, Kensington-Miller, Sneddon and Bartholomew (2011) found several factors were influencing student behaviour and preventing them from engaging by asking or answering questions: social norms such as the perception that in transmission teaching the teacher's explanations are accepted without challenge and the potential embarrassment of being wrong. They also described a 'didactical contract' (Ebert-May, Brewer & Allred, 1997 as cited in Yoon et al., 2011, p.1108) in which

students perceived it was the teacher's duty to get through the allotted content in the allotted time and a student's duty not to interrupt.

In this study, there was a suggestion that the lack of participation was linked to a wider New Zealand cultural issue, 'tall poppy syndrome'. Furthermore, issues with participation were more prominent for students who had entered university straight from high school than those who had had some degree of life experience before coming to university and who may be more comfortable with interactive learning contexts as they recognised that these skills were required in an increasingly competitive world. The findings of Yoon et al. (2011) concur with this: students may lack the skills and subject specific language to feel confident participating in class (Stylianou & Blanton, 2002 as cited in Yoon et al. 2011) and culture may play its part. They observed that New Zealand students were more reserved than US students and that mature students were more likely to make contributions in class. However, Walker et al. (2008) disagreed saying 'research shows that first year students in particular are more receptive to active learning techniques' (Stylianou & Blanton, 2002 as cited in Yoon et al. 2011, p.365). Subjects where personal interpretation is more common have been suggested to encourage participation (Yoon et al., 2011). One student in this study agreed with this, commenting that participation was more difficult in subjects like physics and maths because answers were often precise giving no room for error. They also felt that the pace of the lectures made it hard to keep up with the content in order to answer questions. Students in other mathematics classes have also admitted not understanding the lecture content. They simply took notes, expecting to learn the material outside of lectures (Yoon et al., 2011).

However, whilst any opportunity forcing students to speak in front of their peers was met with a degree of unease, students in this study were making distinctions between different types of participatory activity. Activities which required them to participate as an individual, for example answering a question during a lecture, were viewed differently to those which required them to participate as part of a group, for example providing a response to the class following a group-based discussion. Although still somewhat uncomfortable to be the one chosen from a group to report back to the class, this was easier for the students as it reduced the social pressure since the response represented the thoughts of the entire group rather than just the student reporting them.

Despite their lack of enthusiasm about actually participating in more active learning environments, students in this study clearly valued any interaction that they had with each other and with their lecturers. Although they disliked being forced to answer questions and

felt uncomfortable in such learning environments, they were aware that it was in such settings, particularly those involving smaller group discussion, that they appeared to be learning most effectively. Missildine et al. (2013) also found student dissatisfaction with the interactive learning approach in the flipped classroom even though their course scores were higher than a comparison group who had followed a more traditional course structure. The flipped approach, therefore, had clearly enhanced students' learning but they disliked it. A similar mismatch between student use of e-learning tools, perceived benefit and enjoyment was found by Waha and Davis (2014) who concluded that students may find particular e-learning tools or teaching methods beneficial for their learning but do not enjoy using them and conversely they may enjoy using a particular method or tool, but not find it particularly beneficial. However, in contrast other research has reported that students' attitudes following experience with new teaching approaches and interactive learning activities have been positive (e.g. Baepler et al., 2014).

Furthermore, students in this study indicated that knowing that they could be asked to participate motivated them to be more familiar with the course material prior to and during lectures. A random oral question strategy was found by McDougall and Granby (1996) to be required to produce changes in students' pre-lecture study habits. When a voluntary question strategy was used, students did significantly less reading prior to the lecture. Encouraging student preparedness for lectures has also been the focus of some blended learning studies in science (e.g. Dantas & Kemm, 2008; Moravec et al., 2010) and the results suggest this strategy produces 'significant increases in learning gains' (Moravec et al., 2010, p. 473). In addition, students in this study, like those Waha and Davis (2014) and Walker et al. (2008), also found being part of a group activity more interesting and helpful to their learning since having peers explain concepts as well as having to explain concepts to others was seen as a way to improve understanding of science content. This was in agreement with the finding that 'learners' engagement in articulating what they learn and know and representing this understanding in a way that is accessible to others leads to better cognition' (Jonassen and Carr 2000 as cited in Gebre et al., 2012, p.10).

7.7.3 Students' attitudes are affected by lecturer behaviours

Students would prefer to be taught by the faculty 'stars' (Barber et al., 2013, p.27) and students in this study preferred lecturers who were passionate about their teaching and their

subject. Indeed, teacher behaviours such as clarity of explanation, use of examples, provision of feedback and effort in establishing a rapport (Feldman, 1997 as cited in Zepke et al., 2014) as well as teacher enthusiasm, humour and eye contact (Zepke et al., 2014) have all been linked to student learning.

D'Apollonia and Abrami (1997 as cited in Zepke et al., 2014) found that, under appropriate conditions, more than 45% of the variation in student learning can be explained by student perceptions of teacher effectiveness. Therefore, it is not unexpected that students in this study were critical of lecturers who were unenthusiastic, not well prepared and not able to engage their students through the lecture format. Other studies too have found that students become frustrated with inconsistencies between different lecturers and need more explicit connections to be made between lectures, readings and assessment (McKenzie et al., 2013). Furthermore, one student noted that lectures were not just about relaying information but were also an emotional experience where 'you reflect back the apathy or enthusiasm of the person speaking to you'. Students in this study were more prepared to engage with a lecturer when they perceived that the lecturers themselves had put some effort into their teaching and delivery. In addition, students seemed to have more respect for lecturers who would create participatory lectures or group work in spite of the difficulties in getting students to participate.

While most of the comments students in this study made about lecturer enthusiasm and preparedness related to the face-to-face environment, similar issues were also raised in relation to the online environment. Students were frustrated by courses where the learning management system pages were not kept up to date, did not work properly or were hard to navigate. Students in Osgerby's (2013) study also reported reduced confidence in the online environment when the learning management system had broken links, missing or dated material and variations in presentation style. Bee (2013 as cited in Reed, 2014) found that differences between learning management system uses were common in tertiary organisations and were a significant factor in student dissatisfaction. Addressing this, Reed (2014) raised the need for minimum standards such as all courses having a basic presence including lecturer's contact details, assessment details and reading lists to prevent a 'disjointed student experience' (Reed, 2014, p. 7). Ma, Han, Yang and Cheng (2015) confirmed the preparation of an online course could influence student behaviour and learning: an instructor's course preparation was positively correlated with students' online viewing activities which were, in turn, positively correlated with their completion of learning activities. Interestingly, an

instructor's course preparation had a stronger effect on learning activity completion than their guidance and assistance.

In this study, students with more advanced technology skills and greater experience of blended learning were also able to distinguish between what they felt was effective use of technology. They were not impressed with learning activities that were essentially paper-based but had been put online and were looking for more creative uses of the learning management system. Students have been reported as viewing the best use of the online learning environment as a means to provide information or as an online textbook (Osgerby, 2013). However, others, as in this study, have criticised this: '...if you upload notes, it is the same as looking for a book' (Yuen, 2011, p. 11). Overall, in this study, the lack of care and attention of the majority of lecturers towards the online environment was perceived by students to mean that this part of the learning in the course was of lesser importance.

7.7.4 Blended learning requires new study habits to be developed and supported

Faced with blended learning environments incorporating not only technology but also using innovative active learning approaches such as the flipped classroom model, students in this study were required to adapt not only their perception of tertiary study but also their study habits if they are to succeed. The dominant theoretical construct of blended learning is the shifting of the teaching and learning experience from being teacher-led to being student-centred (Torrisi-Steele & Drew, 2013). Whilst requiring teachers to change their role and adapt their practice (Gerbic, 2011), in parallel students are also required to adapt their own role and practice; to develop responsibility for their learning, self-regulation and to 'operate effectively as independent learners' (McKenzie et al., 2013, p. 118).

Students, however, have difficulty making the transition to student-centred learning as they are 'not adept at taking charge of their learning, regulating and controlling their learning process' (Dabbagh & Kitsanas, 2005 as cited in Monteiro & Morrison, 2014, p. 567). After expecting a largely passive learning experience, the new, unexpected learning environments presented students in this study with new challenges such as being required to meet deadlines throughout their courses not just study for a final exam, actively participate in lectures and tutorials, cope with the distractions that using technology itself brings, manage course material delivered using multiple media and cope with the additional cognitive load that working with unfamiliar technology creates.

As in Osgerby (2013), students in this study believed that they possessed the skills necessary to be successful when learning with technology. However, students' abilities have often been over estimated and they are surprised by what is expected of them (Taylor & Newton, 2013). This study similarly revealed that although the students were confident in their technological skills, for example navigating web sites and downloading and accessing software, they have yet to really understand that the blended learning environment also requires additional learning skills they currently do not have or are yet to even conceive as necessary; skills such as participating in online activities and discussions, collaborating with peers and managing learning using multiple media that. This is not unexpected due to the current nature and use of blended learning within undergraduate science.

The support structures that students in this study described were all based around technological skills with support for learning skills either not available or again not seen as necessary. For all students, in order to increase their willingness to engage with a particular approach it could be beneficial to improve their understanding of the rationale behind a particular teaching method or learning activity and how it supports and improves learning. For students whose technological literacy is low, greater support services, both technological and for learning skills, may be needed if the use of blended learning approaches is to increase and students are to engage effectively with them. Students themselves have suggested orientation information would be useful for those with low technological literacy. This would cover the technologies and skills required for study, for example how to use a headset with a microphone, how to download files, and would incorporate practice sessions where students could have a 'test run' (Taylor & Newton, 2013, p. 57) with key technologies and teaching approaches.

Given that some blended learning approaches such as the flipped classroom are increasingly incorporating a range of interactive learning experiences, consideration needs to be given in order to adequately prepare students for such teaching methods. The students in this study used the course descriptions to choose their courses and noted that some course descriptions were better, more detailed or more correct than others and it was not always easy to ascertain what the format of a course would be until they started it. Marshall (2012) indicated that an essential part of blended learning implementation was communicating with students about the ways in which technology would be incorporated into their courses to allow them to prepare themselves to take advantage of the opportunities this provided to improve their learning experience. The outcome of a lack of consideration of students was demonstrated by the

introduction of a blended learning approach to engineering students (Quinn et al., 2012). The new approach, as well as introducing new content, presented challenges for students' learning approaches and resulted in resistance and a surface learning approach in both the online and face-to-face elements of the course. The authors admitted that although they had transformed the learning environment and paid close attention to teachers' perceptions and conceptions through workshops and collaborative development, they had omitted to put sufficient consideration into students' perceptions and conceptions of the learning environment (Quinn et al., 2012).

CHAPTER EIGHT

CONCLUSIONS AND IMPLICATIONS

8.1 Introduction

In this chapter, the conclusions are presented and discussed in relation to the research questions and current literature. Implications for institutions, lecturers and students are suggested. The limitations for the study are then discussed and recommendations for future research outlined.

8.2 What are undergraduate science lecturer and student perceptions and experiences of blended learning?

Research which considers the perspective of either teachers or students has told us much about their experiences of blended learning but it may miss the crucial connection between their experiences. Teaching and learning are inextricably linked and so it is difficult to fully understand the perspectives and experiences of either lecturers or students without understanding something of the other group. Furthermore, teaching and learning happens within a disciplinary and organisational context which influences the practices of both lecturers and students. In this study, whilst there was not complete overlap between the lecturers and students who participated, they were teaching and learning within the same discipline and within the same organisation which allowed a more complete and contextualised version of their experiences to be revealed. Some studies which have considered both perspectives simultaneously have emphasised the differences between teachers and students (for example, Jones & Jones, 2005; Roblyer et al., 2010; Palmer & Holt, 2009). In contrast, what was most striking about the findings of this study were the similarities that could be drawn between lecturer and student perceptions, conceptions and experiences of blended learning.

In this study, both lecturers and students were positive about the use of blended learning. Where they had positive experiences of effective blended learning both groups were keen to see the approach adopted more widely (González, 2012; Owston et al., 2013). Furthermore, even if they were not currently using blended learning or e-learning tools for particular

activities, they were able to see its potential to support not only learning in general but also learning and skill development in science.

The majority of lecturers in this study taught using a blended learning approach which combines traditional face-to-face lectures and incorporates the online environment as a supplementary resource repository or to communicate key course information. Their use of the online aspects of blended courses could, therefore, be described as administrative or, in the words that Henderson et al (2015) used to describe student use of technology in a blended context, 'concerned with the 'logistics' of university study' (Henderson et al., 2015, p. 9). Students too, perhaps as a reflection of the limitations of the blended courses that they have experienced, largely used the online learning environment to support the management of their study such as organising their academic work (Henderson et al., 2015) or as a safe file storage system (Osgerby, 2013).

In this study, as well as in others, pockets of more innovative, interactive blends were found (Nanayakkara & Whiddett, 2005). Here lecturers with a more student-centred view of teaching and learning had designed learning environments such as small group discussion which encouraged student-student interaction and promoted higher order thinking and critical reflection (Ginns & Ellis, 2007). Students experiencing such courses reported that these were conducive to learning since having to explain scientific concepts to peers helped their own understanding (see also Strayer, 2012) and the environment facilitated participation (see also Baepler et al., 2014).

Technological skills per se, were not a major problem for lecturers and students in this study but they lacked the pedagogical and learning skills to effectively incorporate technology into their teaching and learning. Even students who were active users of technology in their personal lives did not use technology effectively in their learning. Furthermore, some students just did not want to learn using technology and their poor technological skills made technology-enabled learning activities more difficult. For both groups, therefore, understanding blended learning approaches both in terms of the underlying pedagogies, and how effective use of both learning environments can support learning, is crucial so that lecturers are able to design blended courses to maximise the potential for learning and so that students can engage in a way that realises that potential.

