An Investigation into the Use of Applications on Personally Owned Devices to Enhance Student Engagement in Large Lectures

A thesis submitted in fulfilment of the requirements for the Degree of

Doctor of Philosophy in Education

in the University of Canterbury

by Trevor Richard Nesbit

University of Canterbury

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Also to my brothers and their wives (Gary & Shirley and David & Debbie); to my step children (Jessica, Ryan, Ashley & Tom, and Shaun & his son Brayden); to my parents-in-law (Penny & Maurice and Gerry & Svetlana); and to my sister-in-law and brother-in-law (Heidi & Bevan).

Much of the motivation for this research has been inspired by the many students I have taught over more than 25 years and a desire to provide an engaging learning experience for them.

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Abstract

Increasing student numbers and reduced government funding have seen a trend towards there being larger numbers of students in lectures, with this having an impact on the extent of student interaction, participation, and engagement in lectures in many institutions. The impetus for this research came from a desire to retain much of the interaction, participation, and engagement that takes place in smaller classes when changing from small lectures to lectures with more than 100 students.

A pilot study demonstrated that the use of applications on personally owned devices (APODs) in the form of a text messaging based system or an application running on a smart phone could create a marked increase in student interaction, participation, and engagement.

This was followed by a more formal investigation using a pragmatic paradigm and a mixed methods research approach that was consistent with design-based research. This included interviews of lecturers and learning advisers, student surveys and student focus groups.

The findings conclude that the use of APODs during lectures has the potential to increase student interaction. The participation and engagement through the creation of a two-way feedback channel between lecturers and students, allows for student misconceptions to be identified and addressed in a manner that can make learning more enjoyable, authentic and effective. This potential benefit can be realised by addressing the pedagogical and technological issues involved in the use of APODs in lectures.

The main contributions of this research are the models that have been developed surrounding how to use APODs in a pedagogically sound manner; the importance of designing effective activities when APODs are being used; how to use APODs to cater for different groups of students; the benefits of using APODs; and how to address the challenges of using APODs. Implications for further research are also identified.

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Co-authorship forms for seven publications that are based on the thesis are found on the following seven pages. The first six of these are for papers that have been published in the proceedings of conferences, with the seventh being for a journal article that was under review at the time of the original submission.

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Nesbit, T. & Martin A. (2010). *Use of Mobile Technologies to Enhance Student Engagement in Large Lectures: An Initial Exploration and Experiment.* Proceedings of the 23rd Annual Computing and Information Technology Research and Education New Zealand (CITRENZ) Conference, Dunedin, July 2010
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Nesbit, T., O'Steen, B. and Bell T. (2013). *Prevailing Personal Social Communication Technologies Enhancing Engagement in Large Lectures: From Texting to Mobile Web Enabled Devices.* Proceedings of the Annual Conference of the Society of Research into Higher Education, Newport, December 2013.

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Nesbit, T., O'Steen, B. and Bell T. (2014). *Using Mobile Apps to Enhance Student Engagement in Large Lectures.* Proceedings of ITX 2014, incorporating the 27th Annual Conference of Computing and Information Technology Research and Education New Zealand, Auckland, October 2014.
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Nesbit, T., O'Steen, B. and Bell T. (2015a). *Use of Applications on Mobile Web Enabled Devices to Increase Student Engagement during Lectures for Accounting Information Systems Courses*. Proceedings of World Accounting Frontiers Series Biennial Conference, Macau, May 2015.

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Nesbit, T., O'Steen, B. and Bell T. (2015b). *Using Apps on Mobile Devices to Enhance Student Engagement in Large Lectures: Learning Adviser Perspectives*. Proceedings of Educational Innovation in Economic and Business Annual Conference, Brighton, England, June 2015.

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Nesbit, T., O'Steen, B. and Bell T. (2015c). *Use of Smart Phone Applications and Purple Shirts to Enhance Student Engagement in Large Lectures?*. Proceedings the 28th Annual Conference of Computing and Information Technology Research and Education New Zealand, Queenstown, October 2015.

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Nesbit, T., O'Steen, B., Bell, T., & Martin, A. (2016). The journey from texting to applications on personally owned devices to enhance student eEngagement in large lectures: A pilot study. *Journal of Applied Computing & Information Technology, 20*(1).

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1 Introduction and Background

1.1 Introduction

The impetus for this research came from problems encountered by the researcher when moving from teaching within the New Zealand Institute of Technology and Polytechnic (ITP) sector to the New Zealand university sector. One of the main differentiating characteristics between the two sectors is the typical class size, with classes in the ITP sector being much smaller. In the ITP sector 40 students would be viewed as a large class while in many university sector undergraduate courses (particularly first and second year) it is not uncommon to have at least 200 or more students in a lecture.

When moving to teach in the university sector the researcher had a desire to continue what are considered good teaching practices. One of these practices included the use of small groups to discuss questions, with one person from each group providing feedback to the rest of the class in a manner consistent with constructivism's principles of learners actively constructing new knowledge themselves (Bruner, 1973). This approach had worked well with classes of up to 40, where the researcher's teaching experience indicates that one student in a group of five is comfortable with verbally sharing what their group had discussed in front of the class. This approach proved difficult to implement in the larger university class context. This was partly because of the amount of time involved, but mainly because of the very low number of students that were willing to share verbally due to the much higher numbers in class. To elaborate further on the positive aspects of constructivism in the researcher's teaching and learning contexts, it can be described as where "learners could learn actively and construct new knowledge based on their prior knowledge" (Huang, 2002). This also aligns well with Dewey's connection of experience to education (Dewey, 1916), Piaget's developmental process of learning (Piaget, 1973), and Vygotsky's zone of proximal development (Vygotsky, 1978).

The researcher was also aware that during these larger classes many students were using their mobile phones to send text messages to contacts (noting that this was in 2009, and prior to smart phones being widely used). This prompted a plan to develop a system that allowed students to send text messages to the lecturer so that the responses could be shared with the class, thereby overcoming the problem of students not being as willing to share verbally in larger classes.

The development of this system and its initial trial became part of the pilot study for this research. The pilot study also included a survey of students in 2012 which showed that ownership of devices such as smart phones, tablets, and laptops had almost reached the levels of ownership of mobile phones in general. A further survey of a class was conducted where an application that ran on smart phones, tablets, and laptops was used for the same purpose.

Audience feedback is not new; clickers, and prior to them, the use of a show of hands were relatively common. There is a wide body of literature covering the use of clicker technology in lectures with many different terms used for the devices and systems that have been adopted. For the purposes of this study the term Audience Response System (ARS) is used to describe any form of technology that can be used in the classroom to enable students to interact with the lecturer. These ARS include the clicker technology variety, systems that are based on text messaging, and applications running on devices such as smart phones, tablets or laptops.

For the purposes of this study the term Applications on Personally Owned Devices (APODs) has been coined to describe text messaging based systems (such as the one in the pilot study) and applications running on smart phones, tablets, and laptops (which has been the main focus for the study). The literature relating to the use of ARS generally informs the study as does the literature on the use of APODs, specifically with this relationship being shown in Figure 1 on page 3. For the purposes of this study the APODs being investigated are those that can be used as ARS, and as such exclude applications that cannot be used as ARS.

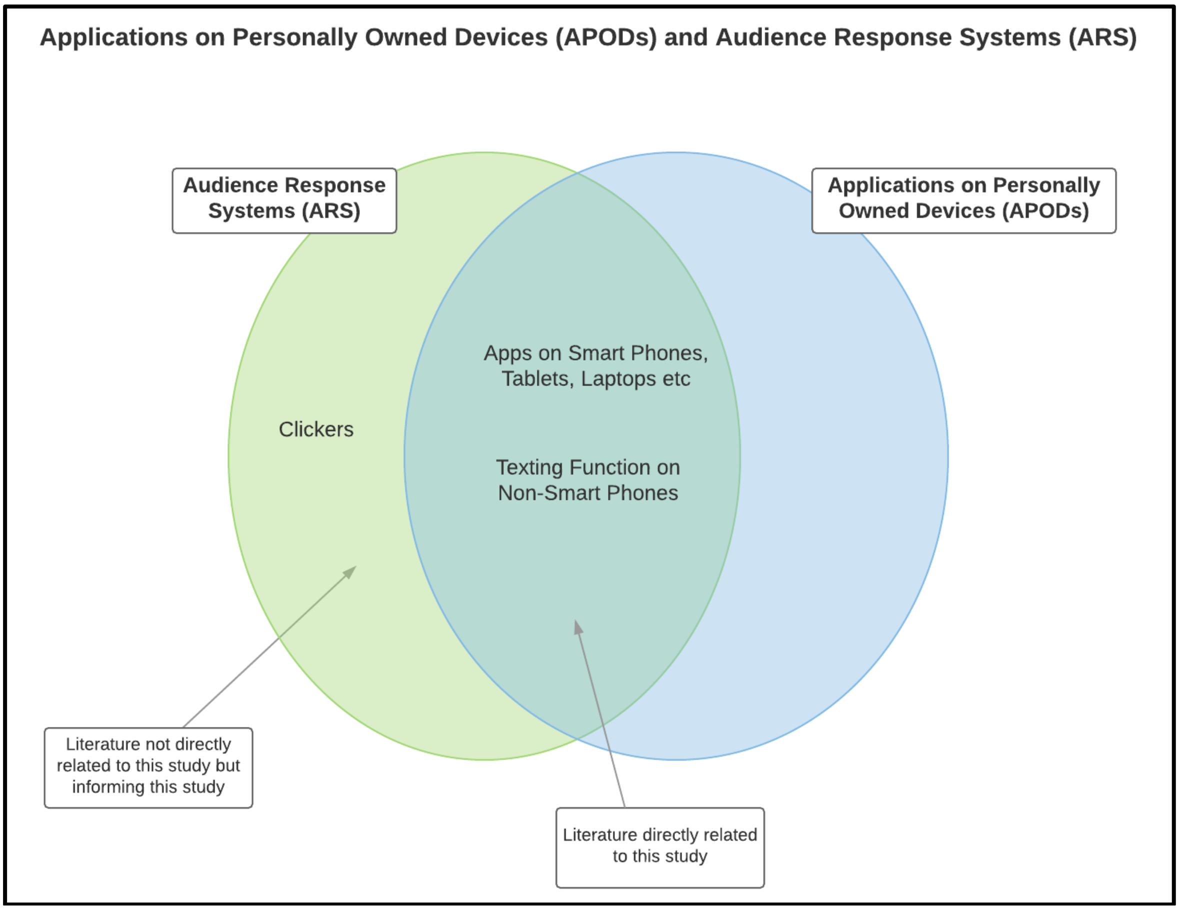

Figure 1 – Literature Relating to Use of APODS and ARS in Lectures

The literature review in chapter two is made up of two components and takes the form of a thematic analysis of the literature. First a thematic analysis was conducted of eleven (11) meta-studies and 86 empirical studies to identify themes that are relevant to this research. The thematic analysis was based on the model outlined by Braun and Clarke (2006) with this process being discussed further in chapter two. The second component is a review of learning and pedagogical theories that have relevance to this research, with these theories being examined later in this introductory chapter.

The overall outcome of the pilot study showed that students who were given the opportunity to use their own personal devices appeared to have a much higher willingness to interact and engage during lectures. Additionally, the ownership level of devices such as smartphones, tablet and laptops had reached sufficient mass to allow the study to be based on applications that run on these types of devices as opposed to using the text messaging based system that had been developed.

Throughout the pilot study and initial review of literature, it became apparent that it was possible to use APODs in a variety of different modes. To gain a better understanding of these modes and the motives that lecturers had for using APODs and ARS in lectures, the decision was made to interview a number of lecturers who had used APODs and ARS in their lectures regarding their perceptions of the benefits and challenges relating to their use of APODS and ARS. The decision to include lecturers who had used ARS in general was based on the belief that findings related to the use of ARS would inform findings related to the use of APODs in a manner similar to that depicted in Figure 1.

With most of the lecturers having had positive experiences, partly due to having been innovators and early adopters, it was decided to interview several learning advisers. The aim of this set of interviews was to get a better understanding on some of the challenges involved for lecturers when using APODs and ARS, and how to deal with these challenges. The decision to interview learning advisers was based on some of the literature regarding the personal characteristics of innovators and early adopters when it came to the use of educational technologies (Elgort, 2005; Moore & McKenna, 1999; Rogers, 1995). Of particular note is the concept that early adopters of technologies would not be held back by the challenges that some of the later adopters may experience: "…. early adopters, who are prepared to pay the price of being first…" and "…putting up with bugs and glitches…" (Elgort, 2005; Moore & McKenna, 1999).

Student participation in this research included the completion of surveys by students in five courses and two focus groups. The purpose of the student participation was to produce some quantitative evidence regarding student perception of the use of APODs through the surveys, and some deeper understanding of the issues involved through the focus groups and, to a lesser extent, some open-ended questions in the surveys.

The main outcome of this research is the development of models for when and how to best use APODs to enhance student engagement to take advantage of the perceived benefits that APODs offer while addressing some of the perceived challenges in their use. Other contributions include a literature review and an approach to conducting research that could both be used as a platform for later researchers.

1.2 The Context of Large Lectures

This section summarises some of the issues of student-lecturer feedback and student engagement in large lectures.

One of the weaker points in the teaching at many universities that was identified in Draper and Brown (2004) was the lack of interactivity during lectures delivered to large classes. The view put forward in this study was that in large lectures, students are not normally required to make any overt responses. As a result of this there is a potential link to little mental processing taking place (Draper & Brown, 2004), and hence, little learning. This is consistent with the 2-sigma problem identified in Bloom (1984) that relates to high student staff ratios and that less effective learning can take place as a consequence. There are many other researchers who have challenged the traditional format of the lecture where students are passive, and stressed the need for learners to play more active roles (Dufresne, Gerace, Leonard, Mestre & Wenk, 1996; Poulis, Massen, Robens & Gilbert, 1998).

The statement that "Large lectures are the predominant ways of teaching first year university students in Norway. However, this is seldom discussed as a context for a formative feedback process" (Ludvigsen, Krumsvij & Furne, 2015, page 48) highlights that within the context of large lectures formative feedback is not usually possible. Ludvigsen, et al. (2015) go on to outline how students refer to traditional lectures as being "passive mode".

The concept that traditional large lectures potentially force students to play a passive role in the classroom has been the motivation of some studies on the use of ARS including Barak, Lipson and

Lerman (2006); Buckley, Bain, Luginbuhl and Dyer (2004); Gray, Steer, McConnell and Owens (2010); and MacGeorge et al. (2008). Other studies including Barr (2004), Curtis and Matthewman (2005), and Greenaway and Haynes (2003) have cited the financial pressure on institutions as being one driving factor behind the increasing class sizes. It had been noted in the literature that the move to larger classes in many cases has been funding related (Cullen, 2011; Heaslip, Donnvan & Cullen, 2014).

If this problem of student engagement in large lectures is looked at from the perspective of a critical paradigm (Lynch, 1999), the focus of the study would need to be on the injustices created by government funding policies relating to higher education that have created the situation where class sizes have increased. However, for this study the problem of large class sizes and the lack of interaction is a problem that exists in the real world (which in the context of this research refers to the real world of what takes place during lectures) and is seen as being one that would be useful to be solved as per the pragmatic paradigm (Crick, 1999; Easton, 2010; Kennedy, 1999; Maxcy, 2003) which focusses on using approaches that are consistent with design-based research (Barab & Squire, 2004; Wang & Hannafin, 2005).

1.3 The Different Perspectives

The differing opinions of lecturers, students and learning advisers are important to this study because they have different perspectives when it comes to the use of APODs in lectures.

An observation that was made by the researcher during the interviews of lecturers is that some lecturers see the lack of interaction and engagement in the traditional lecture as being a problem or issue that needs to be addressed. Alternatively, there are other lecturers who do not have the desire to increase interaction and engagement during lectures as they are of the view that the purpose of the lecture remains as the one-way delivery of content. This study is particularly aimed at those lecturers who have a desire to increase interaction and engagement in large lectures, with many of those interviewed having actively sought to do this in ways that are pedagogically sound.

The perspectives of students are vitally important to the study as it is their experience of the learning environment and how this impacts on their willingness to interact and engage that is the key to determine whether the use of APODs in lectures is worthwhile. Some consideration has been paid to the demographics of the students as some of the literature highlights the need to investigate student perspectives based on a range of backgrounds including age, gender, language, culture, level of study and issues surrounding the cost of the technology for students.

The perspectives of learning advisers are important due to the role they play with lecturers who have the desire to increase interaction and engagement in lectures, but who have issues that need to be addressed in the approach or do not have the confidence to do so on their own. As such the learning adviser perspective creates some balance when compared with the lecturer perspective as many of the lecturers interviewed were early and successful adopters or promoters of the use of APODs. The perspectives of the learning advisers also included how to address the challenges of using APODs; pedagogical approaches to using APODs; and issues surrounding the potential costs faced by institutions.

While the impetus for the study came from a desire to use APODs to facilitate the feedback from small group discussions during lectures, the study extended this to the use of APODs for multiple choice questions, which has received a lot of attention in the literature (Calma, Webster, Petry & Pesina, 2014; Kay & LeSage, 2009a). This is extended to students at the end of lectures either asking questions or being asked to identify the most important content covered during the lecture in a manner consistent with the one-minute paper as per Hattie (1987) and cited in Nicol and Macfarlane-Dick (2006).

The need for further research including how different individuals respond to the use of ARS, particularly relating to gender, age, grade level and learning styles, has been identified in the literature (Kay & LeSage, 2009a), with this providing some input into the data that was collected in the surveys.

1.4 Aims of This Study and Research Questions

The overall aim of this study was to investigate how the use of APODs can be best used to enhance student engagement in large lectures. This section sets out the overarching research question for the research and breaks the research question down into four sub-questions.

The overarching research question for this research is:

"When and how should applications on personally owned devices (APODs) be adopted for use in large lectures to enhance student engagement so that the benefits of their use can be achieved while addressing the challenges relating to their use?"

The four sub-questions to be addressed as part of answering the overall research question are in the following sections:

1.4.1 Sub Question 1

What are the benefits of using applications on personally owned devices (APODs) to engage with students in lectures (from a range of different perspectives and across a range of different contexts)?

Emerging from the literature review was a model for the benefits of the use of APODs and ARS in lectures that was adapted and modified from Kay and LeSage (2009a). These benefits were grouped into physical benefits regarding the classroom environment, learning benefits and assessment benefits. This research question is answered by exploring these benefits from a range of different perspectives (students, lecturers and learning advisers) through interviews of lecturers and learning advisers, and surveys and focus groups involving students. The range of contexts are explored by analysing the results of the student surveys based on the type of course, age, gender and English language background.

1.4.2 Sub Question 2

What are the challenges involved in using applications on personally owned devices (APODs) to engage with students in lectures (from a range of different perspectives and across a range of different contexts) and how can these challenges be addressed?

Emerging from the literature review was a model for the challenges involved in using APODs and ARS in lectures that was adapted and modified from Kay and LeSage (2009a). These challenges were grouped into: technology based challenges, lecturer based challenges and student based challenges. This research question is answered by exploring these benefits from a range of different perspectives (students, lecturers and learning advisers), through interviews of lecturers and learning advisers, and surveys and focus groups involving students. The range of contexts are explored by analysing the results of the student surveys based on the type of course, age, gender and English language background.

1.4.3 Sub Question 3

What are the pedagogical implications involved in using applications on personally owned devices (APODs) to engage with students in lectures?

Emerging from the literature review was a model for the pedagogical issues involved in using APODs and ARS in lectures. Along with this model a number of relevant learning theories were also reviewed. This research question is answered by exploring these pedagogical issues from a range of different perspectives (students, lecturers and learning advisers), through interviews of lecturers and learning advisers, and surveys and focus groups involving students. The findings are also analysed in the light of the relevant learning theories. The range of contexts are explored by analysing the results of the student surveys based on the type of course, age, gender and English language background.

1.4.4 Sub Question 4

How do issues relating to the cost and simplicity of devices impact on the use of applications on personally owned devices (APODs) to engage with students in lectures and how can these issues be addressed?

Emerging from the literature review was a model of issues relating to the cost and simplicity of devices relating to the use of APODs and ARS in lectures. This research question is answered by exploring these issues from a range of different perspectives (students, lecturers and learning advisers), through interviews with lecturers and learning advisers, and surveys and focus groups involving students.

1.5 Use of Technology in Education

The TPACK Framework developed in Koehler and Mishra (2008) and adapted in Harris, Mishra and Koehler (2009) is outlined in the literature review chapter with a brief summary being presented here and being depicted in Figure 2 on page 11.

When the TPACK framework is applied to this research, the emphasis on the technology aspect of the model is not as significant as the pedagogical and content aspects. This is fundamental to this research in that it is intended that the technology used by the lecturer will not be complex and that the focus should not be on the technology, but why it is used. The degree of complexity for the students is also reduced because students are using their own devices for these applications, and as such it would be a technology that the students are already using regularly on a day-to-day basis.

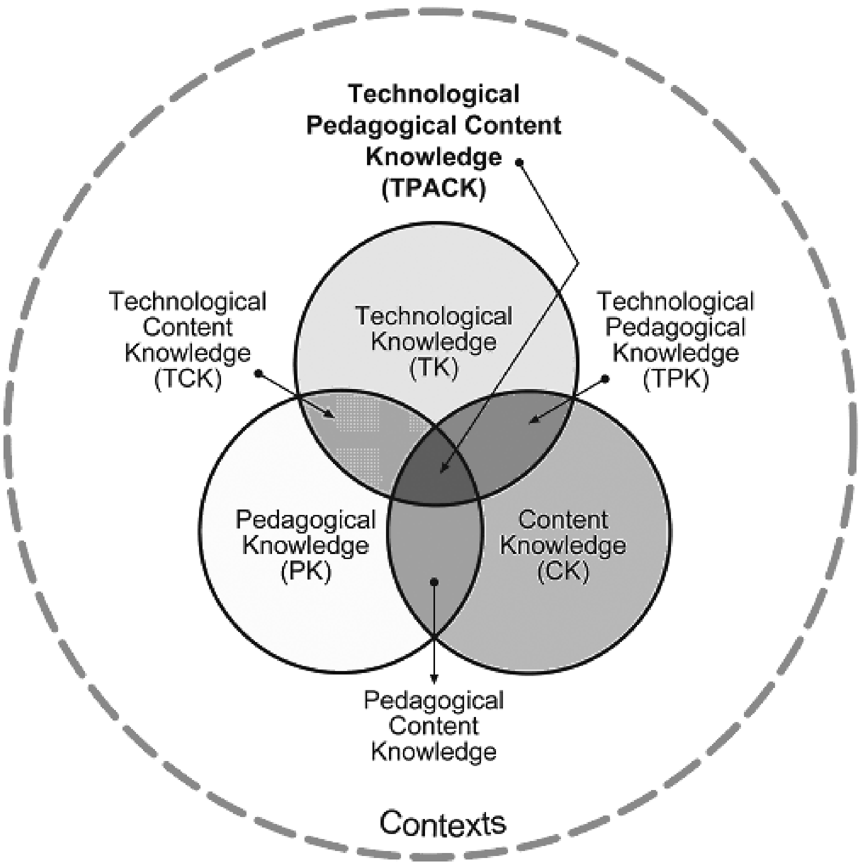

Figure 2 - TPACK Framework (Koehler & Mishra, 2008; Harris et al. 2009)

In a study conducted by Draper and Brown (2004) it was highlighted that there are a range of empirical indications supporting the concept that learning benefits are more dependent on putting the focus on the pedagogy as opposed to the technology. This importance of placing the pedagogy before the technology has also been the focus of a range of other studies (Ascough, 2002; Watson, 2001). In a prior study by one of the authors (Draper, 1998) it was highlighted that those introductions of technologies that did increase the quality of learning were those that identified a deficiency or a problem in a teaching and learning scenario, and then sought to use technology to address the particular problem. An implication flowing from this identified in Draper and Brown (2004) was that researchers should look at the teaching practices around them to try and identify the weakest aspects of the teaching practices, and then seek to discover how technologies can be used to address them.

1.6 Relevant Learning Theories

A number of relevant learning theories have direct relevance to this study. This section will be used to briefly summarise the relevant learning theories with a more in-depth review being included in Chapter Two. This will be used to provide some basis for the analysis and discussion of the findings of the study.