An essential feature of any teaching and learning approach for both lecturers and students was the retention of the face-to-face learning environment including hands-on science

experiences (see also Toth et al., 2014). Both groups valued the face-to-face setting because it allowed student-teacher and student-student interaction. However, although both student and lecturer's espoused views were that interaction was important for learning, this did not translate into practice: lecturer's did not exploit the full interactive potential of either the face-to-face or the online learning environments in their course design. Students also did not make the most of opportunities for interaction as they are resistant to participating, even though they appeared to understand that this was when they learned the most (see also Yoon et al., 2011). However, based on the findings of this study, I would argue that what they termed 'interaction', was potentially, to borrow from other educational research (e.g. Biggs, 1999 as cited in NZCER, 2004), more of a 'surface interaction' than the 'deep interaction' implied in collaborative learning.

Lecturer and student roles and identities are challenged by blended learning. Students expected a passive learning experience where the extent of their involvement would be to take notes. Blended learning, however, shifts the focus and expects students to accept responsibility for their own learning and to become interactive, independent learners with a high degree of self-regulation and self-motivation (Owston et al., 2013). For lecturers, the traditional lecture had always been central to their teaching (McConnell & Zhao, 2006 as cited in Stein et al., 2011) and was seen as a symbol of their role and authority (McShane, 2004). Blended learning challenged this by devolving responsibility for learning from lecturers to students. Lecturers may have associated this with a loss of control over their teaching, particularly if blended learning was also implemented in a top-down process where lecturers felt changes to their teaching were being imposed on them (Bohle Carbonell et al., 2013).

Currently, the majority of blended learning courses described in this study reinforced the traditional passive model from both a teaching and learning perspective. Courses which were exceptions, therefore, and incorporated more interactive innovative blends were isolated, making them more difficult for lecturers to adopt and students to accept. The 'island effect' as it has been termed in this study led to a frustrating experience for lecturers and students. For students, even though their learning outcomes may have been improved they were not satisfied with the learning experience (see also Missildine et al., 2013). For lecturers, the student resistance that this created also made for an unpleasant experience to the extent that they considered returning to their previous traditional course formats.

Lecturers' and students' behaviour and attitudes affect and influence each other and they may be unaware of this (Zepke et al., 2014). Students were critical of poor quality courses (Osgerby, 2013) and were more prepared to put effort into their courses when they perceived that the lecturer too had made an effort. Similarly, if lecturers perceived that there was no 'pay off' in terms of improved learning outcomes, student engagement or satisfaction for the additional time required to develop blended courses then they too questioned whether it was worth the effort.

Both lecturers and students needed to see the value in changing their usual teaching and learning approaches. Students needed reassurance that blended learning would prepare them for assessments as adequately as they believe the face-to-face environment would (Osgerby, 2013). They also needed to be motivated and engaged to compensate for the additional effort that they perceived blended courses to require. Lecturers needed reassurance that the pedagogies surrounding blended learning were effective not only in general but also in relation to their own discipline and that their course evaluations would not suffer due to the dissatisfaction of their students with blended approaches (Brunner, 2007 as cited in Gerbic, 2011). Just as students needed improved grades, lecturers needed recognition, not necessarily financial, for the effort required to change their teaching methods and the time required to develop new courses.

8.3 How do the institutional and disciplinary contexts influence science lecturer and student perceptions and experiences?

8.3.1 The institutional context

In this study, the institutional context affected blended learning adoption as a whole and also the individual experiences of lecturers and students (see also Graham et al., 2013). Although management in this study were keen to realise a wider adoption of blended learning, many of the required structures and strategies were not yet in place. This left the institution without a blended learning strategy to guide implementation at any level. The current bottom-up, ad hoc adoption of blended learning by individual staff has produced a high number of blended courses, but only a few which use more innovative, interactive blends and fully exploit the affordances of both the face-to-face and online learning environments.

Encouragingly, the university in this study had already identified and was considering many of the issues which need to be addressed to move from stage 1 (awareness/exploration) to

stage 2 (adoption/early implementation) of the blended learning adoption framework (Graham et al., 2013). The formation of the e-learning advisory group and their work on an e-learning strategy were two key developments which would allow blended learning to be more visible within the university which is a key step in securing the necessary resources and support for the approach within the wider university community (Garrison & Vaughan, 2013).

The pedagogical support structures that were in place were developing in maturity in response to the needs of the lecturer community. These were well received by staff although there were some indications that not all were able to access pedagogical support to the extent that they might wish to, potentially due to a lack of time. This demonstrated the need for cohesion amongst both the policies that directly influence blended learning and those which influence wider teaching and learning issues such as workload management. Furthermore, it is clear that student support was an area that needed similar attention (see also Porter et al., 2014). Preparing students adequately for blended learning would give them more realistic expectations of what was required of them as tertiary students and would also provide them with the skills to fully engage with blended courses, particularly in terms of participating in interactive learning activities.

8.3.2 Science as a discipline

Blended learning in undergraduate science demonstrated many of the same benefits and successes as well as the same issues and challenges as any discipline in tertiary education. Science as a discipline, however, did influence blended learning due to both the nature of science knowledge and learning and the context surrounding science delivery.

Science is a complex subject. The large quantity of highly specialised content knowledge that is required, coupled with difficulties with abstract subjects, visualisation, language and its mathematical elements make it a challenge both to teach and to learn. In this study, e-learning tools were already used to support visualisation and simulations and modelling. However, there are many other potential uses for e-learning within a science context. Encouragingly, lecturers were supportive of a role for technology in science teaching and learning even though current use of technology and blended approaches was low. As has been suggested elsewhere (e.g. Jimoyiannis, 2010), subject specific professional development would support staff to learn about the available technologies and activities and also the pedagogies

underlying their use so that staff can design and develop courses to meet the outcomes they aspire to provide.

The context of science teaching also creates additional problems for teaching and learning. Large undergraduate courses made more innovative and interactive teaching approaches difficult although not impossible (McKenzie et al., 2013) and the lack of more appropriate teaching spaces exacerbated this issue (see also Baepler et al., 2014). Team teaching was also seen as creating barriers to lecturers wishing to adopt a blended approach. If their colleagues had different pedagogical approaches they either had to agree to a partial blended approach or risk becoming an 'island' within a largely traditionally taught course. Lecturers were concerned that the increasing use of technology in teaching might replace the hands-on aspect of laboratory and field-based science education which they viewed as essential.

8.4 Implications of this study

There are many individual threads within the findings of this study, a number of which have also been identified by other studies and recommendations provided. However, the major implications for this study could be linked to two key themes: the first was lecturer awareness, acceptance and use of the student-centred pedagogies at the heart of blended learning, the second was changing student expectations of tertiary study and improving their learning skills in relation to blended approaches.

Lecturers were concerned with using good pedagogy to improve the learning outcomes for their students. However, although there were a few exceptions, what they perceived to be good pedagogy still seems to be teacher-centred, transmission approaches. Lecturers valued interaction with their students, but they had not yet realised the potential of the online environment in blended learning to maximise that interaction. There may be two reasons for this: awareness and knowledge of how to implement student-centred pedagogies or being prevented from doing so by the wider institutional context. Regardless, both are issues over which institutions can exert positive influence.

Providing appropriate professional development for lecturers is essential. However, what form and focus professional development should take is an area of debate. However, suggestions for this university can be taken from the findings of this study. Blended learning has been portrayed as something new, perhaps due to the emphasis on the new and emerging technologies that can be integrated into a blended learning environment. Lecturers, however,

seemed slightly resistant to this interpretation of blended learning since they viewed blended learning as the combination of different teaching methods and media and, therefore, as something they had always done. There was perhaps an implication that they were not an effective teacher unless they were using technology in their teaching. However, as the lecturers suggested, more important than the technology itself is the use of effective pedagogy. A quality blended learning experience can result from using technology to support a transformation of the face-to-face learning environment as much as making effective use of the online learning environment itself. An appropriate professional development strategy, therefore, might be to shift the emphasis from the use of technology to a focus on student-centred pedagogies, how these promote learning and the tools and strategies, technological or not, that can support those pedagogies.

Whilst the pedagogical support within the university was one of the most mature blended learning systems in place, it was not reaching all of the staff who would make use of it. A focus on how to provide time release for lecturers would enable them to access the professional development they need. In addition to awareness of effective blended learning pedagogy was acceptance of the approach. Perhaps lecturers needed more information about the affordances of blended approaches, for example, flexibility of access, addressing equity, more personalised learning and scaffolds to help learners learn. This could be developed through discussion of an institution-wide strategy for e-learning. A blended learning strategy for academic enhancement which emphasised the importance of the approach in combination with formal incentives might encourage lecturers to make changes to their teaching. This would also strengthen the perception that moving from being a ‘sage on the stage’ to being a ‘guide on the side’ did not affect a lecturer’s role or authority. Following acceptance, the multi-disciplinary course design teams suggested by both management and lecturers would address the issue of the time required to design blended courses by making the most effective use of the time lecturers have available for course planning. It would also ensure that all courses had input from the e-learning advisors. This would also help to address the ‘island effect’ by increasing the number of blended courses or courses with interactive elements within them to the extent that students no longer saw them as isolated or ‘different’ and therefore, as a challenge.

It is accepted that students have unrealistic expectations of tertiary study. In this study, these expectations along with a lack of learning skills made it difficult for them to engage in their learning, particularly with blended and interactive approaches, and led to dissatisfaction with

their courses. Students also need to understand that they can learn from each other and that alternative methods to the face-to-face lecture can equally prepare them for assessments. Changing students' expectations prior to starting university is something institutions have only limited control over. However, efforts to address this through representations of learning and study within marketing materials including university web sites and through school liaison are possible. An institutional policy around the provision of information within the course catalogue would also help students to choose courses more appropriate for their learning style and again allow them to adequately prepare for courses which were taking a new approach. Then once enrolled, online information and modules designed to introduce students to the rationale behind more innovative teaching approaches and outline the skills needed could be used to prepare students for their courses. Orientation sessions, self-help activities and workshops where various technologies can be trialled in advance would support students when they initially begin their studies. A support service linked to the existing student support services but focussed on the learning skills needed to learn with technology or in a blended environment would then provide support throughout students' studies at the university. Ideas for a student support service could be modelled upon the pedagogical support services offered to staff. Disciplines and lecturers too have a role to play in preparing their own students for study in particular courses. Discipline-specific support can be provided by individual departments and lecturers can make the reasons for their teaching approach and their expectations for student participation during the course explicit at the start of each course.

Specifically within science, the team teaching context could be viewed as a potential enabler for blended learning rather than the barrier some lecturers currently perceived it to be. Lecturers reported that they welcome opportunities to learn from their colleagues and that the 'viral nature' (Hardaker & Singh, 2011, p. 226) of informal sharing experiences influenced their practice. Therefore, including early adopters within teaching teams and allowing them to guide their colleagues towards more effective blended approaches could support more lecturers to trial blended learning. To assist this process and support students to accept blended learning, as suggested by Strayer (2012), more innovative and interactive activities can be introduced slowly, perhaps initially using a 30 minute mini-lecture combined with a 30 minute interactive activity and then scaling up as the course progresses. Any institutional level implementation plan or strategy needs to retain the flexibility to address the needs of different disciplines, for example when designing and staffing support services and when

assembling multi-disciplinary teams to develop blended courses. As other institutions have done (Porter et al., 2014), devolving responsibility for course design and approval to the department level may also encourage blended learning adoption by allowing faculty to feel that they are involved in the process and have retained some control over the design of their courses.

8.5 Limitations of this study

While this study makes a contribution to the understanding of undergraduate science lecturer and student perspectives of blended learning, there were a number of limitations. The study was carried out within a single university and comprised a small number of participants in each group. The lecturer and student participants, although from a number of subjects within the science discipline, did not cover the whole range of subjects. The lecturers were purposively chosen for their knowledge of blended learning and so their perspectives and experiences may not be representative of the wider lecturer community although it should be noted that many of the interview findings were supported by the survey results. The survey questions may not have included all areas relevant to the topic at the centre of this study, for example, they did not explore the social learning opportunities of e-learning. The students were all associated with academic student organisations which may indicate that they were particularly academically oriented. Their perspectives are also based on their experiences with blended learning and it was clear that this differed between students. Whilst this might give a wider view of blended learning it remains unknown which student's experiences were more typical. Another limitation is the research design and the reliance on a single researcher's interpretation of the results. Although all efforts were made to increase validity and reliability, the interpretations of the data were subject to my biases and other interpretations were possible. Therefore, these findings are not generalisable to other organisations, lecturers and students in other contexts, but do suggest useful areas for further research in other contexts.

8.6 Recommendations for future research

Given the growth of blended teaching and learning in the tertiary sector (Torrisi-Steele & Drew, 2013), its concurrent failure to 'transform' higher education (Garrison & Kanuka, 2004) and the lack of large-scale research focusing on blended learning within discipline

specific contexts further research on blended learning in undergraduate science education is needed. The findings of this study indicate a number of diverse areas for focus.

A body of literature has explored the support and professional development that lecturers need in order to effectively integrate the face-to-face and online learning environments to facilitate and improve learning. Although the idea that students are 'digital natives' has effectively been dispelled and many studies have advocated for improved student support, little research has been carried out in this area. Wang et al., (2004 as cited in Owens, 2012) wrote that 'until teachers' pedagogical beliefs were addressed effective online learning is unrealisable' (p. 391) but it could be argued that a similar statement is true of students. Such research should be considered from multiple angles including institutional, teacher and student perspectives in order to ascertain what support is needed, would be utilised and can be provided. Therefore, a focus for future research would be the institutional and course-related structures and systems that would best support students within a blended context.