A model of characteristics of effective learning outlines five characteristics: Active, Cumulative, Individual, Self-Regulated and Goal Oriented (Goodyear, 2002), all of which have some degree of relevance to this study. The relevance is specifically related to the first of the sub-questions of the overarching research question, which relates to the benefits of using APODs in lectures within the context of a desire to increase student engagement, and thereby increase student learning.

Social Learning Theory (Vygotsky, 1978) and Constructivist Theory (Bruner, 1973) have relevance to this study particularly with some of the impetus for the study coming from the desire to have students discuss questions in small groups (Social Learning Theory) and sharing answers with the rest of the class with the lecturer giving feedback (Constructivist Theory).

The relevance of Constructivist Theory to this research is evident in the work of Rovai (2004), who in defining constructivism stated that constructivism is "…to maintain that knowledge is the product of many learner centered process…" (Rovai, 2004) and "…includes the social process of communication…" (Rovai, 2004). The implications of this definition for this research include "…the tailoring of teaching strategies to student background and responses, and employing open ended questions that provide dialog amongst learners…" (Rovai, 2004). The relevance of Rovai's work to this research relates strongly to the initial impetus for this research being based on a desire in which students can discuss questions in small groups and having a mechanism for the findings from each group to be shared with the rest of the class.

Given that one of the overall aims of the study was to investigate how the use of APODs can impact on student engagement in large lectures, the concept of what engagement is and its various forms (Fredricks, Blumenfeld & Paris, 2004) has direct relevance, particularly when it comes to cognitive engagement. The concept of cognitive engagement relates to students thinking more deeply about content (Fredricks et al., 2004) with some of the survey questions used asking the students to indicate how much the use of APODs encouraged more thinking about the content of the lecture. Engagement has been the focus of much research, however Scott and Stanway (2005) noted that much of this has been at the macro (or university) level as opposed to the micro (or course) level. The idea that engagement in higher education can have academic and non-academic elements has also been noted (Kuh, 2009). Scott and Stanway (2005) also highlighted the work of Chickering and Gamson (1987) who identified seven principles for best practice in higher education (which will be expanded on in chapter two), with Kuh (2009) suggesting that each of these principles represent a different aspect of engagement.

The relevance to this research connects to the engagement of students during lectures and as such relates to the academic elements (as opposed to the non-academic elements), and in particular to cognitive engagement (Fredricks et al., 2004).

With this study being based in a higher education context and some of the students being more mature students within that context, theories relating to students with experience in real world settings have relevance to this study including the original work on Adragogy (Knowles, 1984) and more recent perspectives on Adragogy (Knowles, Holton III & Swanson, 2014) as well as Adult Learning Theory (Cross, 1981).

The relevance of this research to the previously mentioned studies is that it focusses on cognitive engagement (Fredricks et al., 2004) at a micro level instead of a macro level (Scott & Stanway, 2006) in the context of adult learning (Cross, 1981) where the existing knowledge and experiences of students can be utilised (Knowles, 1984; Knowles et al., 2014).

A model of authentic learning activities was the outcome of a study (Reeves, Herrington & Oliver, 2002) with the model including ten (10) characteristics of authentic learning. Some of these having direct relevance to aspects of this study including tasks that have real world relevance; are ill defined; have a degree of complexity; allow different perspectives to be examined; provide opportunities to collaborate; provide opportunities to reflect; and allow for competing solutions and diversity of outcomes. (Reeves et al., 2002). This has relevance to this research in that the use of APODs allows for a variety of activities to take place that might not normally be possible in a large lecture context.

1.7 Overview of Upcoming Chapters

This section sets out an overview of the upcoming chapters and how they relate to the overall study. Note that the findings of the research are spread across three chapters, with chapter four covering the pilot study, chapter five covering the interviews of lecturers and learning advisers; chapter six covering student surveys and focus groups. The decision to use three chapters to cover the findings was due to the iterative nature of the research that is consistent with the design-based research methodology (Wang & Hannafin, 2005) that was adopted with one of the characteristics of design-based research including "…an iterative cycle of analysis, design, implementation and redesign…" (Wang & Hannafin, 2005).

1.7.1 Chapter Two – Literature Review

As indicated earlier in this chapter the literature review is comprised of three (3) components. The first two components being thematic analyses (Braun & Clarke, 2006) of meta-studies empirical studies respectively, with the third component being a review of relevant learning and pedagogical issues. The groups of themes identified in the thematic analyses form a basis for the analysis and discussion of findings.

1.7.2 Chapter Three – Methodology

Chapter Three outlines the methodology that was used for the research which was in essence a multiple case study analysis. The chapter commences with a discussion of the appropriate paradigms, ontologies and epistemologies for the research and concludes that the best approach for this research was a pragmatic paradigm with an associated epistemology of "the best method is one that solves problems", an ontology of "truth is what is useful", and questions that seek to determine whether interventions will address teaching and learning issues (Kennedy, 1999).

The chapter then outlines how this discussion of paradigms, ontologies and epistemologies led to the adoption of a mixed methods research method that is consistent with design-based research (Wang & Hannafin, 2005). This is then followed by an explanation and justification of the research methods used in the five phases of the research.

1.7.3 Chapter Four – Findings from Pilot Study

This chapter presents the findings from the first phase of the research, which was the pilot study. The pilot study demonstrated that the concept of using APODs for students to interact with lecturers during a lecture had the potential to significantly increase student interaction, participation and engagement. Implications were identified for later phases of this research, which included the need to interview lecturers about their perception of the use of APODs in lectures with these findings being presented in chapter five.

1.7.4 Chapter Five – Findings from Interviews

This chapter presents the findings from the second and third phases of the research. The second phase of the research was the interviews of lecturers, with the findings presenting a summary of each of the interviews; a thematic analysis of the interviews based on the themes emerging from the literature review; with implications for later stages of the research being identified which included the need to interview learning advisers to broaden the perceptions relating to using APODs in lectures.

The third phase of the research was the interviews of learning advisers. The decision to interview learning advisers was based on nearly all of the lecturers being innovators and early adopters of ARS, with the characteristics of innovators and early adopters of new technology including that they are prepared to put up with the challenges and glitches that can be involved (Elgort, 2005; Moore & McKenna, 1999) in comparison to later adopters. Farag, Park and Kaupins (2015) identified the importance of having good support for teachers who did not perceive the ARS being adopted as easy to use. This concept is explored more fully in the discussion of the findings from the interviews of lecturers. The findings of the interviews are presented and include a summary of each of the interviews; a thematic analysis of the lecturer and learning adviser interviews based on the themes emerging from the literature review; with implications for later stages of this research being identified and included the need to conduct surveys of students about their perceptions of the use of APODs in classes, with these findings being presented in chapter six.

1.7.5 Chapter Six – Findings from Student Surveys and Focus Groups

This chapter presents the findings from the fourth and fifth phases of the research. The fourth phase of the research was the surveys of students in classes where APODs had been used. The results of the survey are presented and findings are analysed, with the analysis of responses from different groups of students (based on age, gender, language background, and course enrolled in) being conducted using non-parametric statistical tests including the Mann-Whitney and difference in median tests. Implications for further research were identified with this partly including the need to conduct student focus groups to further explore some of the concepts emerging from the earlier findings.

The fifth and final phase of the research was the student focus groups. The findings of the focus groups are presented in the form of a summary of the discussions that took place and an analysis of a statement ranking exercise that took place. These findings are analysed based on the themes emerging from the earlier phases of the research.

1.7.6 Chapter Seven – Analysis, Discussion and Conclusions

This chapter presents the analysis and discussion of the findings and the conclusions of this research. The findings from the five phases of the research were analysed collectively based on the themes emerging from the preceding phases of the research and were discussed with the aim of producing models for when and how to best use APODs to enhance student engagement to take advantage of the perceived benefits that APODs offer while addressing some of the perceived challenges in their use.

This is followed by an analysis of these key contributions based on the research questions posed to produce an overall summary of the analysis and discussion which is used as a basis for emerging models for the adoption and use of APODs in lectures. Accompanying each model is an outline of a scenario that a lecturer or group of lecturers could find themselves in, and an explanation how the model could be used in that scenario.

1.8 Overall Contribution

As indicated earlier in this chapter, the contribution of this research to the field is a series of models relating to the use of APODs in large lectures. These models show how to best use APODs to enhance student engagement to take advantage of the perceived benefits that APODs offer, while addressing some of the perceived challenges in their use. These models are presented in section 7.3 commencing on page 324.

This research is also the first to coin the term APODs to represent the texting function on mobile phones and applications on smart phones, tablets, and laptops (see Figure 1 on page 3).

2 Literature Review

2.1 Introduction

There are two main groups of studies in the literature that have relevance to this research. First there are studies that have examined the use of Applications on Personally Owned Devices (APODs) and Audience Response Systems (ARS) with some these studies taking the form of meta-studies. Second there are many studies regarding pedagogical approaches in teaching and learning in a higher education context that have direct relevance to this research.

The studies relating to the use of ARS include a number relating to the use of clicker technologies. While the use of clicker technologies is not the focus of this research, these studies do provide a good understanding to many of the issues surrounding the use of APODs as shown in Figure 3 (reproduced from Chapter One).

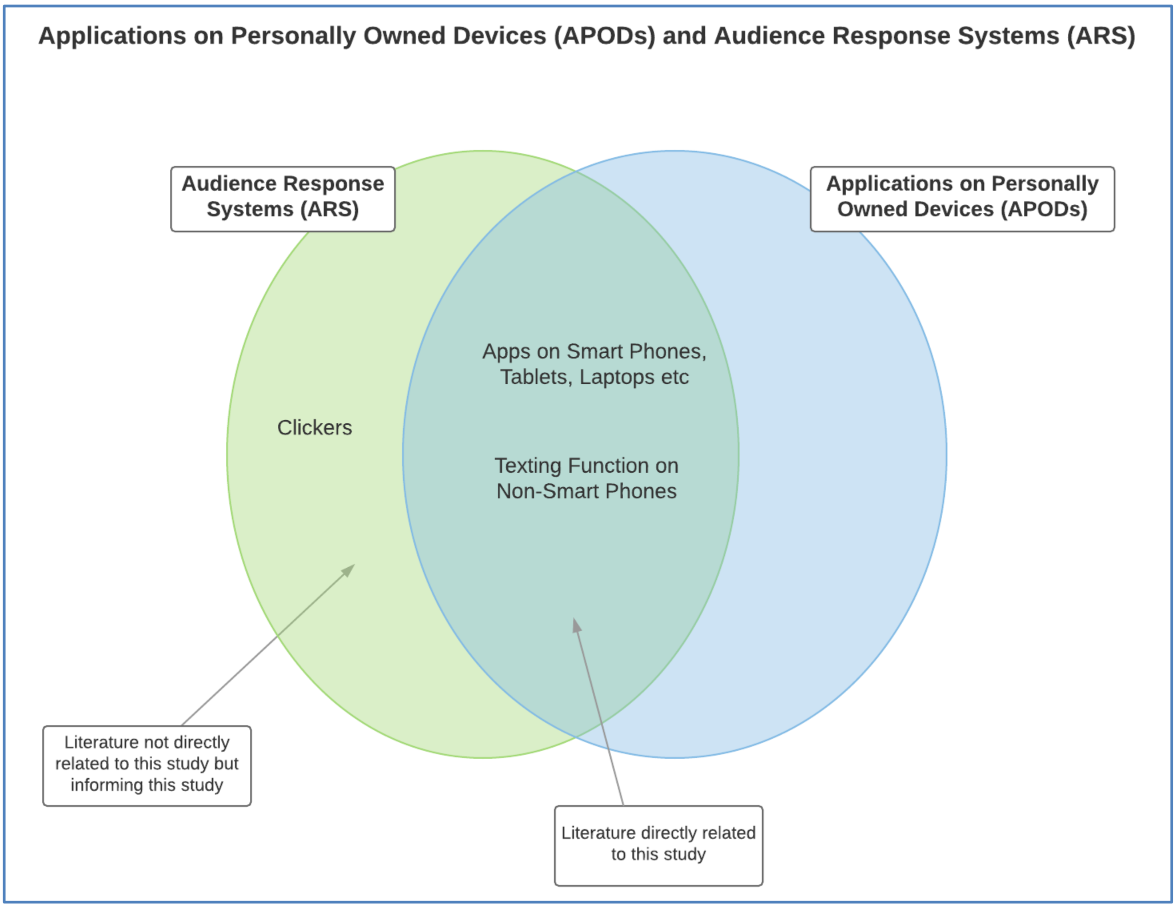

Figure 3 - Literature Relating to Use of APODS and ARS in Lectures

The term ARS is used in this study as a generic term to cover a wide range of terms that exist in the literature that has been reviewed as part of this research. The terms sed in the studies that have been reviewed are shown in Table 1 and may not be an exhaustive list of all terms that are used.

Audience Response Systems (ARS)
Classroom Response Systems (CRS)
Clicker Assessment and Feedback Tools (CAF)
Clickers
Electronic Response Systems (ERS)
Group Response Systems (GRS)
Hand Held Keypads
Personal Response Systems (PRS)
Student Response Systems (SRS)

Table 1 – Terms used to Represent Audience Response Systems in the Literature

As indicated in the introduction chapter, this literature review comprises two main components. First eleven (11) meta-studies and 86 empirical studies relaring to the use of APODs and ARS are analysed to identify themes that relate to the four sub-questions of the overarching research question.

Second the literature relating to pedagogical issues that relate to this study is explored with the relevance of these issues to this research being highlighted, with this analysis particularly relating to the third sub-question of the overarching research question.

The approach taken with the first component of the literature review is consistent with the concept of thematic analysis (Braun & Clarke, 2006). Thematic analysis has been defined as being "a method for identifying, analysing, and reporting patterns (themes) within Data" (Bruan & Clarke, 2006). A summary of thematic analysis is shown in Figure 4.

Phase	Description of the process
1. Familiarising yourself with your data:	Transcribing data (if necessary), reading and re-reading the data, noting down initial ideas.
2. Generating initial codes:	Coding interesting features of the data in a systematic fashion across the entire data set, collating data relevant to each code.
3. Searching for themes:	Collating codes into potential themes, gathering all data relevant to each potential theme.
4. Reviewing themes:	Checking in the themes work in relation to the coded extracts (Level 1) and the entire data set (Level 2), generating a thematic 'map' of the analysis.
5. Defining and naming themes:	Ongoing analysis to refine the specifics of each theme, and the overall story the analysis tells; generating clear definitions and names for each theme.
6. Producing the report:	The final opportunity for analysis. Selection of vivid, compelling extract examples, final analysis of selected extracts, relating back of the analysis to the research question and literature, producing a scholarly report of the analysis.

Figure 4 - Phases of Thematic Analysis (Braun & Clarke, 2006)

The initial set of themes used were those that were identified in the study by Kay and LeSage (2009a) that related to the first two sub-questions of the overarching research question. These themes were added to as the studies were reviewed to produce a revised set of themes that relate to the first two sub-questions of the overarching research question. This approach was consistent with Braun and Clarke (2006) who described how the "keyness" of a theme is not necessarily dependent on quantifiable measures – but in terms of whether it captures something important in relation to the overall research question.

2.2 Thematic Analysis of Studies Relating to APODs and ARS

This section summarises the study conducted by Kay and LeSage (2009a) and justifies the use of the study as a starting point for developing the themes for the thematic analysis in this study.

2.2.1 Using Kay and LeSage (2009a) as a Starting Point

A meta-study of the literature relating to the benefits and challenges of using ARS was conducted by Kay and LeSage (2009a) with a further meta-study presenting a strategic assessment relating to using ARS being conducted by Kay and LeSage (2009b). While these studies pre-date the completion of this research project by several years, these studies are still of relevance to this project due to several factors. One of the factors is the number of citations these studies continue to have into 2015 and 2016, with a further significant factor being the way in which some of these later studies are commenting on the earlier studies (Castillo-Manzano, Castro- Nuño, López-Valpuesta, Sanz-Díaz & Yñiguez, 2016; Hunsu, Adesope & Bayly, 2016; Pimmer, Mateescu & Gröhbiel, 2016).

When it comes to citations of the Kay and LeSage (2009a) study an analysis of citations recorded by Google Scholar in January 2017 showed 364 citations, with 92 (25.3%) of these being from 2016 and 88 (24.2%) being from 2015. A similar analysis of the citations of Kay and LeSage (2009b) shows 74 citations, with 14 (18.9 %) being from 2016 and 7 (9.5 %) being from 2015.

The findings of Kay and LeSage (2009a) and Kay and LeSage (2009b) have been identified as strengthening the findings of other more recent studies (Pimmer et al., 2016). The findings of Kay and LeSage (2009a) have been identified as including that the use of ARS improves learning performance and recognise that qualitative and quantitative research need to be combined (Castillo-Manzano et al., 2016). They also identify that Kay and LeSage (2009a) is one of a number of published reviews in related areas including Caldwell (2007), Flies and Marshall (2006), Han (2014), Judson and Sawada (2002), Keough (2012), Simpson and Oliver (2007).

In Hunsu et al. (2016) it was found that the study by Kay and LeSage (2009a) was more systematic than those pre-dating it, it was not focussed on an estimation of the effect of using ARS in the classroom, and raised some questions that had yet to be dealt with about what ARS are most useful for; and who gains most from their use. Because of the ongoing relevance of the meta-study by Kay and LeSage (2009a), their framework for the benefits and challenges of using ARS will be used as a starting point for the analysis of the other meta-studies and will be adapted based on the findings of the other meta-studies that are reviewed.

2.2.2 Summary of Kay and LeSage (2009a)

In the study conducted by Kay and LeSage (2009a) a review of 28 articles relating to the use of ARS was carried out with the results including a set of key benefits to be gained from the use of ARS and a range of challenges for lecturers adopting ARS.

The benefits that were identified in the study were placed in four categories, with these being overall attitudes to the use of ARS; classroom environment benefits; learning benefits and assessment benefits. The overall attitudes to the benefits of using ARS related to the student attitudes towards their use being positive as well as the lecturer use being positive, and from the student perspective that the technology was relatively easy to use.

The benefits relating to the classroom environment were broken down into four themes of attendance; attention; anonymity and participation; and engagement, with these being shown and described further in Table 2 which is reproduced from Kay and LeSage (2009a). In the learning benefits category, there were five themes identified, with these being interaction; discussion; contingent teaching (CT); learning performance; and quality of learning, which are shown and described further in Table 2. In the assessment benefits category, there were three themes identified, with these being feedback; formative assessment; and comparing responses with other students, which are also shown and described further in Table 2.

The challenges relating to the use of ARS were grouped into technological challenges; teacher or lecturer centered challenges; and student centered challenges, with these being reproduced from Kay and LeSage (2009a) in Table 3. The key themes relating to technological challenges were students being responsible for purchasing their own devices and not consistently bringing them to classes, and more significantly, times when the devices did not function correctly.

There were three teacher or lecturer centered challenges identified: responding to student feedback; coverage of content; and the development of questions, with these being shown and described further in Table 3. The seven themes relating to student centered challenges identified: students having a new method of learning to adapts to; the potential for increased confusion in discussions; the extra effort required by students; that use of an ARS for summative assessment may not be popular amongst the students; students feeling that they are being monitored; students feeling that they may be able to be identified; and that students may not like receiving negative feedback about their responses. These student centred challenges are shown and described further in Table 3.

In the conclusions to the study Kay and LeSage (2009a) identified areas for further research including looking at how different individuals respond to the use of ARS with starting points focussing on gender, grade level, age; and learning styles.

The themes emerging from Kay and LeSage (2009a) map to the first two sub-questions of the overarching research question (reproduced from chapter one):

1. What are the benefits of using applications on personally owned devices to engage with students in lectures (from a range of different perspectives and across a range of different contexts)?
2. What are the challenges involved in using applications on personally owned devices to engage with students in lectures (from a range of different perspectives and across a range of different contexts) and how can these challenges be addressed?

Benefit	Description	Evidence
Classroom environment benefits		
Attendance	Students go to class more	Burnstein & Lederman (2001); Caldwell (2007); Greer & Heaney (2004)
Anonymity	Students are more focussed in class	Bergtrom (2006); Burnstein & Lederman (2001); Caldwell (2007); d'Inverno, Davis & White (2003); Draper & Brown (2004); Elliott (2003); Jackson, Ganger, Bridge & Ginsburg (2005); Jones, Connolly, Gear & Read (2001); Latessa & Mouw (2005); Siau, Sheng, & Nah (2006); Slain, Abate, Hidges, Stamatakis & Wolak (2004)
Participation	All students participate anonymously	Caldwell (2007); Draper & Brown (2004); Jones et al. (2001); Siau et al. (2006); Simpson & Oliver (2007); Stuart, Brown & Draper (2004)
Engagement	Students are more engaged in class	Bergtrom (2006); Caldwell (2007); Draper & Brown (2004); Latessa & Mouw (2005); Preszler, Dawe, Shuster & Shuster (2007); Siau et al. (2006); Simpson & Oliver (2007)
Learning Benefits		
Interaction	Students interact more with peers to discuss ideas	Beatty (2004); Bergtrom (2006); Caldwell (2007); Elliott (2003); Freeman, Bell, Comerton-Forder, Pickering & Blayney (2007); Kennedy, Cutts & Draper (2006); Sharma, Khachan, Chan, & O'Byrne (2005); Siau et al. (2006); Slain et al. (2004); Stuart et al. (2004); Trees & Jackson (2007); Van Dijk, Van Den Berg & Van Keulen (2001)
Discussion	Students actively discuss misconceptions to build knowledge	Beatty (2004); Brewer (2004); Draper & Brown (2004), Jones et al. (2001); Nicol & Boyle (2003)
Contingent teaching	Instruction can be modified based on feedback from students	Brewer (2004); Caldwell (2007); Cutts (2006); Draper & Brown (2004); Elliott (2003); Greer & Heaney (2004), Hinde & Hunt (2006); Jackson et al. (2005); Kennedy & Cutts (2005); Poulis et al. (1998); Stuart et al. (2004)
Learning performance	Learning performance increases as a result of using ARS	Bullock et al. (2002), El-Rady (2006), Fagan, Crouch & Mazur (2002), Kaleta & Joosten (2007); Kennedy & Cutts (2005); Pradhan, Sparano & Ananth (2005); Preszler et al. (2007); Schackow, Milton, Loya & Friedman (2004); Slain et al. (2004)
Quality of learning	Qualitative difference when learning with ARS (e.g., better explanations, thinking about important concepts, resolving misconceptions)	Caldwell (2007); d'Inverno et al. (2003); Draper & Brown (2004); Elliott (2003); Greer & Heaney (2004); Nicol & Boyle (2003)
Assessment benefits		
Feedback	Students and teacher like getting regular feedback on understanding	Abrahamson (2006); Cline (2006); Draper, Cargill & Cutts (2002); McCabe (2006); Pelton & Pelton (2006)
Formative	Assessment is done that improves student understanding and quality of teaching	Beatty (2004); Bergtrom (2006); Brewer (2004); Bullock et al. (2002); Caldwell (2007); Draper & Brown (2004); Dufresne & Gerace (2004); Elliott (2003); Greer & Heaney (2004); Hatch, Murray & Moore (2005); Jackson et al. (2005); Siau et al. (2006); Simpson & Oliver (2007); Stuart et al. (2004)
Compare	Students compare their ARS responses to class responses	Burton (2006); Caldwell (2007); Draper & Brown (2004); Hinde & Hunt (2006); Simpson & Oliver (2007)

Table 2 – Summary of Audience Response Systems Benefits (Kay & LeSage, 2009a)

Challenge	Description	Evidence
Technology-based challenges		
Bringing remotes	Students forgot or lost remotes and could not participate in class	Caldwell (2007); Reay, Bao, Li, Warnakulasooriya & Baugh (2005)
ARS did not work	Remote devices did not function properly	El-Rady (2006); Hatch et al. (2005); Sharma et al. (2005); Siau et al. (2006)
Teacher-based challenges		
Responding to student feedback	Less experienced teachers cannot adjust to student feedback	Abrahamson (2006); Hu et al. (2006)
Coverage	Cover less course content if ARS is used	Beatty (2004); Beatty, Gerace, Leonard & Dufresne (2006); Burnstein & Lederman (2001); Burton (2006); Caldwell (2007); d'Inverno et al. (2003); Cutts (2006); Draper & Brown (2004); Fagan et al. (2002); Freeman et al. (2007); Hatch et al. (2005); Sharma et al. (2005); Siau et al. (2006); Slain et al. (2004); Steinhert & Snell (1999); Stuart et al. (2004)
Developing questions	Time consuming to create ARS questions	Allen & Tanner (2005); Beatty et al. (2006); Boyle (2006); El-Rady (2006); Fagan et al. (2002); Freeman et al. (2007); Horowitz (2006); Paschal (2002); Robertson (2000)
Student-based challenges		
New method	Students find it difficult to shift to a new way of learning	Allen & Tanner (2005); Beatty (2004); Fagan et al. (2002); Siau et al. (2006)
Discussion	Discussion leads to confusion or wasting time	Draper & Brown (2004); Nicol & Boyle (2003); Reay et al. (2005)
Effort	Too much effort is required by students when using ARSs	Trees & Jackson (2007)
Summative assessment	Using ARS for tests may not be popular with students	Caldwell (2007)
Attendance for grades	Students do not like ARSs used for monitoring attendance	Caldwell (2007)
Identifying students	Students want to remain anonymous	Abrahamson (2006)
Negative feedback	Students feel bad when receiving negative feedback	Carnaghan & Webb (2007)

Table 3 – Summary of Audience Response Systems Challenges (Kay & LeSage, 2009a)

2.2.3 Development of Themes

In using thematic analysis to review these studies, new three themes were added to the themes emerging from Kay LeSage (2009a) and the names of some of the themes were generalised. This analysis is based on the themes that relate to the first sub-question of the overarching research question of "What are the benefits of using applications on personally owned devices to engage with students in lectures (from a range of different perspectives and across a range of different contexts)?"