Issues with participation, not just in the online learning environment but also in the face-to-face learning environment have been raised as a concern in this study. Although research into support structures for students has been suggested above, given that successful blended learning approaches are those which encourage communication and collaboration between lecturers and students and also between peers, this is an area worthy of individual mention. Therefore, further investigation of students' perspectives of the social norms which surround participation in face-to-face lectures, small groups and in online environments is essential. This would continue the work of Yoon et al. (2011) in the face-to-face space and of Yun and Kim (2014) in the online space.

The 'island effect' has been an interesting finding from this study. It has arisen in this university due to a combination of factors including a lack of institutional strategy, lecturer culture and student resistance to new approaches. The implication is that effective blended learning implementation is dependent upon a number of factors which occur at all levels of the organisation and their effects can be additive. Whilst studies have anecdotally suggested that blended learning implementation has resulted in a patchwork effect, this phenomenon has not been investigated in any depth. Exploring whether a similar 'island effect' has been experienced by other institutions during their implementation of blended learning would show whether this is a situation unique to this university or is experienced more widely. If it is experienced more widely this would add further knowledge to the field by indicating the

issues that institutions might need to address simultaneously in order to successfully prepare themselves, their lecturers and their students for a blended learning environment.

Clearly research on blended learning within discipline specific contexts is both warranted and needed. This could investigate science specific blended learning pedagogies, affordances of technology within a blended learning setting and the acceptance of technology in science teaching and learning from the perspective of both lecturers and students. A further interesting avenue of exploration would be whether the team-teaching approach used in undergraduate science courses could be used to encourage and support more staff to adopt a blended learning approach.

REFERENCES

Abd-El-Khalick, F., & Lederman, N.G. (2000). Improving science teachers' conceptions of nature of science: a critical review of the literature. *International Journal of Science Education, 22*(7), 665- 701. Retrieved from http://www.tandf.co.uk/journals

Allen, I.E., & Seaman, J. (2006). Making the Grade: Online Education in the United States, 2006. Needham, MA: Sloan Consortium. Retrieved from http://files.eric.ed.gov/fulltext/ED529697.pdf

Anderman, E.M., Sinatra, G.M., & Gray, D.L. (2012). The challenges of teaching and learning about science in the twenty-first century: exploring the abilities and constraints of adolescent learners. *Studies in Science Education, 48*(1), 89-117. doi:10.1080/03057267.2012.655038

Arbaugh, J.B., Bangert, A., & Cleveland-Innes, M. (2010). Subject matter effects and the Community of Inquiry (CoI) framework: An exploratory study. *Internet and Higher Education, 13*, 37–44. doi:10.1016/j.iheduc.2009.10.006

Ashley, L.D. (2012). Case study research. In J. Arthur, M. Waring, R.J. Coe, & L.V. Hedges (Eds.), *Research Methods & Methodologies in Education* (pp.102-106). London, United Kingdom: Sage.

Baepler, P., Walker, J.D., & Driessen, M. (2014). It's not about seat time: Blending, flipping, and efficiency in active learning classrooms. *Computers & Education, 78,* 227-236. doi:10.1016/j.compedu.2014.06.006

Barber, M., Donnelly. K., & Rizvi, S. (2013). *An Avalanche is Coming: Higher Education and the Revolution Ahead*. London, United Kingdom: Institute for Public Policy Research. Retrieved from https://www.insidehighered.com/sites/default/server_files/files/FINAL%20Embargoed%20Avalanche%20Paper%20130306%20%281%29.pdf

Benson, V., Anderson, D., & Ooms, A. (2011). Educators' perceptions, attitudes and practices: blended learning in business and management education. *Research in Learning Technology, 19*(2), 143–154. doi:10.1080/21567069.2011.586676

Blake, H. (2009). Staff perceptions of e-learning for teaching delivery in healthcare. *Learning in Health and Social Care*, *8*(3), 223–234. doi:10.1111/j.1473-6861.2009.00213.x

Bliuc, A.-M., Ellis, R.A., Goodyear, P., & Piggott, L. (2011). A Blended Learning Approach to Foreign Policy: Student Experiences of Learning through Face-To-Face and Online Discussions. *Computers and Education, 56*(3), 856-864. Retrieved from www.journals.elsevier.com/computers-and-education/

Bluic, A-M., Goodyear, P., & Ellis, R.A. (2007). Research focus and methodological choices in studies into students' experiences of blended learning in higher education. *Internet and Higher Education, 10,* 231–244. doi:10.1016/j.iheduc.2007.08.001

Bogdan, R.C., & Biklen, S.K. (1998). *Qualitative Research for Education: An Introduction to Theory and Methods* (3rd ed.). Boston: Allyn & Bacon.

Bohle Carbonell, K., Dailey-Hebert, A., & Gijselaers, W. (2013). Unleashing the creative potential of faculty to create blended learning. *Internet and Higher Education, 18,* 29–37. doi:10.1016/j.iheduc.2012.10.004

Braund, M., & Reiss, M. (2006). Towards a more authentic science curriculum: the contribution of out-of-school learning. *International Journal of Science Education, 28*(12), 1373–1388. doi: 10.1080/09500690500498419

Briedenhann, J. (2007). The mature student experience in higher education: From the horse's mouth. *The International Journal of Learning*, *14*(2), 265-273. Retrieved from http://ijl.cgpublisher.com/

Brinkworth, R., McCann, B., Matthews, C., & Nordstrom, K. (2009). First year expectations and experiences: student and teacher perspectives. *Higher Education*, *58,* 157–173. doi:10.1016/j.iheduc.2009.10.006

Brown, M., Anderson, B., & Murray, F. (2007). E-learning policy issues: global trends, themes and tensions. In R.J. Anderson, C. McBeath, S.K.A. Soong, & C. Cheers (Eds.), *ICT: Providing choices for learners and learning. Proceedings of Ascilite 2007, Singapore, 2-5 December* (pp.75-81). Retrieved from http://www.ascilite.org.au/conferences/singapore07/procs/

Brunsell, E., & Horejsi, M. (2011). Science 2.0. *The Science Teacher, 78,* 10. Retrieved from http://learningcenter.nsta.org/browse_journals.aspx?journal=tst

Castaňo-Muňoz, J., Duart, J.M., Sanchez-Vinuesa, T. (2014). The Internet in face-to-face higher education: can interactive learning improve academic achievement? *British Journal of Educational Technology, 45*(1), 149–159. doi:10.1111/bjet.12007

Chen P.-S.D., Lambert, A.D., & Guidry, K.R. (2010). Engaging online learners: the impact of Web-based learning technology on college student engagement. *Computers & Education, 54*, 1222–1232. doi:10.1016/j.compedu.2009.11.008

Cochrane, T., & Bateman, R. (2010). Smartphones give you wings: pedagogical affordances of mobile Web 2.0. *Australasian Journal of Educational Technology*, *26*(1), 1-14. Retrieved from www.ascilite.org.au/ajet

Cohen, L., Manion, L., & Morrison, K. (2011). *Research Methods in Education* (7th ed.). London, United Kingdom: Routledge Falmer.

Coil, G., Wenderoth, M.P., Cunningham, M., & Dirks, C. (2010). Teaching the process of science: faculty perceptions and an effective methodology. *CBE Life Science Education, 9*(4), 524-35. doi:10.1187/cbe.10-01-0005

Comer, K., & Brogt, E. (2010). Student engagement in relation to their field of study. In A. Radlof (Ed.), *Student Engagement in New Zealand Universities* (pp.11-21). Wellington, New Zealand: Ako Aotearoa. Retrieved from https://akoaotearoa.ac.nz/ako-aotearoa/student-engagement

Crandall, P.G., O'Bryan, C.A., Killian, S.A., Beck, D.E., Jarvis, N., & Clausen, E. (2015). A Comparison of the Degree of Student Satisfaction using a Simulation or a Traditional Wet Lab to Teach Physical Properties of Ice. *Journal of Food Science Education, 14*, 24-29. doi:10.1111/1541-4329.12049

Creswell, J.W. (2007). *Qualitative Inquiry & Research Design: Choosing Among Five Approaches* (2nd ed.). Thousand Oaks, CA: Sage.

Creswell, J.W. (2012). *Educational Research: Planning, Conducting and Evaluating Quantitative and Qualitative Research* (4th ed.). New Jersey, NY: Pearson Education Inc.

Crow, J., & Smith, l. (2005). Co-teaching in higher education: reflective conversation on shared experience as continued professional development for lecturers and health and social care students. *Reflective Practice: International and Multidisciplinary Perspectives, 6*(4), 491-506. doi:10.1080/14623940500300582

Dantas, A.M., & Kemm, R.E. (2008). A blended approach to active learning in a physiology laboratory-based subject facilitated by an e-learning component. *Advances in Physiology Education, 32*, 65-75. doi:10.1152/advan.00006.2007

Davidson, C., & Tolich, M. (1999). Competing traditions. In C. Davidson, & M. Tolich (Eds.), *Social Science Research in New Zealand: Many Paths to Understanding* (pp.23-38). Auckland, New Zealand: Pearson Education.

Dearnley, C., Dunn, G., & Watson, S. (2006). An exploration of on-line access by traditional students in higher education: a case study. *Nurse Education Today*, *26*, 409-415. doi:10.1016/j.nedt.2005.11.011

de Fátima Wardenski, R., de Espíndola, M.B., Struchiner, M., & Gianella, T.R. (2013). Blended Learning in Biochemistry Education. *Biochemistry and Molecular Biology Education, 40*(4), 222–228. doi:10.1002/bmb.20618

DeHaan, R.L. (2005). The Impending Revolution in Undergraduate Science Education. *Journal of Science Education and Technology*, *14*(2), 253-269. doi:10.1007/s10956-005-4425-3

Dias, S. B., & Diniz, J. A. (2014). Towards an Enhanced Learning Management System for Blended Learning in Higher Education Incorporating Distinct Learners' Profiles. *Educational Technology & Society*, *17*, 307–319. Retrieved from http://www.ifets.info/

Donnelly, R. (2010). Harmonizing technology with interaction in blended problem-based learning. *Computers & Education, 54*, 350–359. doi:10.1016/j.compedu.2009.08.012

Duda, G., & Garrett, K. (2008). Blogging in the physics classroom: a research-based approach to shaping students' attitudes toward physics. *American Journal of Physics*, *76*(11), 1054-1065. Retrieved from http://aapt.org/ajp

Ellis, R. A., Goodyear, P., Prosser, M., & O'Hara, A. (2006). How and what university students learn through on-line and face-to-face discussion: Conceptions, intentions, and approaches. *Journal of Computer Assisted Learning*, *22*, 244−256. Retrieved from http://www.olj.online-learningconsortium.org

Ellis, R.A., Hughes, J., Weyers, M., & Riding, P. (2009). University teacher approaches to design and teaching and concepts of learning technologies. *Teaching and Teacher Education, 25*, 109–117. doi:10.1016/j.tate.2008.06.010

Ellis, R., Steed. A., & Applebee, A. (2006). Teacher conceptions of blended learning, blended teaching and associations with design. *Australasian Journal of Educational Technology*, *22*(3), 312-335. Retrieved from www.ascilite.org.au/ajet/

Eskey, M.T., & Schulte, M. (2012). Comparing Attitudes of Online Instructors and Online College Students: Quantitative Results for Training, Evaluation and Administration. *Online Journal of Distance Learning Administration, 15*(5). Retrieved from http://www.westga.edu/~distance/ojdla/

Finkelstein, N.D., Adams, W.K., Keller, C.J., Kohl, P.B., Perkins, K.K., Podolefsky, N.S., Reid, S., & LeMaster, R. (2005). When learning about the real world is better done virtually: a study of substituting computer simulations for laboratory equipment. *Physical Review Special Topics - Physics Education Research*, 1, 1-8. doi:10.1103/PhysRevSTPER.1.010103

Flyvbjerg, B. (2011). Case Study. In N. K. Denzin, & Y.S. Lincoln. (Eds.), *The Sage Handbook of Qualitative Research (*4th ed.), (pp. 301-316). Thousand Oaks, CA: Sage.

Foasberg, N.M. (2014). Student Reading Practices in Print and Electronic Media. *College and Research Libraries*, *75*(5), 705-723. doi:10.5860/crl.75.5.705

Gardner, S.K. (2008). "What's too much and what's too little?": the process of becoming a n independent researcher in doctoral education. *The Journal of Higher Education*, *79*(3), 326-350. Retrieved from https://ohiostatepress.org/index.htm?journals/jhe/jhemain.htm

Garrison, D.R., & Kanuka, H. (2004). Blended learning: Uncovering its transformative potential in higher education. *Internet and Higher Education*, *7*, 95-105. doi:10.1016/j.iheduc.2004.02.001

Garrison, D.R., & Vaughan, N.D. (2013). Institutional change and leadership associated with blended learning innovation: two case studies. *Internet and Higher Education, 18*, 24–28. doi:10.1016/j.iheduc.2012.09.001

Gebre, E., Saroyan, A., & Bracewell, R. (2012). Students' engagement in technology rich classrooms and its relationship to professors' conceptions of effective teaching. *British Journal of Educational Technology.* Advance online publication. doi:10.1111/bjet.12001

Gedik, N., Kiraz, E., & Özden, M.Y. (2012). The Optimum Blend: Affordances and Challenges of Blended Learning For Students. *Turkish Online Journal of Qualitative Inquiry*, *3*(3) 102-117.