Two new categories of themes were identified during the analysis of these studies. The first new category relates to pedagogical issues which corresponds to the third sub-question of the overarching research question which is "What are the pedagogical implications involved in using applications on personally owned devices to engage with students in lectures?" The second new category is the cost and simplicity of devices which corresponds to the fourth sub-question of the overarching research question which is "How do issues relating to the cost and simplicity of devices impact on the use of applications on personally owned devices to engage with students in lectures and how can these issues be addressed?

2.3 Benefits Relaing to the use of ARS and APODs

In analysing the literature, two new themes were added to the benefits with these being student attention and making learning more enjoyable. The theme of Contringent Teaching was broadended to Contingent Teaching and Question Driven Instruction. This section presents an analysis of the literature based on this expanded set of themes.

2.3.1 Attendance

The increase in student attendance was one of the motivational strategies related to the use of ARS in higher education were identified in Kay and LeSage (2009b). The study conducted by Caldwell (2007) identified increased class attendance as being one of the outcomes from the use of ARS with an increase in attendance resulting from the use of ARS also being noted in Han (2014); Hunsu et al. (2016); and Chien, Change and Chang (2016), with this being particularly noticed when ARS is used to record attendance (Hunsu et al., 2016).

Empirical studies have also identified that the use of an ARS can be associated with improved attendance (Nelson & Hauck, 2008; Fortner-Wood, Armistead, Marchand & Morris, 2013) with this also having been identified in a mobile phone voting context (Habel & Stubbs, 2014). The concept of using such systems as a motivational strategy for attendance has also been identified (Kay & LeSage, 2009b). The idea of using ARS to monitor student attendance has been identified as a possible deployment strategy (Carnaghan, Edmonds, Lechner & Olds, 2011) and has been seen as a benefit of using ARS in some circumstances (Friedline, Mann & Lieberman, 2013).

In summary, increased attendance can be one of the consequences of the use of ARS in large lectures. This has relevance to this research in that attendance would be a necessary requirement for students to have a chance of being engaged during lectures.

2.3.2 Anonymity

The importance of anonymity was identified as one of the benefits from the perspective of students of the use of clicker technology in the study conducted by Blood and Gluchak (2013) and was reiterated in the conclusion to their study. This increase in student engagement due to anonymity is one of the outcomes of the use of ARS (Hunsu et al., 2016).

The concept of anonymity for students was present in the work of Chien et al. (2016) who highlighted the public manner of students answering questions verbally and the anxiety that this can create. One of the consequences of using anonymous ARS is that students do not perceive feedback about incorrect answers to be as threatening (Chien et al., 2006), with the speed of feedback also being valued by students (Chien et al., 2006).

The importance of anonymity was identified as a major issue in a number of empirical studies involving the use of ARS in the form of clickers (Banks, 2006; Freeman & Blayney, 2005; Gould, 2016; Heaslip et al., 2014; Innes & Main, 2013; Landrum, 2013) with Walklet, Davis, Farrelly & Muse (2016) particularly commenting on anonymity being related to engagement for shy students.

The relevance of anonymity is seen of particular significant importance when it comes to the discussion of sensitive subject areas (Tucker, Candler, Hamm, Smith & Hudson, 2010), with this idea also being present in the concept of creating a safe environment for discussion to take place in (Friedline et al., 2013). The concept that the willingness of students to participate in classroom activity is related to their preference for anonymity has also been identified (Freeman, Blayney & Ginns, 2006) and that increased participation can be a result of this (Heden & Ahlstrom, 2016). Studies that have involved the use of applications on mobile web-enabled devices have also highlighted that anonymity is a significant factor (Binder, 2013; Bristol, 2011), with students commenting specifically about the anonymity concept (Dunn, Richardson, Oprescu & McDonald, 2013).

The issue of student shyness is pointed to in some studies as being one of the underlying reasons for anonymity being a significant factor (Draper et al., 2002; Freeman & Blayney, 2005), with the concepts of introversion and extroversion being examined within the context of shyness and anonymity in the study by Latham and Hill (2014).

The concept of the power-distance orientation was also identified in Latham and Hill (2014) as being one of the underlying factors for students in some cultures not wanting to be seen as asking questions of the lecturer. Issues were also raised in Latham and Hill (2014) about the use of the responses after the lecture and whether this could lessen the extent of anonymity (Freeman et al., 2006) with this also having some connection with monitoring student attendance (Carnaghan et al., 2011; Friedline et al., 2013). The concept of anonymity was identified in Heden and Ahlstrom (2016) as being a significant factor that increased student participation when ARS were used in large lectures.

The importance of anonymity for this research has a high level of significance as lack of anonymity is one of the key reasons identified why many students choose not to engage in lectures whether through the asking or answering of questions. An important aspect of this is the shyness barrier which is significant for many students. The importance of anonymity for this research is that the use of ARS and APODs can provide anonymity for students when asking and answering questions.

2.3.3 Participation

The increase in student participation was one of the motivational strategies related to the use of ARS in higher education were identified in Kay and LeSage (2009b). The study conducted by Keough (2012) highlighted that many students commented on the value of using clicker technology to increase student participation in the classroom. The increasing of student participation through using ARS was identified was being a benefit from the perspective of students, and was also identified as being a benefit from the perspective of teachers (Blood & Gluchak, 2013), with this being reiterated in their conclusion.

The idea that the use of ARS could serve to increase participation in the classroom was identified in the study conducted by Caldwell (2007) and was one of the outcomes of using ARS in the classroom that was identified in Hunsu et al. (2016). In the study conducted by Flies and Marshall (2006) the concept of student participation being increased through use of wireless devices was identified as a potential area for further research.

Increasing student participation in classes has been identified by other writers with the concept that this is a benefit to both students and lecturers (Blood & Gluchak, 2013); enabling students to participate when they would not normally (Keough, 2012; Landrum, 2013); that participation increases due to anonymity (Freeman et al., 2006); and that the increased participation may be due to the creation of a safe environment (Friedline et al., 2013).

Studies involving the use of applications on mobile web-enabled devices have also identified increased participation by students as being one of the major benefits (Dunn et al., 2013; Habel & Stubbs, 2014; Wash, 2014), with the value of peer learning techniques in this context also being highlighted (Crouch & Mazur, 2001; Habel, 2011; Habel & Stubbs, 2014; Simpson & Oliver, 2007).

Students commenting in the Ludvigsen, Krumsvik & Furnes (2015) study that they did not feel they had to do anything in the traditional lecture but that they had to play an active role when ARS were used for activities. More recent studies also highlighted that increased participation was a possible outcome of using ARS in lectures (Gould, 2016; Heden & Ahlstrom, 2016; Daniel & Tivener, 2016; Walklet at al., 2016).

In summary, participation, which relates to studentds joining in with activities in lectures, can be increased through the use of ARS and APODS, particularly when the participation involves the asking and answering of questions. As such, the theme of participation has relevance to this research.

2.3.4 Engagement

The increase in student engagement was one of the motivational strategies related to the use of ARS in higher education were identified in Kay and LeSage (2009b). Increasing student engagement in the classroom has been one of the outcomes of using ARS in the classroom (Hunsu et al., 2016), who went on to highlight that more engaged students show greater commitment to tasks and put more effort in to their learning.

The study conducted by Carnaghan et al. (2011) found clear evidence of the increase in student engagement when ARS use is adopted. Increasing student engagement was identified in Blood and Gluchak (2013) as being a benefit to teachers that can be brought about through using ARS.

That the increase in engagement could apply to students with or without disabilities was commented on in the conclusion to the study by Blood and Gluchak (2013). Increased engagement was highlighted as being one of the non-cognitive outcomes to emerge from the use of ARS (Han, 2014). Engaging students in large classes is more complex than in small classes and ARS can help with this (Hunsu et al., 2016).

The motivation to increase student engagement for some lecturers stems from the problems associated with large classes and how this can lead to reduced engagement (Scornavacca, Huff & Marshall, 2007). Other studies have concluded that the use of ARS provide a tool for lecturers who wish to maintain engagement with students during lectures (Freeman et al., 2006), with the use of ARS as a motivational strategy to increase student engagement also being highlighted (Kay & LeSage, 2009b). The concept that there are relationships between student engagement, participation, attendance and preparation has also been identified (Habel & Stubbs, 2014).

The benefits of using ARS to increase engagement have been part of the findings of a number of studies (Blood & Gulchak, 2013; Heaslip et al., 2014; Kay & LeSage, 2009b; Landrum, 2013; Ludvigsen et al., 2015; Roscchelle et al., 2004 Stewart & Stewart, 2013), with this having the potential to extend to students with disabilities (Blood & Gulchak, 2013), and the usefulness in large classes also being noted (Landrum, 2013; Heden & Ahlstrom, 2016).

The increased engagement extends through to studies that have been based on the use of applications on mobile web-enabled devices (Calma et al., 2014; Dunn et al., 2013; Habel & Stubbs, 2014; Shishah, Hopkins, FitzGerald & Higgins, 2013). In a number of studies, the students involved reported that the use of the ARS had resulted in them feeling more engaged (Blasco-Arcas, Bull, Hernandez-Ortega & Sese, 2013; Carnaghan et al., 2011; Chen & Lan, 2013; Dunn, et al., 2013; Fortner-Wood et al., 2013; Han & Finklestein, 2013; Sternberger, 2012). The importance of engagement for student learning was also highlighted in a number of these studies (Coates, 2005; Crouch & Mazur, 2001; Habel, 2011; Habel & Stubbs, 2014; Simpson & Oliver, 2007).

A particular focus on cognitive engagement has emerged from some of the studies (Mayer & Wittrock, 2006; Wash, 2014; Wolter, Lundeberg, Kang & Herreid, 2011), with the finding that cognitively engaged students learn more (Mayer & Wittrock, 2006), and that the appropriate use of ARS can increase cognitive engagement (Wash, 2014; Wolter et al., 2011) and therefore increase learning.

A number of more recent studies also demonstrated that the use of ARS can increase student engagement in lectures (Farag et al., 2015; Ludvigsen et al., 2015; Gould, 2016; Daniel & Tivener, 2016; Walklet et al., 2016).

For this research, the theme of engagement has a high level of importance. This is due to the use of ARS and APODs having been shown to have the potential to increase student engagement in large lectures, and with this having been a common motivator for many of the studies that have been and reviewed, and was also one of the motivators for this research. The increase in cognitive engagement has been especially noted as having relevance to this research.

2.3.5 Attention

This theme ws added to the initial set of themes. Increasing the attention of students through the use of ARS was identified in the study conducted by Hunsu et al. (2016). The study of Dunn et al. (2013) also showed that the use of the technology also served to increase attention with this finding being consistent with the findings of other research (Kaleta & Joosten, 2007; Graham, Tripp, Seawright & Joeckel, 2007).

That students appear to pay more attention when ARS and APODs are being used in lectures has relevance to this research as students paying more attention to what is happening in the classroom will have more potential to become more engaged.

2.3.6 Making Learning More Enjoyable

This theme ws added to the initial set of themes. The idea that the use of ARS can make learning more enjoyable has been identified in a number of studies (Blood & Gluchak, 2013; Chen & Lan, 2013; Stewart & Stewart, 2013) with the game like environment that can result in contributing to this (Sternberger, 2012). That the use of ARS can have a positive effect on the enjoyment of students was identified in Buil, Catalan and Martinez (2016) and the positive effect that this can have on students' extrinsic and intrinsic motivation.

The idea that students find ARS fun to use has been noted (Blood & Gluchak, 2013; Chen & Lan, 2013; Camacho-Minano & del Campo, 2014; Innes & Main, 2013; MacArthur & Jones, 2008; Stewart & Stewart, 2013), with student responses indicating that they enjoy the novelty of the approach and the game-like environment that it can create (Sternberger, 2012). The extension of the concept of students enjoying the use of ARS and that the learning process is more effective if students are enjoying the learning process can be seen in a number of studies (Beekes, 2006; Camacho-Minano & del Campo, 2014; Eastman, Iyer & Eastman, 2011).

Making learning more enjoyable has direct relevance to this research as one of the conseqeunces of increasing student engagement can be to enhance the learning process and make learning more enjoyable. From the literature that has been reviewed, there is evidence to suggest that the use of ARS and APODs has the potential to make learning more enjoyable.

2.3.7 Interaction

That the use of ARS can increase student interaction was one of the main considerations identified by Flies and Marshall (2006) and that this was particularly relevant to the possible use of next generation systems including wireless devices. The benefit of increased student interaction through the use of ARS was one of the significant findings of the study conducted by Caldwell (2007) with this also being one of the motivational strategies identified in Kay and LeSage (2009b) in the context of enabling peer interaction.

The level of interaction in classrooms can drop as class sizes increase (DeCaparaiis, 1997; Tobias, 1990; Wolter et al., 2011) with maintaining interaction being one of the motivating factors for adopting ARS (Kay & LeSage, 2009b; Sternberger, 2012). The use of ARS to increase student activity has been demonstrated in a number of other studies (Blasco-Arcas et al., 2013; Shishah et al., 2013; Sternberger, 2012). Models have been developed relating to the increased interactivity, including a conceptual framework (Blasco-Arcas et al., 2013), the contingent teaching model (Stewart & Stewart, 2013) and the question driven instruction (QDI) model (Beatty et al., 2006).

The important aspect of social interaction has been highlighted (Camacho-Minano & del Campo, 2014), including how this can enhance learning in a manner consistent with a social constructivist view (Brown, Collins & Duguid, 1989; Driscoll, 2005; Van de Pol, Volman & Beishuizen, 2011; Vygotsky, 1978). This is also seen as being intertwined with the concept of cognitive engagement (Mayer & Wittrock, 2006; Wolter et al., 2011).

The concept that ARS can be used to create more interaction when the topics are more sensitive has been identified (Friedline et al., 2013) and the idea of using ARS to create an additional communication channel has also been identified (Scornavacca et al., 2007). More recent studies that highlighted the increasing student interaction brought about through the use of ARS included Gould (2016) and Walklet et al. (2016).

To summarise, the use of ARS and APODs in lectures can increase the interaction of students within the lecture, particularly when students are encouraged to discuss responses with each other before they make their responses. Some of this is related to a social constructivist viewpoint. This has direct relevance to this research as one of the intial motivators for this research was for students to interact with each other in small groups and then share their group's responses with the rest of the class.

2.3.8 Discussion

The discussion that can take place amongst students while answering questions using ARS was identified as being one of the learning strategies that can be adopted through use of ARS (Kay & LeSage, 2009b). The importance of questions that stimulate class discussion was also identified in Kay and LeSage (2009b) and Hunsu et al. (2016).

The relationship between peer discussion and learning outcomes was highlighted in Chien et al. (2016), with ARS being an enabler of the results of peer discussion being shared with the rest of the class. Chien et al. (2006) goes on to identify the importance of peer discussion as lying in students being encouraged to explain their reasoning. The decision as to whether to have students asking questions using ARS based on individual work or on the results of group discussion was identified as a key deployment strategy in the work conducted by Carnaghan et al. (2011).

Students being able to gain a deeper understanding through discussion and collaboration with each other through the environment created by the use of ARS is consistent with the pedagogical approach of social constructivism (Sternberger, 2012). Student grades were found to be related to the amount of student discussion, as well as motivation and provision of feedback, particularly in a social constructivist setting (Camacho-Minano & del Campo, 2014). The importance of discussion in a group setting is seen as being a factor that enhances student performance (Blasco-Arcas et al., 2013), and the decision for student responses from an ARS being individual or group based is identified as a significant deployment decision (Carnaghan et al., 2011).

The importance of collaborative learning for enhancing student performance has also been highlighted (Blasco-Arcas et al., 2013), along with the importance of being able to facilitate classroom discussion through the use of ARS (Friedline et al., 2013). Engaging students in peer discussion through the use of ARS has been found to lead to better educational outcomes (Mazur, 1998; Scornavacca et al. 2007).

A student in the Ludvigsen et al. (2015) study stated "… I cannot answer the questions until I discuss them out loud…" which indicates that for some students the discussion that takes place before the question is answered is vitally important for learning. As part of their conclusion Ludvigsen et al. (2015) went on to outline how the use of ARS could be of use to those students who are likely to learn more through the discussion of concepts (Ludvigsen et al., 2015).

The importance of discussing concepts and peer discussion and how this could be facilitated through using ARS was identified in more recent studies including Gould (2016); Daniel & Tivener (2016); and Walklet et al. (2016).

There has been some negative reaction to the use of ARS relating to the time it takes to discuss the answers to the questions (Innes & Main, 2013).

The relevance of the discussion theme to this research is significant as one of the motivators for the research was to enable the results of small group discussions to be shared with the rest of the class. The use of ARS and APODs has the potential to facilitate this sharing of the outcomes of the discussions in a large class context. This is seen as being important for the learning process as discussion can lead to deeper understanding of content.

2.3.9 Contingent Teaching and Question Driven Instruction

Contingent teaching (CT) where teaching is adjusted based on feedback from the class was identified as one of the potential benefits to be gained through the use of ARS (Kay & LeSage, 2009b) and with CT being enabled by the use of ARS (Kay & LeSage, 2009a). The feedback-intervention loop outlined in Chien et al. (2016) has commonalities with the concept of CT where student responses to questions can be used to guide the direction of the content being covered in a class. Chien et al. (2016) go on to identify how the use of ARS is an enabler of this process.

The concept of CT has also been linked to the concept of question driven instruction (QDI) that has been discussed in a number of studies (Beatty et al., 2006; Wolter et al., 2011), with students having responded positively to QDI (Welch, 2013). The idea that the direction of teaching in the rest of a class could be contingent on student responses to questions, or driven by the students' responses to questions, has been identified as being a key benefit in teaching and learning (Cline, Zullo & VonEpps, 2012, Stewart & Stewart, 2013).

The concept of CT was implicit in some of the findings of Ludvigsen et al. (2015) as it relates to the usefulness of the feedback received by the lecturer. This was further explained as how the use of feedback from ARS could create moments of contingency that are implicit in the concept of CT. The concept of CT was also implicit in the findings of Heden and Ahlstrom (2016) who identified the opportunity for lecturers to re-explain concepts based on the students' answers when using ARS in lectures.

The pedagogical issues category from the analysis of meta-studies also included CT and QDI as a theme, with aspects relating to these now being included here in the category of benefits. The enabling of QDI and CT through using ARS in classes was identified in thr meta-study that was conducted by Hunsu et al. (2016).

The models of question driven instruction (QDI) and contingent teaching (CT) have emerged from the empirical studies reviewed as being useful and beneficial approaches to adopt when using ARS. These models can be used to deal with the design of lectures and in particular the design of effective questions for use with ARS (Beatty et al., 2006).

The concept of CT where the direction of a lecture can be based, or be contingent on, feedback from students using ARS has been developed and refined (Draper & Brown, 2004; Stewart & Stewart, 2013) and has been identified as being a significant adoption strategy for the use of ARS (Kay & LeSage, 2009b).

The use of CT and QDI has significant relevance to this research as in a large class context ARS and APODs would facilitate these approaches in a way that might not be possible otherwise. This is due to the lecturer being able to receive timely feedback from students as to the extent of their understanding and their learning process.

2.3.10 Learning Performance

Increased learning outcomes were one of the results of using ARS effectively was identified in Han (2014). The use of ARS to increase student performance has been the goal for many instructors when adopting ARS (Hunsu et al., 2016). There is a body of thought that sees the use of ARS as increasing interactivity and engagement but not necessarily increasing student performance, and it has been identified that the use of ARS can reduce the effort students put into a course and at the same time not reduce their performance (Chui, Martin & Pike, 2013).

The key to the use of ARS to increase student performance appears to be in the way in which they are used, with discussion between peers (Blasco-Arcas et al., 2013; Smith et al., 2009; Blasco-Arcas et al., 2013), the enabling of cognitive engagement (Mayer & Wittrock, 2006; Wolter et al., 2011), the adoption of appropriate pedagogies (Brady, Selit & Rosenthal, 2013) that involve deeper cognitive processing (Mayer et al., 2009), and in particular social constructivist pedagogies (Camacho-Minano & del Campo (2014).

The study conducted by Ludvigsen et al. (2015) indicated that the use of ARS resulted in students becoming aware of concepts that they were unsure of with this then enabling them to study more in those areas thereby increasing their learning performance.

The ways in which ARS may help learning was something that had been identified as being missing in much of the literature (Buil et al., 2016).

To summarise, there is a suggestion that the use of ARS and APODs can lead to increased learning performance although this is not present in all of the literature to a great extent. This is not as significant for this research as the main focus of this research is on engagement in lectures.

2.3.11 Quality of Learning

The use of ARS to potentially increase the quality of learning was identified in Han (2014). Participation in active learning (as can be facilitated by the use of ARS) can result in increased knowledge acquisition (Hunsu et al., 2016). The importance of the impact on learning (and not just on student engagement) was an issue that was identified in Flies and Marshall (2006), Scornavacca et al. (2007) and Nelson and Hauck (2008). In these studies, there were reports of students being happy using CRS or SMS technologies, but that it was in some cases problematic to measure the impact on learning.

The clarification of the main points and concepts covered during a lecture has been identified as improving the quality of learning (Blood & Gulchak, 2013) with this including the coverage of key points from the lecture (Stewart & Stewart, 2013) and the reinforcement of key concepts from a lecture (Keough, 2012). Being able to identify misunderstandings of concepts earlier so that they could be clarified sooner is an extension of this (Blasco-Arcas et al., 2013). Key to being able to clarify the main points of a lecture is that the lecturer has a way of checking the understanding and comprehension of students (Blasco-Arcas et al., 2013; Blood & Gulcak, 2013; Heaslip et al., 2014).

The quality of learning can be assisted by activities that are enabled by the use of ARS (Bristol, 2011; Camacho-Milnano & del Campo, 2014; Freeman & Blayney, 2005; Heaslip et al., 2014), with the impact on the quality of learning being due to the activity that is enabled more than the use of the ARS (Chen & Lan, 2013; Eilks & Byers, 2010). This extends to the improvement in the quality of learning due to changes in approaches to teaching (Landrum, 2013) and the pedagogical development that is needed to use ARS well (Bruff, 2009; Han & Finkelstein, 2013; Wieman, 2010).

The relationship between students' perceptions and the quality of their learning and the quality of the courses they are enrolled in has become evident, with students perceiving the use of hand held devices as improving their learning (Camacho-Minano & del Campo, 2014; Carnaghan et al., 2011; Chen & Lan, 2013; Freeman et al., 2006; Freeman & Blayney, 2005; Han & Finkelstein, 2013; Landrum, 2013; Sternberger, 2012; Welch, 2013). This extends into students having increased perceptions of the courses and lecturers (Fortner-Wood et al., 2013; Nelson & Hauck, 2008).

The increased motivation experienced by some students is also seen as being related to an increase in the quality of learning that can result from the use of ARS (Camacho-Minano & del Campo, 2014; Scornavacca et al., 2007). In the studies conducted by Farag et al. (2015) and Gould (2016) it was identified that the use of ARS can improve the quality of teaching with this being supported by the conclusions to the study conducted by Heden and Ahlstrom (2016) which included that ARS can be used to increase student learning in large lectures.