Gerbic, P. (2011). Teaching using a blended approach – what does the literature tell us? *Educational Media International, 48*(3), 221–234. Retrieved from http://www.tandfonline.com

Ginns, P., & Ellis, R. (2007). Quality in blended learning: Exploring the relationships between on-line and face-to-face teaching and learning. *Internet and Higher Education, 10*, 53-64. doi: 10.1016/j.iheduc.2006.10.003

Glesne, C., & Peshkin, A. (1993). *Becoming Qualitative Researchers: An Introduction*. White Plains, NY: Longman.

Glogowska, M., Young, P., Lockyer, L., & Moule, P. (2011). How 'blended' is blended learning?: Students' perceptions of issues around the integration of online and face-to-face learning in a continuing professional development (CPD) health care context. *Nurse Education Today*, *31*, 887–891. doi:10.1016/j.nedt.2011.02.003

Golden, S., McCrone, T., Walker, M., & Rudd, P. (2006). *Impact of E-learning in Further Education: Survey of Scale and Breadth.* Research Report RR745. London, United Kingdom: Department for Education and Skills.

González, C. (2009). What do university teachers think eLearning is good for in their teaching? *Studies in Higher Education,* 35(1), 61–78. doi: 10.1080/03075070902874632

González, C. (2012) The relationship between approaches to teaching, approaches to e-teaching and perceptions of the teaching situation in relation to e-learning among higher education teachers. *Instructional Science*, *40*, 975–998. doi: 10.1007/s11251-011-9198-x

Gorra, A., Finlay, J., Devlin, M., Lavery, J., Neagle, R., Sheridan-Ross, J., … Boyle, R. (2010). Learning With Technology: What do Students Want? In I. Ismail (Ed.), *Proceedings of the 5th International Conference on e-Learning, Penang, Malaysia, 12-13 July* (pp.126-133). Retrieved from http://academic-conferences.org/icel/icel2010/icel10-home.htm

Graham, C.R., Woodfield, W., & Harrison, J.B. (2013). A framework for institutional adoption and implementation of blended learning in higher education. *Internet and Higher Education, 18*, 4–14. doi: 10.1016/j.iheduc.2012.09.003

Guiney, P. (2011). *E-Learning Provision and Participation: Trends, Patterns and Highlights.* Wellington, New Zealand: Ministry of Education. Retrieved from http://www.educationcounts.govt.nz/publications/ict/e-learning-provision-and-participation-trends,-patterns-and-highlights/summary

Guiney, P. (2012). *Learners' Participation, Retention and Success in e-learning: An Annotated Bibliography.* Wellington, New Zealand: Ministry of Education. Retrieved from http://www.educationcounts.govt.nz/publications/ict/learners-participation,-retention-and-success-in-e-learning-an-annotated-bibliography

Guiney, P. (2013). *Organisational approaches to e-learning in the tertiary sector: An annotated bibliography*. Wellington, New Zealand: Ministry of Education. Retrieved from http://www.educationcounts.govt.nz/publications/ict/organisational-approaches-to-e-learning-in-the-tertiary-sector

Guiney, P. (2014).*Government and sector-level elearning initiatives: An annotated bibliography*. Wellington, New Zealand: Ministry of Education. Retrieved from http://www.educationcounts.govt.nz/publications/ict/147086

Halverston, L.R., Graham, C.R., Spring, K.J., & Drysdale, J.S. (2012). An analysis of high impact scholarship and publication trends in blended learning. *Distance Education, 33*(3), 381–413. doi: 10.1080/01587919.2012.723166

Hardaker, G., & Singh, G. (2011). The adoption and diffusion of eLearning in UK universities. *Campus-Wide Information Systems*, *28*(4), 221–233. doi:10.1108/10650741111162707

Harnisch, H., & Taylor-Murison, L. (2012). Transition and technology—Evaluation of blended learning delivered by university staff to 6th form students. *British Journal of Educational Technology, 43*(3), 398-410. doi:10.1111/j.1467-8535.2011.01190.x

Harrison, J., MacGibbon, L., & Morton, M. (2001). Regimes of trustworthiness in qualitative research: The rigors of reciprocity. *Qualitative Inquiry, 7*(3), 323-345. Retrieved from http://qix.sagepub.com/

Harwood, W.S. (2004). Science Education Reform: Factors affecting Science and Science Faculty Collaborations. In D.W. Sunal, E.L. Wright, & J. Bland (Eds.), *Reform in Undergraduate Science Teaching for the 21st Century* (pp. 53-68). Greenwich, CT: Information Age Publishing.

Hassan, G. (2008). Attitudes toward science among Australian tertiary and secondary school students. *Research in Science & Technological Education*, *26*(2), 129-147. doi:10.1080/02635140802034762

He, Y., Swenson, S., & Lents, N. (2012). Online Video Tutorials Increase Learning of Difficult Concepts in an Undergraduate Analytical Chemistry Course. *Journal of Chemical Education*, *89*, 1128-1132. doi:10.1021/ed200685p

Henderson, C., Beach, A., & Famiano, M. (2007). Diffusion of Educational Innovations via Co-Teaching. *AIP Conference Proceedings*, *883*, 117-120. doi: 10.1063/1.2508706

Henderson, C., Beach, A., & Finkelstein, N. (2011). Facilitating Change in Undergraduate STEM Instructional Practices: An Analytic Review of the Literature. *Journal of Research in Science Teaching*, *48*(8), 952–984. doi:10.1002/tea.20439

Henderson, M., Selwyn, N., & Aston, R. (2015). What works and why? Student perceptions of 'useful' digital technology in university teaching and learning. *Studies in Higher Education.* Advance online publication. doi:10.1080/03075079.2015.1007946

Hood, M. (2013). Bricks or clicks? Predicting student intentions in a blended learning buffet. *Australasian Journal of Educational Technology*, *29*(6), 762-776. *Retrieved from* http://www.ascilite.org.au/ajet

Huang, T.-Y., Wu, H.-L., She, H.-C., & Lin, Y.-R. (2014). Enhancing Students' NOS Views and Science Knowledge Using Facebook-based Scientific News. *Educational Technology & Society*, *17*(4), 289–301. Retrieved from http://www.ifets.info/

Inglis, M., Palipana, A., Trenholm, S., & Ward, J. (2012). Individual differences in students' use of optional learning resources. *Journal of Computer Assisted Learning*, *27*, 490–502. doi:10.1111/j.1365-2729.2011.00417.x

Ituma, A. (2011). An evaluation of students' perceptions and engagement with e-learning components in a campus based university. *Active Learning in Higher Education*, *12*(1), 57-68. Retrieved from www.alh.sagepub.com/

Jeffrey, L.M., Atkins, C., Laurs, A., & Mann, S. (2006). *e-Learner Profiles: Identifying Trends and Diversity in Student Needs, Orientations and Aspirations*. Wellington, New Zealand: Ministry of Education. Retrieved from https://www.educationcounts.govt.nz/publications/ict/57985

Jeffrey, L.M., Milne, J., Suddaby, G., & Higgins, A. (2012). *Strategies for engaging learners in a blended environment*. Wellington, New Zealand: Ako Aotearoa. Retrieved from https://akoaotearoa.ac.nz/download/ng/file/group-3089/strategies-for-engaging-learners-in-a-blended-environment.pdf

Jimoyiannis, A. (2010). Designing and implementing an integrated technological pedagogical science knowledge framework for science teachers' professional development. *Computers & Education, 55*, 1259–1269. doi: 10.1016/j.compedu.2010.05.022

Johnson, M.J., & Smyth, K. (2011). Diversity, value and technology: exposing value pluralism in institutional strategy. *Campus-Wide Information Systems*, *28*(4), 211 – 220. doi:10.1108/10650741111162699

Jones, G.H., & Jones, B.H. (2005). A Comparison of Teacher and Student Attitudes Concerning Use and Effectiveness of Web-based Course Management Software. *Educational Technology & Society*, *8*(2), 125-135. Retrieved from www.ifets.info/

Kardash, C.M., & Wallace, M.L., (2001). The perceptions of science classes survey: what undergraduate science reform efforts really need to address. *Journal of Educational Psychology*, *91*(1), 199-210. doi: 10.1037//0022-0663.93.U99

Kennepohl, D. (2012). Pitfalls and Prospects: Integrating ICTs in Tertiary Science Education. In J. Peterson, O. Lee, T. Islam, M. Piscioneri (Eds.), *Effectively Implementing Information Communication Technology in Higher Education in the Asia-Pacific Region* (pp. 371–388). New York: Nova Publishers

Kim, J.-Y. (2012). A study on learners' perceptional typology and relationships among the learner's types, characteristics, and academic achievement in a blended e-Education environment. *Computers & Education, 59*, 304–315. doi:10.1016/j.compedu.2012.01.010

King, N., & Horrocks, C. (2010). *Interviews in Qualitative Research*. London, United Kingdom: Sage.

Kvale, S., & Brinkmann, S. (2009). *InterViews: Learning the Craft of Qualitative Research Interviewing* (2nd ed.). Los Angeles, CA: Sage.

Lancaster, J.W., McQueeney, M.L., & Van Amburgh, J.A. (2011). Online lecture delivery paired with in class problem-based learning: does it enhance student learning? *Currents in Pharmacy Teaching and Learning*, *3*, 23–29. doi:10.1016/j.cptl.2010.10.008

Lawrence, B., & Lentle-Keenan, S. (2013). Teaching beliefs and practice, institutional context, and the uptake of Web-based technology. *Distance Education, 34*(1), 4–20. doi:10.1080/01587919.2013.770432

Leggett, M., Kinnear, A., Boyce, M., & Bennett, I. (2004). Student and staff perceptions of the importance of generic skills in science. *Higher Education Research and Development*, *23*, 295–312. doi:10.1080/0729436042000235418

Leithbridge College (2011). *Leithbridge College Instructor Survey – 2011*. Retrieved 17 September 2013 from http://eet.lethbridgecollege.net

Lewis, J.S., & Harrison, M.A. (2012). Online Delivery as a Course Adjunct Promotes Active Learning and Student Success. *Teaching of Psychology, 39,* 72-76. doi:10.1177/0098628311430641

López-Pérez, M.V., Pérez-López, M.C., & Rodríguez-Ariza, L. (2011). Blended learning in higher education: Students' perceptions and their relation to outcomes. *Computers & Education, 56*, 818–826. doi:10.1016/j.compedu.2010.10.023

López-Pérez, M.V., Pérez-López, M.C., Rodríguez-Ariza, L., & Argente-Linares, E. (2013). The influence of the use of technology on student outcomes in a blended learning context. *Educational Technology Research & Development, 61*, 625–638. doi:10.1007/s11423-013-9303-8

Lovel, K., & Vignare, K. (2009). MSU medical colleges blended learning for first year science courses: uniting pedagogy to maximize experience and real world limitations. *Journal of Asynchronous Learning Networks*, *13*(1), 55-63. Retrieved from http://www.olj.onlinelearningconsortium.org

Ma, J., Han, X., Yang, J., & Cheng, J. (2015). Examining the necessary condition for engagement in an online learning environment based on learning analytics approach: The role of the instructor. *Internet and Higher Education, 24*, 26–34. doi:10.1016/j.iheduc.2014.09.005

Mackeogh, K., & Fox, S. (2009). Strategies for Embedding e-Learning in Traditional Universities: Drivers and Barriers**.** *Electronic Journal of e-Learning, 7*(2), 145–154. Retrieved from www.ejel.org

Mackinven, K. (2011). Bringing the outside in: Using technology to support teaching of the nature of science strand. *Computers in New Zealand Schools: Learning, teaching, technology, 23*(3) 227-247. Retrieved from http://www.otago.ac.nz/cdelt/cinzs/

Mahdizadeh, H., Biemans, H., & Mulder, M. (2008). Determining factors of the use of e-learning environments by university teachers. *Computers & Education, 51,* 142–154. doi: 10.1016/j.compedu.2007.04.004

Marshall, S. (2010). A Quality Framework for Continuous Improvement of e-Learning: The e-Learning Maturity Model. *Journal of Distance Education, 24*(1), 143-166. Retrieved from www.jofde.ca/

Marshall, S. (2011). Change, technology and higher education: are universities capable of organisational change? *ALT-J, Research in Learning Technology, 18*(3), 179–192. doi: 10.1080/09687769.2010.529107

Marshall, S. (2012). Improving the quality of e-learning: lessons from the eMM. *Journal of Computer Assisted Learning, 28,* 65–78. doi:10.1111/j.1365-2729.2011.00443.x

McFarlin, B.K. (2008). Hybrid lecture-online format increases student grades in an undergraduate exercise physiology course at a large urban university. *Advances in Physiology Education, 32,* 86-9. doi:10.1152/advan.00066.2007

McDougall, D., & Granby, C. (1996). How Expectation of Questioning Method Affects Undergraduates' Preparation for Class. *Journal of Experimental Education, 65*(1), 43-54. Retrieved from http://www.tandfonline.com

McGee, P., & Reis, A. (2012). Blended Course Design: A Synthesis of Best Practices. *Journal of Asynchronous Learning Networks, 16*(4), 7-22. Retrieved from http://olj.onlinelearningconsortium.org

McKenzie, W.A., Perini, E., Rohlf, V., Toukhsati, S., Conduit, R., & Sanson, G. (2013). A blended learning lecture delivery model for large and diverse undergraduate cohorts. *Computers & Education, 64,* 116–126. doi:10.1016/j.compedu.2013.01.009

McShane, K. (2004). Integrating face-to-face and online teaching: academics' roles concept and teaching choices. *Teaching in Higher Education, 9*(1), 3-16. doi:10/1080.1356251032000155795

Merriam, S.B. (1998). *Qualitative Research and Case Study Applications in Education*. San Francisco: Jossey-Bass.