The concept that students feel that the use of ARS supported their learning (Ludvigsen et al., 2015) and that the use of ARS can enhance the overall learning experience (Buil et al., 2016) have been identified.

In summary, the use of ARS and APODs can result in students reporting a higher quality of learning, with some studies reporting that there is an increase in the quality of learning. The relevance to this research is not as significant as in a similar concept to learning performance, the focus is on student engagement, with the view that increased engagement will facilitate a higher quality of learning.

2.3.12 Feedback

That feedback from the students in the class can be gained through use of ARS was identified in Kay and LeSage (2009b) and that this can enable a contingent teaching approach. The importance and value of feedback was one of the significant findings to come out of the study conducted by Keough (2012), with this including the reinforcing of important concepts. The value of feedback enabled through using ARS was also highlighted in Han (2014).

ARS being used to provide feedback to facilitate teachers being able to check on student comprehension level and for students to be able to check on their own comprehension level were identified as significant benefits of the use of ARS (Blood & Gluchak, 2013). The speed of the feedback was also identified as being significant (Blood & Gluchak, 2013). The timing of feedback, and the increased speed at which it can take place, was also identified in Flies and Marshall (2006).

The importance of creating interventions in the learning process so that feedback on the learning process can take place was highlighted in the work of Chien et al. (2016), with the use of ARS being a key enabler of this. Chien. et al. (2006) goes on to identify that more research is needed into the importance of feedback coming from the lecturer when ARS are being used.

The importance of providing feedback to lecturers from students through the use of ARS has been seen as a costly alternative to asking students to raise their hands, but proves to be a quick method and addresses other issues such as anonymity (Freeman & Blayney, 2005). The provision of feedback to the lecturer was part of a question cycle that was developed (Beatty et al., 2006), with the benefits of this being highlighted in other studies (Guthrie & Carlin, 2004; Wash, 2014; Wolter et al., 2011). A particular emphasis on lecturers receiving feedback on the comprehension levels of students was also been identified (Chui et al., 2013).

The importance of the lecturer receiving feedback on student comprehension is vital to concepts such as the collection of formative data and for CT (Kay & LeSage, 2009b). Students receiving feedback from the lecturer in an environment where ARS have been used has been highlighted as being of importance in a number of studies (Azevedo & Bernard, 1995; Bangert-Downs, Kulik, Kulik & Morgan, 1991; Blood & Gulchak, 2013; Calma et al. 2014; Camacho-Minano & del Campo, 2014; Dunn et al., 2013; Flies & Marshall, 2006; Heaslip et al., 2014; Kennedy & Robson, 2008; Keough, 2012; Kulik & Kulik, 1998; Nelson & Hauck, 2008), and of particular relevance to Net Generation learners (Robinson & Ritzko, 2006).

The importance of the feedback being from student to lecturer and from lecturer to student is also significant (Guthrie & Carlin, 2004; Wolter et al., 2011). The timing of the feedback is seen as being particularly important in a number of studies (Azevedo & Bernard, 1995; Bangert-Downs et al., 1991; Kulik & Kulik, 1998), and is supported by a number of other studies (Blood & Gulchak, 2013; Chui et al., 2013; Dunn et al., 2013; Flies & Marshall, 2006; Kennedy & Robson, 2008; Wash, 2014).

The concept that feedback was one of the cores of formative assessment as an importance part of student learning was part of the basis for the study conducted by Ludvigsen et al. (2015) and was reiterated in the conclusions of their study. It was noted that the provision of this type of feedback is hard to achieve in a large class context without the use of ARS (Ludvigsen et al., 2015).

Ludvigsen et al. (2015) also identified the concept that students receiving feedback that their answers were correct could lead them to not work as hard on those concepts, with this being part of the notion of students using feedback from ARS based activities to regulate their own learning.

The importance of feedback was also identified in Gould (2016) and Heden and Ahlstrom (2016). The use of ARS to enable feedback was identified in Walklet et al. (2016). The importance of feedback provided through using ARS was highlighted in the study conducted by Buil et al. (2016) with a particular emphasis being placed on the speed of the feedback that is possible.

The theme of feedback has significant relevance to this research, whether from student to lecturer or lecturer to student. The significance for this research includes that one of the initial motivations for this research lay in a desire for the lecturer to receive feedback on student understanding during a lecture, and that the use of ARS and APODs would facilitate this in large classes that may not being possible in ways that would work in smaller classes.

2.3.13 Formative Assessment

The use of ARS to conduct formative assessment was identified as one of the key strategies in the use of ARS (Kay & LeSage, 2009b) with this including that enabling formative assessment was a clear benefit to come about through the adoption of ARS. It was noted that while the benefit of using ARS for formative assessment was clear, that this was not the case for summative assessment (Kay & LeSage, 2009b).

In outlining the "testing effect", Chien et al. (2016) demonstrates that the use of ARS is a significant aid in formative assessment with the use of ARS to enable formative assessment also being highlighted in Han (2014). The decision as to whether to use ARS for formative and summative assessment was part of the deployment strategies to emerge from Carnaghan et al. (2011).

Some studies have focussed on the issue of whether ARS should be used for formative assessment, summative assessment or a combination of both (Carnaghan et al., 2011; Han & Finkelstein, 2013; Kay & LeSage, 2009b). A number of the studies have concluded that there is a greater positive impact on student engagement and learning when the ARS are used for formative assessment and not for summative assessment (Han & Finkelstein, 2013), while others conclude that it is unclear about the benefits for summative assessment, but that is very helpful for formative assessment (Kay & LeSage, 2009b). It is clear that the decision about whether or not to use ARS for summative assessment is a decision that lecturers need to make with consideration of the impacts of the different forms of use (Carnaghan et al., 2011).

The concept of using ARS for "formative feedback practice" was the focus of study by Ludvigsen et al. (2015), with part of the goal being to determine whether this practice would enable students to be more aware of, and monitor their own learning. In Gould (2016) the usefulness of ARS for formative assessment was identified within the context of the importance of being able to use ARS so that comprehension was measure during lectures than during an exam was seen as being significant. The use of ARS for formative assessment was also identified in Walklet et al. (2016).

For this research the theme of formative assessment is significant as the process of gaining feedback from students about what they understand is consistent with the concept of formative assessment. For this research the feedback from student to lecturer to enable formative assessment to take place during the lecture can be facilitated through the use of ARS and APODs in ways that might not be possible in other ways when classes are large.

2.3.14 Comparing Responses

The concept of students was one of the themes identified in Kay and LeSage (2009a) with this being paid little attention in the other meta-studies that were reviewed. There is some evidence that the feedback the students receive, and the ability to compare their responses with other students, will serve to increase their confidence levels (Chui et al., 2013), but that this extra confidence may result in less preparation being completed for major assessment items.

Ludvigsen et al. (2015) highlighted that the use of ARS in letting them see what others though was something that the students found useful in their learning, with this being supported in the study conducted by Gould (2016).

The relevance of this theme to this research is that the use of ARS and APODs can facilitate students being able to see the responses of other students in a way that might not be possible in other ways in large classes.

2.4 Challenges Relating to the Use of ARS

In analysing the literature, one more theme was added to the challenges relating to the use of ARS and APODs. This theme was that of students with disabilities. The exisiting themes of summative assessment; attendance for grades; and identifying students were combined into one theme of "summative assessment/identifying students". Two themes were generalised and renamed from "Student not bringing remote" to "Students not having or bringing the required device" and "ARS did not work" to "Technology not functioning" respectively. This renaming is a reflection of this research relating to APODs and not being restricted to the more traditional ARS in the form of clickers.

2.4.1 Students not Having or Bringing the Required Device

This challenge received some attention in the study conducted by Kay and LeSage (2009a). The issue of requiring students to purchase devices (eg clickers) can meet with some resistance (Binder, 2013), and there are some who see issues relating to students using their own devices (smart phones, tablets, or laptops) where the students may use them for other purposes during the class and create distractions for themselves and others (Binder, 2013; Lytle, 2012).

The issue of all students not having a device (whether through not owning one or not bringing it to class) can be dealt with by getting students to work in small groups (Scornavacca et al., 2007). Use of small group work appears to resolve some of the issues of not all students having a device that they can participate with (Dunn et al., 2013; Scornavacca et al., 2007). With increasing numbers of students owning devices like smart phones, tablets, and laptops, using applications that run on these devices address this issue also (Wash, 2014).

In summary, increasing numbers of students owning devices that APODs can run on and the use of small group work can reduce this challenge as if not all students have a device there is a high chance that one student in each group will have a device. The use of small group work and the small groups being able to share their responses in large class settings was one of the main motivators for this research, and as such this challenge, and the addressing of this challenge is significant for this research.

2.4.2 Technology not Functioning Correctly

The issues of having the ARS not work is one of the logistical difficulties was identified in the study conducted by Flies and Marshall (2006). Issues that result in the ARS malfunctioning or not working at all has been identified as a major technology based challenge facing the use of ARS that was identified in Kay and LeSage (2009a), with some of this being based on the findings of other studies (El-Rady, 2006; Hatch et al., 2005; Sharma et al., 2005; Siau et al., 2006).

Comments relating to technical problems surrounding the use of ARS in the form of clickers included battery life, the hand-held devices not functioning correctly, and the software that was required not being set up correctly (Graham et al., 2007; Keough, 2012). However, there is evidence that many of the technical issues surrounding the use of clickers that had been identified in earlier studies (Graham et al., 2007) have now been resolved (Heaslip et al., 2014). Technical and practical issues emerged as consistent barriers to the use of ARS in the study completed by Walklet et al. (2016).

The relevance of this theme to this research may not have high significance as the devics that APODs run on are devices that students are likely to be using for other purposes on a regular basis. As a consequence, this challenge is likely to have reduced in significance in comparison to what might have been experienced with ARS in the form of clicker devices in the past.

2.4.3 Responding to student feedback

That some teachers adopting the use of ARS may experience some logistical difficulties was identified in the study conducted by Flies and Marshall (2006). Some of this challenge relates to the adjustments required to giving feedback in a manner that is consistent with CT (Kay & LeSage, 2009a) This particular challenge was also identified in the meta-study conducted by Flies and Marshall (2006) but appears to have had little attention in the empirical studies that have been reviewed. Responding to student feedback creating additional stress for lecturers was identified as an issue for some lecturers (Heden & Ahlstrom, 2016).

In summary, this theme has the potential to be siginificant for this research, particularly for the stresses that may be created for some lecturers.

2.4.4 Coverage of Course Content

There are some that perceive that interrupting lecture time to use ARS for questions may be counter-productive when it comes to covering course content (Hunsu et al., 2016). The issue of coverage of course content was identified as an issue facing lecturers or teachers adopting ARS (Flies & Marshall, 2006), with the issue of coverage of course content was present in the work of Caldwell (2007) who identified the importance of not "wasting time" with ARS.

The issue of coverage of course content being reduced because of the time taken with ARS use was identified as a potential drawback by Dunn et al. (2013) and Elliot (2003). The concept of not having time to cover course content was identified as a reason why some lecturers might choose to not adopt the use of ARS (Farag et al., 2015).

One of the conclusions of the study by Gould (2016) that may address this challenge was that lecturers should "… *focus on student learning outcomes rather than content coverage* …" and that this would see the significance of this challenge reduce.

This theme may have relevance to this research as the time taken to use the ARS and APODs in lectures may reduce time for coverage of course content. This could be balanced by the feedback that the lecturer receives from students could enable some content to be focused on more than others due to the level of understanding that students already have.

2.4.5 Development of Effective Questions

The increased time and effort need for lecturers and teachers adopting ARS to develop effective questions and activities was present in the findings of Flies and Marshall (2006). The issue of developing good questions for use with ARS was also identified in Caldwell (2007) and was one of the keys to the success of the use of ARS (Caldwell, 2007). The design of questions for use with ARS was identified as being one of the key success factors in adopting ARS (Han, 2014).

The planning needed for the development of the right types of question for use with ARS should not be underestimated (Caldwell, 2007). Planning effective questions was identified as a key strategy in Kay and LeSage (2009b), particularly when it comes to developing questions that stimulate classroom discussion. One of the factors highlighted in the study completed by Han (2014) was the importance of pedagogical training for instructors using ARS.

The need to design effective questions for use with ARS is related to the need to redesign aspects of courses so that they are more interactive (Castillo-Manzano et al., 2016). The issues relating to the development of effective questions for use with ARS can be separated into two areas: the time it takes to develop effective questions, and the importance of developing effective questions.