Ministry of Economic Development. (2008). *The Digital Strategy 2.0*. Wellington, New Zealand: Ministry of Education. Retrieved from http://www.aotearoapeoplesnetwork.org/sites/aotearoapeoplesnetwork.org/files/Digital-Strategy.pdf

Ministry of Education. (2004). *Interim Tertiary e-Learning Framework*. Wellington, New Zealand: Ministry of Education. Retrieved from http://www.minedu.govt.nz/NZEducation/EducationPolicies/TertiaryEducation/ELearning/~/media/MinEdu/Files/EducationSectors/TertiaryEducation/InterimTertiaryeLearningFrameworkweb.pdf

Ministry of Education. (2006). *ICT Strategic Framework for Education*. Wellington, New Zealand: Ministry of Education. Retrieved from http://ccti.colfinder.org/sites/default/files/nz_ictstrategicframeworkeducation.pdf

Ministry of Education. (2010a). What is e-Learning? Retrieved April 23, 2015 from http://www.minedu.govt.nz/NZEducation/EducationPolicies/TertiaryEducation/ELearning/WhatIsELearning.aspx

Ministry of Education. (2010b). The Ministry's role in tertiary e-Learning**.** Retrieved April 23, 2015 from http://www.minedu.govt.nz/NZEducation/EducationPolicies/TertiaryEducation/ELearning/StrategicContext.aspx

Ministry of Education. (2011). *ICT Investment Framework 2011-2014*. Wellington, New Zealand: Ministry of Education. Retrieved from http://www.minedu.govt.nz/~/media/MinEdu/Files/Agencies/EducationAgenciesICTInvestmentFrameworkStrategy20112014.pdf

Missildine, K., Fountain, R., Summers, L., & Gosselin, K. (2013). Flipping the Classroom to Improve Student Performance and Satisfaction. *Journal of Nursing Education, 52*(10), 597-599. doi:10.3928/01484834-20130919-03

Mitchell, P., & Forer, P. (2010). Blended learning: the perceptions of first-year geography students. *Journal of Geography in Higher Education, 34*(1), 77–89. doi: 10.1080/03098260902982484

Monteiro, E., & Morrison, K. (2014). Challenges for collaborative blended learning in undergraduate students. *Educational Research and Evaluation: An International Journal on Theory and Practice, 20*(7-8), 564-591. doi:10.1080/13803611.2014.997126

Moore, N., & Gilmartin, M. (2010). Teaching for better learning: A blended learning pilot project with first-year geography undergraduates. *Journal of Geography in Higher Education, 34*(3), 327–344. doi: 10.1080/03098265.2010.501552

Moravec, M., Williams, A., Aguilar-Roca, N., & O'Dowd, D.K. (2010). Learn before Lecture: A Strategy That Improves Learning Outcomes in a Large Introductory Biology Class. *CBE—Life Sciences Education, 9*, 473–481. doi:10.1187/cbe.10–04–0063

Mortera-Gutiérrez, F. (2006). Faculty Best Practices Using Blended Learning in E-Learning and Face-to-Face Instruction. *International Journal on E-Learning, 5*(3), 313-337. Retrieved from http://www.editlib.org/j/IJEL/

Moskal, P., Dzuiban, C., & Hartman, J. (2013). Blended learning: a dangerous idea? *Internet and Higher Education, 18*, 15–23. doi:10.1016/j.iheduc.2012.12.001

Mueller, P.A., & Oppenheimer, D.M. (2014). The Pen is Mightier than the Keyboard: Advantages of Longhand Over Laptop Note Taking. *Psychological Science, 25*(6), 1159-1168. doi:10.1177/0956797614524581

Nanayakkara, C., & Whiddett, D.J. (2005). A model of user acceptance of e-learning technologies: A case study of a polytechnic in New Zealand. In R. Kaschek, HC. Mayr, & S. Liddle (Eds.), *Proceedings of the 4th International Conference of Information Systems Technology and Its Applications ISTA, Palmerston North, New Zealand, 23-25 May* (pp. 180-189). Retrieved from http://dblp1.uni-trier.de/db/conf/ista/ista2005.html

Neumann, D. L., & Hood, M. (2009). The effects of using a wiki on student engagement and learning of report writing skills in a university statistics course. *Australasian Journal of Educational Technology, 25*(3), 382-398. Retrieved from http://www.ascilite.org.au/ajet

New Zealand Council for Educational Research. (2004). *Critical Success Factors and Effective Pedagogy for e-learning in Tertiary Education*. Wellington, New Zealand: New Zealand Council for Educational Research. Retrieved from http://www.minedu.govt.nz/~/media/MinEdu/Files/EducationSectors/TertiaryEducation/NZCERFinalReport.pdf

Ng, W. (2011). Why digital literacy is important for science teaching and learning. *Teaching Science, 57*(4), 26-31. Retrieved from http://www.asta.edu.au/resources/teachingscience

Nicholson, L., Putwain, D., & Hornby-Atkinson, P. (2013). The key to successful achievement as an undergraduate student: confidence and realistic expectations? *Studies in Higher Education, 38*(2), 285–298. doi:10.1080/03075079.2011.585710

Niemic, M., & Otte, G. (2010). An Administrator's Guide to the Whys and Hows of Blended Learning. *Journal of Asynchronous Learning Networks, 14*(1), 115-126. Retrieved from http://www.olj.onlinelearningconsortium.org

Norberg, A., Dziuban, C. D., & Moskal, P. D. (2011). A time-based blended learning model. *On the Horizon, 19*(3), 207–216. Retrieved from http://www.emeraldinsight.com/loi/oth

Ocak, M.A. (2010). Blend or not to blend: a study investigating faculty members' perceptions of blended teaching**.** *World Journal on Educational Technology, 2*(3), 196-210. Retrieved from www.world-education-center.org/index.php/wjet

OECD. (2008). *Encouraging Student Interest in Science and Technology Studies.* Paris, France: OECD Publishing. Retrieved from www.sourceoecd.org/education/9789264040694

Oh, E., & Parks, S. (2009). How are universities involved in blended instruction? *Educational Technology and Society, 12*(3), 327-342. Retrieved from http://www.ifets.info/

Osborne, J., & Collins, S. (2001). Pupils' views of the role and value of the science curriculum: a focus-group study. *International Journal of Science Education, 23*(5), 441–467. doi: 10.1080/09500690010006518

Osborne, J., & Henessey, S. (2006). *Literature Review in Science Education and the Role of ICT: Promise, Problems and Future Directions*. FutureLab Report. Retrieved from http://archive.futurelab.org.uk

Osgerby, J. (2013). Students' Perceptions of the Introduction of a Blended Learning Environment: An Exploratory Case Study. *Accounting Education: An International Journal*, *22*(1), 85-99. doi: 10.1080/09639284.2012.729341

O'Toole, J.M., & Absalom, D.J. (2003). The Impact of Blended Learning on Student Outcomes: Is there room on the horse for two? *Journal of Educational Media*, *28,* 179-190. doi: 10.1080/1358165032000165680

Owens, T. (2012). Hitting the nail on the head: the importance of specific staff development for effective blended learning. *Innovations in Education and Teaching International, 49*(4), 389–400. doi:10.1080/14703297.2012.728877

Owston, R. (2013). Blended learning policy and implementation: Introduction to the special issue. *Internet and Higher Education, 18,* 1–3. doi:10.1016/j.iheduc.2013.03.002

Owston, R., York, D., & Murtha, S. (2013). Student perceptions and achievement in a university blended learning strategic initiative. *Internet and Higher Education, 18*, 38–46. doi:10.1016/j.iheduc.2012.12.003

Paechter, M., & Maier, B. (2010). Online or face-to-face? Students' experiences and preference in e-learning. *Internet and Higher Education, 13*, 292-297. doi: 10.1016/j.iheduc.2010.09.004

Palmer, S., & Holt, D. (2009). Staff and student perceptions of an online learning environemtn: Difference and development. *Australasian Journal of Educational Technology*, *25*(3), 366-381. Retrieved from www.ascilite.org.au/ajet

Parkinson, T.J., Hughes, H., Gardner, D.H., Suddaby, G.T., Giling, M., & MacIntyre, B.R. (2011). *Engaging learners effectively in science, technology and engineering: The pathway from secondary to university education*. Wellington, New Zealand: Ako Aotearoa. Retrieved from https://akoaotearoa.ac.nz/projects/engaging-learners-effectively-science-technology-and-engineering-pathway-secondary-university-educat

Pombo, L., & Moriera, A. (2012). Evaluation Framework for Blended Learning Courses: A Puzzle Piece for the Evaluation Process. *Contemporary Educational Technology*, *3*(3), 201-211. Retrieved from http://www.cedtech.net/

Porter, W.W., Graham, C.R., Spring, K.A., & Welch, K.R. (2014). Blended learning in higher education: Institutional adoption and implementation. *Computers & Education, 75*, 185–195. doi:10.1016/j.compedu.2014.02.011

Poon, J. (2013). Blended Learning: An Institutional Approach for Enhancing Students' Learning Experiences. *MERLOT Journal of Online Learning and Teaching*, *9*(2), 271-289. Retrieved from http://jolt.merlot.org/index.html

Pratrap, P., & Salah, J. (2004). The Effectiveness of Internet-Controlled Astronomical Research Instrumentation for Education. *Journal of Science Education and Technology, 13*(4), 473-484. doi:1059-0145/04/1200-0473/1

Prensky, M. (2001). Digital natives, digital immigrants. *On the Horizon*, *9*(5), 1-6. Retrieved from http://www.emeraldinsight.com

Qualtrics. (2014). Qualtrics software, Version 2013 of the Qualtrics Research Suite. Copyright © 2014 Qualtrics, Provo, UT, USA. http://www.qualtrics.com

Quinn, D., Amer, Y., Lonie, A., Blackmore, K., Thompson, L., & Pettigrove, M. (2012). Leading change: applying change management approaches to engage students in blended learning. *Australasian Journal of Educational Technology, 28*(1), 16-29. Retrieved from www.ascilite.org.au/ajet

Ramasundaram, V., Grunwald, S., Mangeot, A., Comerford, N.B., & Bliss, C.M. (2005). Development of an environmental virtual field laboratory. *Computers & Education, 45*, 21–34. doi:10.1016/j.compedu.2004.03.002

Reed, P. (2014). Staff experience and attitudes towards technology-enhanced learning initiatives in one Faculty of Health and Life Sciences. *Research in Learning Technology*. Advanced online publication. doi:10.3402/rlt.v22.22770

Roberts, J., & Styron, R. (2010). Student satisfaction and persistence: factors vital to student retention. *Research in Higher Education*, *6*(3), 1-18. Retrieved from http://www.aabri.com/rhej.html

Roblyer, M.D., McDaniel, M., Webb, M., Herman, J., & Witty, J.V. (2010). Findings on Facebook in higher education: A comparison of college faculty and student uses and perceptions of social networking sites. *Internet and Higher Education, 13*, 134–140. doi:10.1016/j.iheduc.2010.03.002

Rogers, L. (2003). *Does ICT in science really work in the classroom?* Paper presented at International Research Group on Physics Teaching, Udine, Italy, 1-6 September. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.111.4688&rep=rep1&type=pdf

Rosenberg, W.J. (2007). What's needed for e-learning to take off? Designing a suitable national and institutional policy runway. *Journal of Distance Learning*, *11*(1), 1-12. Retrieved from http://www.deanz.org.nz/journal/

Rundgren, C.-J., & Tibbell, L.E.A. (2010). Critical features of visualizations of transport through the cell membrane—an empirical study of upper secondary and tertiary students' meaning-making of a still image and an animation. *International Journal of Science and Mathematics Education*, *8*, 223-246. Retrieved from http://www.springer.com

Russell, C. (2009). A systemic framework for managing e-learning adoption in campus universities: individual strategies in context. *Research in Learning Technology, 17*(1), 3–19. doi: 10.1080/09687760802649871

Schmidt, L. (2010). *Academic Technology Survey*. Retrieved 14 September 2013 from http://www.doit.wisc.edu/about/research/

Scott, K.M. (2014). Change in university teachers' elearning beliefs and practices: a longitudinal study. *Studies in Higher Education*. Advanced online publication. doi:10.1080/03075079.2014.942276

Seidel, S.B., & Tanner, K.D. (2013) "What if students revolt?" Considering Student Resistance: Origins, Options, and Opportunities for Investigation. *CBE—Life Sciences Education, 12*, 586–595. doi:10.1187/cbe-13-09-0190

Sharpe, R., Benfield, G., & Francis, R. (2006). Implementing a university e-learning strategy: levers for change within academic schools. *ALT-J, Research in Learning Technology, 14*(2), 135–151. doi:10.1080/09687760600668503

Sharpe, R., Benfield, G., Roberts, G., & Francis, R. (2006). *The undergraduate experience of blended e-learning: a review of UK literature and practice*. York, United Kingdom: Higher Education Academy. Retrieved from http://www.heacademy.ac.uk/research/Sharpe_Benfield_Roberts_Francis.pdf

Shen, J. (2010). Nurturing Students' Critical Knowledge Using Technology-enhanced Scaffolding Strategies in Science Education. *Journal of Science Education and Technology, 19*, 1–12. doi: 10.1007/s10956-009-9183-1

Silverman, D. (2000). *Doing Qualitative Research: A Practical Handbook*. London, United Kingdom: Sage.

Skelton, D. (2010). Blended learning: Lecturers have their say. In S. Mann & M. Verhaart (Eds.), *Proceedings of the 1st Annual Conference of Computing and Information Technology Research and Education New Zealand (CITRENZ2010) incorporating the 23rd Annual Conference of the National Advisory Committee on Computing Qualifications, Dunedin, New Zealand, 6-9th July* (pp. 235-245). Retrieved from http://www.naccq.ac.nz

Smythe, M. (2012*). Blended learning: A transformative process?* Paper presented at National Tertiary Learning & Teaching Conference 2011. Nelson, New Zealand, 12-14 October 2011. Retrieved from https://akoaotearoa.ac.nz/community/national-teaching-and-learning-conference-2010/resources/files/smythe-blended-learning-transformative-process

Stacey, E., & Wiesenberg, F. (2007). A study of face-to-face and online teaching philosophies in Canada and Australia. *Journal of Distance Education, 22*(1), 19-40. Retrieved from www.jofde.ca

Stake, R.E. (2006). *Multiple Case Study Analysis*. New York: Guilford Press

Staples, K. (2004). A University Student's perspective on Reform in Teaching Undergraduate Science. In D.W. Sunal, E.L. Wright, & J.B. Day (Eds.), *Reform in Undergraduate Science Teaching for the 21st Century* (pp. 351-370). Greenwich, CT: Information Age Publishing.

Steel, C. (2009). Reconciling university teacher beliefs to create learning designs for LMS environments. *Australasian Journal of Educational Technology, 25*(3), 399-420. Retrieved from www.ascilite.org.au/ajet/

Stein, S.J., Sheppard, K., & Harris, I. (2011). Conceptions of e-learning and professional development for e-learning held by tertiary educators in New Zealand. *British Journal of Educational Technology, 42(1),* 145–165. doi:10.1111/j.1467-8535.2009.00997.x

Strayer, J.F. (2012). How learning in an inverted classroom influences cooperation, innovation and task orientation. *Learning Environment Research*, *15*, 171–193. doi:10.1007/s10984-012-9108-4

Taylor, J.A., & Newton, D. (2013). Beyond blended learning: a case study of institutional change at an Australian regional university. *Internet and Higher Education*, *18*, 54–60. doi:10.1016/j.iheduc.2012.10.003

Thomas, G. (2011). *How to do Your Case Study: A Guide for Students and Researchers*. London, United Kingdom: Sage.

Tibbell, L.E.A., & Rundgren, C.-J. (2010). Educational Challenges of Molecular Life Science: Characteristics and Implications for Education and Research. *CBE—Life Sciences Education*, *9*, 25–33. doi:10.1187/cbe.08–09–0055

Torrisi-Steele, G., & Drew, S. (2013). The literature landscape of blended learning in higher education: the need for better understanding of academic blended practice. *International Journal for Academic Development*, *18*(4), 371-383. doi:10.1080/1360144X.2013.786720

Toth, E.E., Ludvico, L.R., & Morrow, B.L. (2014). Blended inquiry with hands-on and virtual laboratories: the role of perceptual features during knowledge construction. *Interactive Learning Environments*, *22*(5), 614-630. doi:10.1080/10494820.2012.693102

Tselios, N., Daskalakis, S., & Papadopoulou, M. (2011). Assessing the Acceptance of a Blended Learning University Course. *Educational Technology & Society*, *14(2)*, *224–235*. Retrieved from http://www.ifets.info/

Twigg, C. (2003). Improving learning and reducing cost: new models for online learning. *Educause Review*, *38*, 28−38. Retrieved from www.educause.edu

Tynan, B., Ryan, Y., & Lamont-Mills, A. (2015). Examining workload models in online and blended teaching. *British Journal of Educational Technology*, *46*(1), 5-15. doi:10.1111/bjet.12111

Tytler, R. (2007). *Re-Imagining Science Education: Engaging students in science for Australia's future*. Camberwell, Australia: Australian Council for Education Research. Retrieved from www.acer.edu.au/research/reports/AER.html

Ulriksen, L., Madsen, L.M., & Holmegaard, H.T. (2010). What do we know about explanations for drop out/opt out among young people from STM higher education programmes? *Studies in Science Education, 46*(2), 209-244. Retrieved from http://www.tandfonline.com/loi/rsse

Vaughan, N. (2007). Perspectives on blended learning in higher education. *International Journal on E-Learning, 6(*1), 81-94. Retrieved from http://editlib.org/j/IJEL/

Verkroost, M.J., Meijerink, L., Lintsen, H., & Veen, W. (2008). Finding a Balance in Dimensions of Blended Learning. *International Journal on E-Learning, 7*(3), 499-522. Retrieved from http://www.editlib.org/j/IJEL/

Waha, B., & Davis, K. (2014). University students' perspective on blended learning, *Journal of Higher Education Policy and Management*, *36*(2), 172-182. doi:10.1080/1360080X.2014.884677

Walker, J.D., Cotner, S.H., Baepler, P.M., & Decker, M.D. (2008). A Delicate Balance: Integrating Active Learning into a Large Lecture Course. *CBE—Life Sciences Education*, *7*, 361–367. doi:10.1187/cbe.08–02–0004

Wegerif, R. (2002). *Literature Review in Thinking Skills, Technology and Learning*. Slough, United Kingdom: FutureLab. Retrieved from http://archive.futurelab.org.uk/resources/documents/lit_reviews/Thinking_Skills_Review.pdf

Williams, A., Brosi, D., & O'Dowd, D. (2013). *An Experimental "Flipped" Introductory Biology for Majors: Preliminary results and Recommendations*. Unpublished manuscript, University of California - Irvine, Irvine, CA.

Wilson, G., & Randall, M. (2012). The implementation and evaluation of a new learning space: a pilot study. *Research in Learning Technology*, *20*, 14431. doi:10.3402/rlt.v20i0.14431h

Witjmans, M., van Rens, L., van Muijlwijk-Koezen, J.E. (2014). Activating Students' Interest and Participation in Lectures and Practical Courses Using Their Electronic Devices. *Journal of Chemical Education*, *91*, 1830−1837. doi:10.1021/ed500148r

Wolter, B.H.K., Lundeberg, M.A., & Bergland, M. (2013). What makes science relevant?: student perceptions of multimedia case learning in ecology and health. *Journal of*

STEM Education: Innovations and Research, *14*(1), 26-35. Retrieved from http://www.jstem.org

Wright, E.L., & Sunal, D.W. & Day, J.B. (2004). Reform in undergraduate science classrooms. In D.W. Sunal, E.L. Wright, & J.B. Day (Eds.), *Reform in Undergraduate Science Teaching for the 21st Century* (pp. 33-52). Greenwich, CT: Information Age Publishing.

Yin, R.K. (1994). *Case Study Research: Design and Methods* (2nd ed.). Thousand Oaks, CA: Sage.

Yoon, C., Kensington-Miller, B., Sneddon, J., & Bartholomew, H. (2011). It's not the done thing: social norms governing students' passive behaviour in undergraduate mathematics lectures. *International Journal of Mathematical Education in Science and Technology*, *42*(8), 1107–1122. doi: 10.1080/0020739X.2011.573877

Yuen, A.H.K. (2011). Exploring teaching approaches in blended learning. *Research and Practice in Technology Enhanced Learning, 6,* 3-23. Retrieved from www.worldscientific.com/worldscinet/rptel

Yun, S.M., & Kim, H.-B. (2014). Changes in Students' Participation and Small Group Norms in Scientific Argumentation. *Research in Science Education.* Advanced online publication. doi: 10.1007/s11165-014-9432-z

Zepke, N., Leach, L., & Butler, P. (2014). Student engagement: students' and teachers' perceptions. *Higher Education Research & Development*, *33*(2), 386-398. doi:10.1080/07294360.2013.832160

APPENDICES

Appendix A: Management interview schedule

1. Introduction– quickly explain purpose of study is to better understand the policy and issues surrounding adoption and implementation of BL at UC.

2. General questions
a. How do you think UC defines blended learning?
b. Do you think UC is actively trying to implement BL?
c. What do you think are the primary purposes for adopting BL at UC? (related to improved pedagogy, increased flexibility for students/faculty, reduced costs, etc.)
d. What issues and challenges have you faced in trying to implement BL at UC?

3. Strategy
a. Vision/Plan
i. Where do you think the drive/promotion of BL at UC comes from?
ii. Has UC's vision/purpose for BL been communicated to staff and students? If so how?
iii. Does UC have explicit written policies surrounding blended learning? If so, would you be willing to share them with me.

b. Implementation strategy
i. Does UC have a strategy for implementing BL across UC? If so, what does it involve?
ii. Does UC have a strategy for getting buy-in for faculty and department adoption of BL practices?
iii. Does UC have a strategy for measuring the progress of BL implementation?
iv. Do you think external constraints such as accreditation affect decisions around blended learning?

4. Structure
a. Institutional policy structure
i. Models— Does UC have a specific model or architectures that have been adopted for blended learning? If so, explain.
ii. Course development— Does UC have a course development model for blended learning courses? What does the course development process look like?
iii. Recruitment— How do staff become interested in and pursue teaching a blended learning course?
iv. Scheduling—How are blended learning courses planned and scheduled? E.g. Can staff reduce F2F time when moving learning online?
v. Catalog— When students look at courses, can they see whether a course is blended or not? If so, what does it look like to them? How do blended learning sections of a course look different from traditional sections?

b. Comparison to F2F and online courses
i. Ownership — Where does ownership for blended learning courses and materials reside? (within the academic departments, with a teaching and learning centre, with an online learning or continuing education unit, etc.)
ii. Are the learning outcomes or competencies the same for blended learning courses as their equivalent courses in the traditional format?
iii. Instructors—Do the same instructors teach both blended and traditional formats?

iv. Student–teacher ratios—Are there different student–teacher ratio expectations for F2F and BL courses?
v. Assessments—Are students evaluated/assessed the same way in blended learning courses as they are in traditional courses?
vi. Faculty load—Are blended learning and traditional F2F courses viewed differently in terms of staff workload?

c. Incentive structure
i. Faculty incentives—Does UC offer any incentives to faculty who implement blended learning? If so, what are they (e.g. tenure incentives, funding, equipment, weighing blended learning courses more heavily than regular classes in measuring teaching load)?

d. Physical/Technological infrastructure
i. Are you aware of any additional technical infrastructure, if any, that has been needed to support blended learning? (libraries, academic services,)

e. Evaluation of implementation
i. What institutional-level evaluations are in place to look at the desired outcomes for blended learning institution wide?
ii. Does UC currently have students or professors report the types of blended learning they utilize in their classes?
iii. Does UC currently ask students and/or professors to report the level of access, flexibility, and/or quality of blended learning? How?

5. Support
a. Faculty professional development
i. What technological and pedagogical support is available for staff who have decided to teach in a blended learning format?
ii. Has UC conducted any training for staff regarding how to adopt blended learning in their pedagogy? Please describe.
iii. If UC held initial training, have you had any subsequent seminars or forums for staff to provide updates and/or best practices? Please describe.
iv. Are there plans to increase this support in the future? What are they?

b. Student support
i. What support is needed for students enrolled in BL courses?
ii. What support is available for students in BL courses?

6. Final questions
Do you have any comments specifically about blended learning in undergraduate science?

Any additional institutional issues related to blended learning that you think are relevant to our conversation? If so, please share.

Appendix B: Lecturer interview schedule

1. Introduction
The purpose of this interview is to better understand your perspectives and opinions on learning and teaching of science at UC, particularly with regard to the use of technology.

2. General
How long have you been teaching in a tertiary setting?

How would you describe your teaching style/approach?

What does the term blended learning mean to you?

How long you have been using a blended approach in your teaching?

How have you used blended learning approaches in your undergraduate science teaching? Can you give a specific example? What other examples have you come across?

What do you think are the main benefits of using a blended learning approach?

3. Experience of planning and delivering BL in science
What do you think are the challenges of teaching undergraduate science? (If answer is general, follow-up: Specifically learning science content or the nature of science?)

What roles do you think technology can play in science learning and teaching?

What do you think technology has successfully enabled you to do that you couldn't have done otherwise?

What are the key things to consider when planning and designing science courses which incorporate and use technology?

How do you approach teaching courses which include both F2F and online contexts?

How do you think blended learning impacts on your role as a teacher?

4. Drivers, barriers and enablers for BL
What are the issues you have encountered with using a blended learning approach?

What support is available for blended learning? Is this effective?

5. Perceptions of students' views of BL
Do you think the majority of students want blended learning in their courses?

Do you think the majority of students are equipped with the knowledge/skills to be successful in blended learning? From a science perspective?

How do you think blended learning impacts on your students' learning and motivation?

6. Institutional factors
Do you think UC has a blended learning vision/strategy?

What institutional factors help provide an optimal blended learning environment?

How do you think institutions need to change to improve science teaching?

Appendix C: Student interview schedule

1. Introduction

The purpose of this interview is to better understand your perspectives and opinions on learning in science at UC, particularly with regard to the use of technology in learning.

2. General

How long have you been studying at university?

What degree are you studying towards?

Before you came to UC what was your perception of what studying at university would be like?

Did that change throughout your courses?

How do you prefer to learn or to be taught? (Examples if needed: independent, in groups, by reading, by watching etc.)

What do you find difficult about learning in science?

3. Experience of planning and delivering BL in science

What does the term blended learning mean to you?

How have you experienced blended learning or e-learning in your undergraduate science courses? Can you give a specific example? What other examples have you come across?

Do you think that using technology helped/helps you learn? How? Why? (Particularly in science)

How do you think blended learning or e-learning impacts on your motivation for learning? Do you think it impacts on how well you do in your courses?

What do you think are the main benefits of using technology in learning?

Do you want blended learning in your courses?

Do you think you have the knowledge/skills to be successful in blended learning?

What kind of technology do you usually have with you in a lecture/lab/tutorial? What do you use them for during class time? Would you like to use them more? Can you give any examples of what for?

4. Drivers, barriers and enablers for BL

What are the issues you have encountered with using a blended learning approach? e.g. with using Learn or computers at UC

What support is available to help you with blended learning? Is this effective?

5. Institutional factors

How do you think UC needs to change to improve science teaching?

Appendix D: Lecturer survey questions

Q1 Blended learning in undergraduate science: the present and the future Information for survey participants I am Kathryn Mackinven, a Masters student at the College of Education, University of Canterbury. I have previously taught high school science in the UK and recently completed a Postgraduate Diploma in Education (endorsed in e-learning and digital technologies). Blended learning is the combination of face-to-face (lectures) and technology-enabled learning environments (UC Learn and other ICT). I am interested in teacher experiences of blended learning within undergraduate courses and their perspectives about what it might look in the future. I would like to invite you to participate in my present study by completing a survey about your experiences of blended learning within science courses at UC. This online survey should take about 15-25 minutes to complete. Participation is voluntary, and responses will be kept anonymous. I will take particular care to ensure the confidentiality of all data gathered for this study. I will also take care to ensure your anonymity in publications of the findings. All the data will be securely stored in password protected facilities and locked storage at the University of Canterbury for five years following the study. It will then be destroyed. The results of this study will be reported in my thesis and may also be reported nationally and internationally at conferences and in education and teaching related journals. You have the option to not respond to any questions that you choose. Participation or non-participation will not impact your relationship with The University of Canterbury. Submission of the survey will be interpreted as your informed consent to participate and that you affirm that you are at least 18 years of age. If you have any questions about the study, please contact me (kathryn.mackinven@canterbury.ac.nz or tel no.) or my supervisors, Dr Julie Mackey and Associate Professor Lindsey Conner, College of Education, University of Canterbury, Private Bag 4800, Christchurch 8140 (julie.mackey@canterbury.ac.nz or lindsey.conner@canterbury.ac.nz). If you have a complaint about the study, you may contact the Chair, Educational Research Human Ethics Committee, University of Canterbury, Private Bag 4800, Christchurch 8140 (human-ethics@canterbury.ac.nz). Please print or save a copy of this page for your records. Thank you in advance for your participation.

Q2 What department are you from?

Q3 How many years have you been a teacher/lecturer in a tertiary education environment?

Q4 In the last year, across all of the undergraduate courses that you have taught, which of the following teaching methods have you used? You may select more than one answer if appropriate.

- ❑ Face-to-face (entire course is classroom based) (1)
- ❑ Online (entire course is online) (2)
- ❑ Blended (combines face-to-face and online components) (3)
- ❑ Video conference webinar (for example, via the Access grid) (4)
- ❑ I have not taught in the last year (5)

Q5 Which are your preferred teaching methods? You may select more than one answer if appropriate.

- ❑ Face-to-face (entire course is classroom based) (1)
- ❑ Online (entire course is online) (2)
- ❑ Blended (combines face-to-face and online components) (3)
- ❑ Video conference webinar (for example, via the Access grid) (4)
- ❑ I do not have a preference (5)

Q6 Please briefly explain your reasons for the preference(s) given in the previous question?

Q7 In the last year, what percentage of the undergraduate courses you have taught had a blended learning component?

- ❍ All (100%) (1)
- ❍ Almost all (80-99%) (2)
- ❍ Most (50-79% (3)
- ❍ Some (1-49%) (4)
- ❍ None (0%) (5)
- ❍ I have not taught in the last year (6)

Q8 Consider the continuum from 100% face-to-face classroom delivery to 100% online delivery. In general, where would you place your instructional delivery on this continuum?

- ❍ All face-to-face (no online instruction (1)
- ❍ Technology enhanced (face-to-face instruction with supplementary online instructional material such as resources or reading material) (2)
- ❍ Blended (less than 50% of the instruction is delivered online with the remainder face-to-face instruction) (3)
- ❍ Mostly online (50-99% of the instruction is delivered online with the remainder face-to-face) (4)
- ❍ All online (no face-to-face instruction) (5)
- ❍ I have not taught in the last year (6)

Q9 How frequently do you use e-learning tools in your teaching to:

Prepare schemes of work/lesson plans	❍	❍	❍	❍	❍
Create teaching materials	❍	❍	❍	❍	❍
Research and access teaching materials	❍	❍	❍	❍	❍
Make course materials available to learners	❍	❍	❍	❍	❍
Present information in front of the class	❍	❍	❍	❍	❍
Share course materials with colleagues	❍	❍	❍	❍	❍
Record and track learners' progress	❍	❍	❍	❍	❍
Develop learners' understanding of the subject	❍	❍	❍	❍	❍
Communicate with learners outside of the classroom	❍	❍	❍	❍	❍
Test learners' understanding)	❍	❍	❍	❍	❍
Provide feedback	❍	❍	❍	❍	❍

Q10 To what extent do you agree that blended learning:

Improves attendance	❍	❍	❍	❍	❍
Improves student retention	❍	❍	❍	❍	❍
Creates a more enjoyable learning experience	❍	❍	❍	❍	❍
Makes students more motivated	❍	❍	❍	❍	❍
Facilitates higher overall grades	❍	❍	❍	❍	❍
Makes students more employable	❍	❍	❍	❍	❍
Facilitates better record keeping	❍	❍	❍	❍	❍
Makes course management easier	❍	❍	❍	❍	❍

Q11 What do you think are the major challenges for teaching and learning in undergraduate science?

Q12 Please describe a specific example where e-learning tools have supported teaching and learning of undergraduate science.

Q13 Do you think e-learning tools could support the following aspects of teaching in undergraduate science:

Visualisation of unobservable items/processes	❍	❍	❍	❍
Identifying students' misconceptions	❍	❍	❍	❍
Provide authentic learning experiences	❍	❍	❍	❍
Providing access to equipment and experiments not possible in UC laboratories	❍	❍	❍	❍
Delivering scientific content	❍	❍	❍	❍
Improving students' attitudes towards science	❍	❍	❍	❍
Providing real world relevance of course material	❍	❍	❍	❍
Modelling/simulation	❍	❍	❍	❍
Demonstrating complex concepts	❍	❍	❍	❍
Improving students' understanding of the nature of science	❍	❍	❍	❍
Knowledge construction	❍	❍	❍	❍

Q14 Do you think e-learning tools could support students to develop the following science skills:

Data collection	❍	❍	❍	❍
Data interpretation skills (e.g. graphs, blots, gels)	❍	❍	❍	❍
Ability to construct an argument from data	❍	❍	❍	❍
Understanding basic statistics	❍	❍	❍	❍
Data presentation	❍	❍	❍	❍
Written communication of scientific results and ideas	❍	❍	❍	❍
Oral communication of scientific results and ideas	❍	❍	❍	❍
Ability to design an experiment (e.g. identify variables, develop controls)	❍	❍	❍	❍
Problem solving/critical thinking	❍	❍	❍	❍
Reading and evaluating primary literature	❍	❍	❍	❍
Conducting an effective literature search	❍	❍	❍	❍
Ability to create a testable hypothesis	❍	❍	❍	❍
Creating a bibliography and citation of references	❍	❍	❍	❍
Working collaboratively to accomplish a task	❍	❍	❍	❍
Being an effective peer mentor	❍	❍	❍	❍
Working independently when needed	❍	❍	❍	❍
Knowing when to ask for guidance	❍	❍	❍	❍
Being able to infer plausible reasons for failed experiments	❍	❍	❍	❍
Being able to effectively monitor their own learning progress	❍	❍	❍	❍
Lab skills and techniques	❍	❍	❍	❍
Field skills and techniques	❍	❍	❍	❍
Safety awareness	❍	❍	❍	❍
Ability to ask questions	❍	❍	❍	❍

Q15 How frequently do you think students use e-learning tools to:

Present written work/data	❍	❍	❍	❍	❍
Research topics	❍	❍	❍	❍	❍
Create visual presentations	❍	❍	❍	❍	❍
Work independently	❍	❍	❍	❍	❍
Reinforce knowledge	❍	❍	❍	❍	❍
Submit assignments/work on time	❍	❍	❍	❍	❍
Engage with subject matter in the classroom	❍	❍	❍	❍	❍
Organise work	❍	❍	❍	❍	❍
Contact lecturer with queries	❍	❍	❍	❍	❍
Solve problems set by the lecturer	❍	❍	❍	❍	❍
Work collaboratively with peers in the classroom	❍	❍	❍	❍	❍
Catch up on missed lectures	❍	❍	❍	❍	❍
Work collaboratively with peers outside of the classroom	❍	❍	❍	❍	❍
Track their own progress	❍	❍	❍	❍	❍
Support learning during lectures	❍	❍	❍	❍	❍
Support learning during laboratory activities	❍	❍	❍	❍	❍
Support learning during tutorials	❍	❍	❍	❍	❍

Q16 To what extent do you agree with the following statements?

Learners expect lecturers to use e-learning in teaching	❍	❍	❍	❍	❍
Students know how to use e-learning tools successfully	❍	❍	❍	❍	❍
Students want to be able to access material from anywhere	❍	❍	❍	❍	❍
Students are confident to contact a lecturer by email	❍	❍	❍	❍	❍
Students own a variety of technologies that they currently use in learning	❍	❍	❍	❍	❍
Students own a variety of technologies that could be used in teaching and learning but currently are not	❍	❍	❍	❍	❍
Students would prefer to attend lectures face-to-face than access them online	❍	❍	❍	❍	❍
Students would prefer to participate in a face-to-face discussion than an online discussion	❍	❍	❍	❍	❍
Students would prefer to attend a face-to-face laboratory than a virtual one	❍	❍	❍	❍	❍

Q17 Which if the following do you feel is a barrier to your use of e-learning tools? Choose all that apply.

- ❑ Lack of technical skill (1)
- ❑ Lack of technical support (2)
- ❑ Availability of technology resources (3)
- ❑ Reliability of technology resources (4)
- ❑ Lack of instructional design skills (5)
- ❑ Lack of instructional design support (6)
- ❑ Lack of time (7)
- ❑ Lack of money (8)
- ❑ Extra work has little pay off in the course (9)
- ❑ Instructional technology does not fit my teaching style (10)
- ❑ Instructional technology does not support the teaching approach needed for my subject matter (11)
- ❑ Little impact on promotion (12)
- ❑ Lack of incentives/rewards (13)
- ❑ Technologies change too much (14)
- ❑ Copyright/intellectual property issues (15)
- ❑ Not applicable (16)
- ❑ Other, please specify (17) _____

Q18 To what extent do you agree with the following statements?

UC has an e-learning strategy and vision	❍	❍	❍	❍	❍
UC's e-learning strategy and vision are clearly communicated	❍	❍	❍	❍	❍
There is an expectation among senior management that lecturers use e-learning	❍	❍	❍	❍	❍
There is an expectation from the College of Science that lecturers use e-learning	❍	❍	❍	❍	❍
There is an expectation from my department that lecturers use e-learning	❍	❍	❍	❍	❍
My department promotes good practice and innovation in e-learning	❍	❍	❍	❍	❍
E-learning is incorporated into curriculum planning	❍	❍	❍	❍	❍
I am confident that I can identify opportunities to use e-learning in my subject	❍	❍	❍	❍	❍
There are strong support structures and tools I can use to help develop e-learning	❍	❍	❍	❍	❍

Q19 In the future, how do you think your use of e-learning tools in the following activities will change?

Prepare lessons/schemes of work	❍	❍	❍	❍
Create teaching materials	❍	❍	❍	❍
Research and access teaching materials	❍	❍	❍	❍
Make course materials available to learners	❍	❍	❍	❍
Present information in front of the class	❍	❍	❍	❍
Share course materials with colleagues	❍	❍	❍	❍
Record and track learners' progress	❍	❍	❍	❍
Develop learners' understanding of the subject	❍	❍	❍	❍
Communicate with learners outside of the classroom	❍	❍	❍	❍
Test learners' understanding	❍	❍	❍	❍
Provide feedback)	❍	❍	❍	❍

Q20 In the future do you think blended learning has the potential to:

Increase the flexibility of learning provision	❍	❍	❍	❍	❍
Become the main delivery mode in tertiary education	❍	❍	❍	❍	❍
Become the main delivery mode in tertiary science education	❍	❍	❍	❍	❍
Help stimulate better understanding	❍	❍	❍	❍	❍
Equip learners more effectively for future employment	❍	❍	❍	❍	❍
Help widen participation in tertiary education	❍	❍	❍	❍	❍
Improve how staff communicate with students	❍	❍	❍	❍	❍
Tailor learning to individual learner's needs	❍	❍	❍	❍	❍
Save lecturer time by using online/reusable resources	❍	❍	❍	❍	❍
Improve the quality of teaching	❍	❍	❍	❍	❍

Q21 Any other comments?

Appendix E: Student survey questions

Q1 Blended learning in undergraduate science: the present and the future Information for survey participants. I am Kathryn Mackinven, a Masters student at the College of Education, University of Canterbury. I have previously taught high school science in the UK and recently completed a Postgraduate Diploma in Education (endorsed in e-learning and digital technologies). Blended learning is the combination of face-to-face (lectures) and technology-enabled learning environments (UC Learn and other ICT). I am interested in student experiences of blended learning within undergraduate courses and their perspectives about what it might look in the future. I would like to invite you to participate in my present study by completing a survey about your experiences of blended learning within science courses at UC. This online survey should take about 20-25 minutes to complete. Participation is voluntary, and if you do not enter your email address to enter the pool for the reward your responses will be anonymous. If you do enter your email address then you will not be anonymous to me but I will maintain your anonymity within my thesis and in any publications and presentations resulting from this study. I will take particular care to ensure the confidentiality of all data gathered for this study. I will also take care to ensure your anonymity in publications of the findings. All the data will be securely stored in password protected facilities and locked storage at the University of Canterbury for five years following the study. It will then be destroyed. The results of this study will be reported in my thesis and may also be reported nationally and internationally at conferences and in education and teaching related journals. You have the option to not respond to any questions that you choose. Participation or non-participation will not impact your relationship with The University of Canterbury. Submission of the survey will be interpreted as your informed consent to participate and that you affirm that you are at least 18 years of age. If you have any questions about the study, please contact me (kathryn.mackinven@canterbury.ac.nz or tel no.) or my supervisors, Dr Julie Mackey and Associate Professor Lindsey Conner, College of Education, University of Canterbury, Private Bag 4800, Christchurch 8140 (julie.mackey@canterbury.ac.nz or lindsey.conner@canterbury.ac.nz). If you have a complaint about the study, you may contact the Chair, Educational Research Human Ethics Committee, University of Canterbury, Private Bag 4800, Christchurch 8140 (human-ethics@canterbury.ac.nz). Please print or save a copy of this page for your records. Thank you in advance for your participation.

Q2 What degree and subject are you studying? e.g. BSc in Chemistry, Physics, Geography, Biology.

Q3 How many years have you been a student at a university?

Q4 In the last year, across all of the undergraduate courses that you have taken, which of the following teaching methods have you experienced? You may select more than one answer if appropriate.

- ❑ Face-to-face (entire course is classroom based) (1)
- ❑ Online (entire course is online) (2)
- ❑ Blended (combines face-to-face and online components) (3)
- ❑ Video conference webinar (for example, via the Access grid) (4)

Q5 How do you prefer to be taught? You may select more than one answer if appropriate.

- ❑ Face-to-face (entire course is classroom based) (1)
- ❑ Online (entire course is online) (2)
- ❑ Blended (combines face-to-face and online components) (3)
- ❑ Video conference webinar (for example, via the Access grid) (4)
- ❑ I do not have a preference (5)

Q6 Please briefly explain your reasons for the preference(s) given in question 4?

Q7 In the last year, what percentage of the undergraduate courses you have taken included blended learning?

- ❍ All (100%) (1)
- ❍ Almost all (80-99%) (2)
- ❍ Most (50-79% (3)
- ❍ Some (1-49%) (4)
- ❍ None (0%) (5)

Q8 How frequently do you use e-learning tools to:

Present written work/data	❍	❍	❍	❍
Research topics	❍	❍	❍	❍
Create visual presentations	❍	❍	❍	❍
Work independently	❍	❍	❍	❍
Reinforce knowledge	❍	❍	❍	❍
Submit assignments/work on time	❍	❍	❍	❍
Engage with subject matter in the classroom	❍	❍	❍	❍
Organise work	❍	❍	❍	❍
Contact lecturer with queries)	❍	❍	❍	❍
Solve problems set by the lecturer	❍	❍	❍	❍
Work collaboratively with peers in the classroom	❍	❍	❍	❍
Catch up on missed lectures	❍	❍	❍	❍
Work collaboratively with peers outside of the classroom (13)	❍	❍	❍	❍
Track your own progress	❍	❍	❍	❍
To support learning during lectures	❍	❍	❍	❍
To support learning during laboratories	❍	❍	❍	❍
To support learning during tutorials	❍	❍	❍	❍

Q9 To what extent do you agree with the following statements?

I expect lecturers to use e-learning in teaching	❍	❍	❍	❍	❍
I know how to use e-learning tools successfully	❍	❍	❍	❍	❍
I want to be able to access material from anywhere	❍	❍	❍	❍	❍
I am confident to contact a lecturer by email	❍	❍	❍	❍	❍
I own a variety of technologies that I currently use in learning	❍	❍	❍	❍	❍
I own a variety of technologies that could be used in teaching and learning but currently are not	❍	❍	❍	❍	❍
I expected my university courses to include more e-learning	❍	❍	❍	❍	❍
I would prefer to attend lectures face-to-face than access them online	❍	❍	❍	❍	❍
I would prefer to participate in a face-to-face discussion than an online discussion	❍	❍	❍	❍	❍
I would prefer to attend a face-to-face laboratory than a virtual one	❍	❍	❍	❍	❍

Q10 To what extent do you think that blended learning:

Improves attendance	❍	❍	❍	❍	❍
Stops students from dropping courses	❍	❍	❍	❍	❍
Creates a more enjoyable learning experience	❍	❍	❍	❍	❍
Makes students more motivated	❍	❍	❍	❍	❍
Facilitates higher overall grades	❍	❍	❍	❍	❍
Makes students more employable	❍	❍	❍	❍	❍
Facilitates better record keeping	❍	❍	❍	❍	❍
Makes management of studying easier	❍	❍	❍	❍	❍

Q11 What do you find most difficult about learning in science?

Q12 Please describe a specific example where e-learning tools have supported your learning in undergraduate science.

Q13 Do you think e-learning tools could support the following aspects of learning in undergraduate science:

Visualisation of unobservable items/processes, e.g. molecular structures	❍	❍	❍	❍
Identifying your misconceptions about science	❍	❍	❍	❍
Providing authentic learning experiences	❍	❍	❍	❍
Providing access to equipment and experiments not possible in UC laboratories (4)	❍	❍	❍	❍
Delivering scientific content (5)	❍	❍	❍	❍
Improving students' attitudes towards science (6)	❍	❍	❍	❍
Providing real world relevance of course material (7)	❍	❍	❍	❍
Modelling/simulation (8)	❍	❍	❍	❍
Demonstrating complex concepts (9)	❍	❍	❍	❍
Improving your understanding of the nature of science (10)	❍	❍	❍	❍
Knowledge construction (11)	❍	❍	❍	❍

Q14 Do you think e-learning tools could support students to develop the following science skills:

Data collection	❍	❍	❍	❍
Data interpretation skills (e.g. graphs, blots, gels)	❍	❍	❍	❍
Ability to construct an argument from data	❍	❍	❍	❍
Understanding basic statistics	❍	❍	❍	❍
Data presentation	❍	❍	❍	❍
Written communication of scientific results and ideas	❍	❍	❍	❍
Oral communication of scientific results and ideas	❍	❍	❍	❍
Ability to design an experiment (e.g. identify variables, develop controls)	❍	❍	❍	❍
Problem solving/critical thinking	❍	❍	❍	❍
Reading and evaluating primary literature	❍	❍	❍	❍
Conducting an effective literature search	❍	❍	❍	❍
Ability to create a testable hypothesis	❍	❍	❍	❍
Creating a bibliography and citation of references	❍	❍	❍	❍
Working collaboratively to accomplish a task	❍	❍	❍	❍
Being an effective peer mentor	❍	❍	❍	❍
Working independently when needed	❍	❍	❍	❍
Knowing when to ask for guidance	❍	❍	❍	❍
Being able to infer plausible reasons for failed experiments	❍	❍	❍	❍
Being able to effectively monitor your own learning progress	❍	❍	❍	❍
Lab skills and techniques	❍	❍	❍	❍
Field skills and techniques	❍	❍	❍	❍
Safety awareness	❍	❍	❍	❍
Ability to ask questions	❍	❍	❍	❍

Q15 Which if the following devices do you or would you use in your learning?

Laptop computer	❍	❍	❍
Tablet computer (e.g. ipad, surface)	❍	❍	❍
Smart phone	❍	❍	❍
mp3 player	❍	❍	❍
Other	❍	❍	❍

Q16 During the lectures and laboratories you have attended in the last week, which of the following devices did you have with you? Choose all that apply.

Laptop computer	❍	❍
Tablet computer	❍	❍
Smart phone	❍	❍
mp3 player	❍	❍
Other	❍	❍

Q17 During the lectures and laboratories you attended in the last week, what did you use these devices for? Choose all that apply.

Access the internet	❑	❑	❑
Read or send an instant/text message	❑	❑	❑
Read or send an email	❑	❑	❑
Participate in a learning activity	❑	❑	❑
Read a document	❑	❑	❑
Other	❑	❑	❑

Q18 If you indicated that you accessed the internet in the previous question, what did you access it for? e.g. access UC Learn, Facebook, google a word definition etc.

Q19 In the future, how do you think your use of e-learning tools in the following activities will change?

Present written work/data	❍	❍	❍	❍
Research topics	❍	❍	❍	❍
Create visual presentations	❍	❍	❍	❍
Work independently	❍	❍	❍	❍
Reinforce knowledge	❍	❍	❍	❍
Submit assignment/work on time	❍	❍	❍	❍
Engage with subject matter in the classroom	❍	❍	❍	❍
Organise work	❍	❍	❍	❍
Contact lecturer with queries	❍	❍	❍	❍
Solve problems set by the lecturers	❍	❍	❍	❍
Work collaboratively with peers in the classroom	❍	❍	❍	❍
Catch up on missed lectures	❍	❍	❍	❍
Work collaboratively with peers outside of the classroom	❍	❍	❍	❍
Track your own progress	❍	❍	❍	❍
To support learning during lectures	❍	❍	❍	❍
To support learning during laboratories	❍	❍	❍	❍
To support learning during tutorials	❍	❍	❍	❍

Q20 In the future do you think blended learning has the potential to:

Increase the flexibility of learning provision	❍	❍	❍	❍	❍
Become the main delivery mode in tertiary education	❍	❍	❍	❍	❍
Become the main delivery mode in tertiary science education	❍	❍	❍	❍	❍
Help stimulate better understanding	❍	❍	❍	❍	❍
Equip learners more effectively for future employment	❍	❍	❍	❍	❍
Help widen participation in tertiary education	❍	❍	❍	❍	❍
Improve how lecturers communicate with students	❍	❍	❍	❍	❍
Tailor learning to individual learner's needs	❍	❍	❍	❍	❍
Save lecturer time by using online/reusable resources	❍	❍	❍	❍	❍
Improve the quality of teaching	❍	❍	❍	❍	❍

Q21 Any other comments?

Appendix F: Example information sheet

Tel:

Email: kathryn.mackinven@canterbury.ac.nz

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

Blended learning in undergraduate science: the present and the future

Information sheet for managers

I am Kathryn Mackinven, a Masters student at the College of Education, University of Canterbury. I have previously taught high school science in the UK and recently completed a Postgraduate Diploma in Education (endorsed in e-learning and digital technologies).

Blended learning is the combination of face-to-face (lectures) and technology-enabled learning environments (UC Learn and other ICT). I am interested in management, teacher and student experiences of blended learning within undergraduate courses and their perspectives about what it might look in the future.

I would like to invite you to participate in my present study. If you agree to take part you will be agreeing to:

- Provide me with documentation relating to teaching and learning within the university such as strategy documents.
- Take part in an interview about your perspectives of blended learning within undergraduate degrees (with particular reference to science disciplines) and your views on the future of blended learning. This will last approximately one hour and will be recorded.

Please note that participation in this study is voluntary. If you do participate, you have the right to withdraw from the study at any time without penalty. If you withdraw, I will do my best to remove any information relating to you, provided this is practically achievable.

I will take particular care to ensure the confidentiality of all data gathered for this study. I will also take care to ensure your anonymity in publications of the findings. All the data will be securely stored in password protected facilities and locked storage at the University of Canterbury for five years following the study. It will then be destroyed.

The results of this study will be reported in my thesis and may also be reported nationally and internationally at conferences and in education and teaching related journals. All participants will receive a copy of the completed thesis.

If you have any questions about the study, please contact me (details above) or my supervisors, Dr Julie Mackey and Associate Professor Lindsey Conner, College of Education, University of Canterbury, Private Bag 4800, Christchurch 8140 (julie.mackey@canterbury.ac.nz or lindsey.conner@canterbury.ac.nz). If you have a complaint about the study, you may contact the Chair, Educational Research Human Ethics Committee, University of Canterbury, Private Bag 4800, Christchurch 8140 (human-ethics@canterbury.ac.nz).

If you agree to participate in this study, please complete the attached consent form and return it to me in the envelope provided by [Day/Month].

Appendix G: Example consent form

Tel:

Email: kathryn.mackinven@canterbury.ac.nz

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

Blended learning in undergraduate science: the present and the future

Consent form for Managers

I have been given a full explanation of this project and have been given an opportunity to ask questions.

I understand what will be required of me if I agree to take part in this project.

I understand that my participation is voluntary and that I may withdraw at any stage without penalty.

I understand that any information or opinions I provide will be kept confidential to the researcher and that any published or reported results will not identify me or my school.

I understand that all data collected for this study will be kept in locked and secure facilities at the University of Canterbury and will be destroyed after five years.

I understand that I may choose to receive a copy of the thesis produced from this research. I have provided my email details below for this.

I understand that if I require further information I can contact the researcher, Kathryn Mackinven or her supervisors, Dr Julie Mackey and Associate Professor Lindsey Conner of the College of Education at the University of Canterbury.

If I have any complaints, I can contact or the Chair of the University of Canterbury Educational Research Human Ethics Committee at the University of Canterbury.

By signing below, I agree to participate in this research project.

Name: _____

Date: _____

Signature: _____

Email address: _____