The extra time it takes for lecturers to develop the questions needed has been highlighted (Carnaghan et al., 2011; Innes & Main, 2013; Kay & LeSage, 2009b) with this extending to the time it take to set up the ARS for use (Innes & Main, 2013). The issue of time for lecturers to adapt to the use of ARS has also been identified (Chen & Lan, 2013).

The importance of developing effective questions has seen the development of a threefold model (Beatty et al., 2006) that covers content goals, process or cognitive goals, and meta-cognitive goals. The model suggests that the most effective questions direct students' attention; stimulates their thinking or cognitive skills relating to the topic; and are able to see how their responses relate to the rest of the class and allow for discussion about the topic (Beatty et al., 2006).

The importance of designing effective questions relates to the need to, in some cases, redesign lectures to incorporate the ARS (Innes & Main, 2013). It also relates to the need to make decisions about whether the questions are formative or summative; multiple choice or open-ended; individual or group based (Carnaghan et al. 2011); and the types of questions and their format (Kay & LeSage, 2009b; Kennedy & Robson, 2008).

The success of the design of effective questions for use with an ARS will depend to an extent on the enthusiasm and willingness of the lecturer in relationship to the different approaches to learning (Mankin, Boone, Flores & Willyard, 2004; Sternberger, 2012; Welch, 2013). The time taken to develop effective questions for use with ARS was also identified as a challenge in Farag et al. (2015) and Gould (2016).

It was also identified that ARS should be implemented with careful consideration (Walklet et al., 2016).

The development of effective questions for use with ARS and APODs is a very significant theme for this research. The previous theme of the time taken with activities reducing the time available for covering content is addressed by the use of ARS and APODs being used in effective ways. The concept to be drawn out of this is that it is not just the use of ARS and APODs that makes a difference for student engagement, but how they are used, and implicit in this is the need for good pedagogical approaches.

2.4.6 Adjusting to a New Method of Teaching

That students may react differently to the use of ARS was identified as a potential student-based challenge in Flies and Marshall (2006). Flowing on from this is the strategy of being careful to explain to students why the ARS is being used (Kay & LeSage, 2009b). The use of ARS can result in classes becoming more unstructured which may be a challenge for some students (Carnaghan et al., 2011).

The importance of students and lecturers needing time to adjust to the use of an ARS has also been noted (Chen & Lan, 2013).

While there may be some adjustment needed for student, the nature of APODs in that the students personally own some of the devices has the potential to reduce this challenge. As a consequence of this, the challenge of this adjustment for students may not be a signification issue for this research.

2.4.7 Discussion of Topics Creating Confusion or Wasting Time

This challenge received little attention in the studies that were reviewed aside from the one conducted by Kay and LeSage (2009a). As a consequence, this theme is likely to have little significance for this research.

2.4.8 Too Much Effort Required by Students

This challenge received little attention in the studies that were reviewed aside from the one conducted by Kay and LeSage (2009a). This particular challenge was touched on in Trees and Jackson (2007).

With APODs being the main focus of this research (as opposed to ARS in the form of clickers), this theme is likely to have little relevance to this research as the devices that APODs run on are likely to be quite familiar to the students as they are likely to be using them on a regular basis, and as such, the effort requied to use them may be minimal.

2.4.9 Summative Assessment

The awarding of grades for activities and questions completed with ARS, and the associated anxiety, was commented on as a potential student challenge in the work of Caldwell (2007). The use of ARS for summative assessment was identified as a potential deployment strategy in Kay and LeSage (2009b) who went on to comment that benefits of using ARS in summative assessment are unclear (in comparison to the use of ARS for formative assessment where the benefits are clear).

The issue of whether ARS should be used for summative assessment was also addressed in the study of Carnaghan et al. (2011) with this including whether the use of ARS was compulsory or optional for students. Gould (2016) while highlighting the usefulness of ARS for formative assessment, did highlight mixed responses to the use of ARS for summative assessment.

This theme is likely to have little relevance to this research as the main focus is on the use of ARS and APODs in an anonymous mode. This results in this theme being combined with the themes of attendance for grades and the theme of identifying students and being renamed as "summative assessment/identifying students".

2.4.10 Attendance for Grades

The use of ARS for recording student attendance was identified by Carnaghan et al. (2011) as a deployment strategy that could be deployed. Using ARS to record attendance was identified as a possible use of ARS (Han, 2014). Where ARS is used for recording attendance there can be an increase in attendance (Hunsu et al., 2016).

The use of ARS for recording attendance where attendance is a grading criterion was seen as a potential deployment strategy that has the potential to increase attendance (Carnaghan et al., 2011; Han, 2014; Hunsu et al., 2016). This needs to be balanced with the issue of students not liking the use of ARS for tracking their attendance has been identified as being one of the challenges from a student perspective (Caldwell, 2007; Kay & LeSage, 2009a). Gould (2016) also identified this as a potential use.

The awarding of grades for attendance recorded is similar in concept to the use of ARS for summative assessment.

This theme is likely to have little relevance to this research as the main focus is on the use of ARS and APODs in an anonymous mode. This results in this theme being combined with the themes of summative assesment and the theme of identifying students and being renamed as "summative assessment/identifying students".

2.4.11 Identifying Students

This challenge received some attention in the study conducted by Kay and LeSage (2009a). The concept of being able to identify the students appears at odd to concept of anonymity, and is also connected to using ARS for summative assessment and recording attendance for grades, as in these scenarios the students would need to be identified. This is partly related to the study conducted by (Abrahamson, 2006). This challenge needs to be looked at alongside the anonymity issue as the potential identification of students goes against the concept of anonymity (Abrahamson, 2006).

This theme is likely to have little relevance to this research as the main focus is on the use of ARS and APODs in an anonymous mode. This results in this theme being combined with the themes of summative assesment and the theme of identifying students and being renamed as "summative assessment/identifying students".

2.4.12 Negative Feedback

The issue of students feeling bad when receiving negative feedback from the lecturer when an ARS has been identified as one of the challenges faced from a student perspective (Carnaghan & Webb, 2007; Kay & LeSage, 2009a). This particular issue appears to receive little attention in the other studies that were reviewed and as such is likely to have little relevance to this research.

2.4.13 Students with Disabilities

Issues relating to the use of ARS by students with disabilities have been noted. On one hand there is the possibility that some ARS may be helpful to students with some disabilities (Blood & Gluchak 2013) whereas it may be that some students with some disabilities may find that there are specialized applications or installations required for them to use ARS (Carnaghan et al., 2011).

This theme may have some relevance to this research as the use of ARS and APODs, which creating challenges for some students, may create opportunities for other students that may be difficult to create in other ways.

2.5 Pedagogical Issues Relating of the Use of ARS

In the intial set of themes there was specific mention of pedagogical issues related to the use of ARS, the benefits and challenges were alluded to. A number of other studies reviewed paid specific attention to pedagogical issues of themes. This section provides an analysis of pedagogical issues or themes relating to the use of ARS that were identified with this relating to the third sub-question of the overarching research question of "What are the pedagogical implications involved in using applications on personally owned devices to engage with students in lectures?"

There have been many pedagogical and teaching issues identified that relate to the use of ARS with many specifically identifying the importance of placing pedagogy before technology (Beatty et al., 2006; Flies & Marshall, 2006). Some of these issues have been identified in the literature as relating to good teaching strategies, while others have specifically addressed these as being pedagogical issues, with some of them specifically focussing on issues to do with large classes. Specific pedagogical issues can be broken down into those relating to social constructivism; QDI or CT; issues relating to instructional design; issues relating to learning styles and cultures; and whether participation in the activities surrounding ARS are optional or mandatory.

2.5.1 Good Teaching Strategies

The study conducted by Flies and Marshall (2006) highlighted the importance of adopting good teaching strategies when using ARS, and in their conclusion identified that much of the literature at the time related to general learning and that there would be a need for a body of literature surrounding the use of ARS in learning to be developed. The use of good teaching strategies was identified in Hunsu et al. (2016) was being vital for the successful use of ARS.

The importance of the use and enablement of good teaching strategies when using ARS has been identified (Blood & Gluchak 2013; Brady et al., 2013; Mayer et al., 2009) with other studies concluding that the successful use of ARS is more about the teaching strategies being adopted through their use (Christopherson, 2011; Landrum, 2013; Wolter et al., 2011), and in particular that the adoption of ARS does not provide a 'magic bullet' for better teaching (Banks, 2006; Stewart & Stewart, 2013).

The study conducted by Daniel and Tivener (2016) while highlighting that increased engagement, participation, and learning could come about through the use of ARS, went on to say that "… the results were not due to the clickers so much as to the active learning environment made possible by clickers…", with this being partly based on the work of Martyn (2007) and Mayer et al. (2009).

The development of learning based strategies (Kay & LeSage, 2009b) and deployment strategies (Carnaghan et al., 2011) for use with ARS is further indication of the importance of adopting good teaching strategies. The study conducted by Walklet et al. (2016) highlighted the importance of using ARS for a mixture of activities including peer group discussion and other activities promoting individual reflection.

2.5.2 Specifically Addressed as Pedagogical Issues

Flies and Marshall (2006) also commented that there was general agreement that the use of ARS would promote learning when used with appropriate pedagogies and in identifying implications for further research identified the need to look at the use of ARS with a diverse range of pedagogies. This use of appropriate pedagogies was also pointed out in Hunsu et al. (2016) as being very significant, with this also being highlighted in Han (2014) who emphasized the importance of the relationship between the use of ARA and pedagogical issues.

The concept that the use of ARS in conjunction with well-founded pedagogical approaches will promote better learning has been identified (Brady et al., 2013; Flies & Marshall, 2006), with the importance of focussing on pedagogy before technology also being paramount (Draper & Brown, 2004; Stewart & Stewart, 2013). A consequence of this is that pedagogical development should play a vital role in the adoption of ARS (Han & Finkelstein, 2013). Appropriate pedagogy has enabled students to obtain deeper understanding of content (Sternberger, 2012), and that this can increase student satisfaction (Sternberger, 2012).

The importance of pedagogy being intertwined with aspects of engagement, participation, attendance and preparation has also been identified (Habel & Stubbs, 2014). The need for the development of new pedagogical skills was identified in Gould (2016).

2.5.3 Large Class Issues

The value of the use of ARS in large classes was highlighted by Hunsu et al. (2016). This is particularly relevant to this research as the impetus for this research came from a desire to increase student engagement in the context of large classes.

Issues specifically relating to the use of ARS have been identified particularly as it relates to the decreased classroom interaction that takes place as class sizes increase (Cutler, 2007; Freeman & Blayney, 2005; Heaslip et al., 2014; Scornavacca et al., 2007; Wolter et al., 2011). The use of ARS can be a way to overcome this (Freeman et al., 2006; Heaslip et al., 2014; Landrum, 2013; Sternberger, 2012). Studies relating to the use of applications on smart phones and similar devices also specifically mention their use in large classes (Shishah et al., 2013). It has also been noted that the increasing class sizes are becoming more common in higher education due to staffing and funding issues (Cullen, 2011; Heaslip et al., 2014).

2.5.4 Constructivism

Theories of scaffolding and constructivism were identified by Chien et al. (2016) as being one way of explaining the usefulness of ARS in the classroom. This has particular relevance to this research as APODs can be used to find out what students already know so that this base can be built on when constructing knew knowledge.

The use of ARS particularly in conjunction with social constructivist pedagogical approaches is an emerging trend in the literature, with some of this being based on the concept that social interaction will help students in the classroom (Mayer & Wittrock, 2006; Vygotsky, 1978; Wolter et al., 2011), and the idea that constructivist theory could be used to create better environments for learning in that this could allow for deeper learning (Sternberger, 2012).

The importance of coupling the use of ARS with social constructivist approaches was also highlighted in other studies that demonstrated that learning is enhanced through human interaction (Brown et al., 1989; Camacho-Minano & del Campo, 2014; Driscoll, 2005; Van de Pol et al., 2011; Vygostky, 1978). This importance has also been noted in studies based on the use of applications running on smart phones, tablets, and laptops (Habel & Stubbs, 2014).

The idea of feedback through dialog being associated with a social constructivist approach was identified in the study conducted by Ludvigsen et al. (2015). The study conducted by Daniel and Tivener (2016) also highlighted that the use of ARS was one way of facilitating constructivism.

2.5.5 Question Driven Instruction (QDI) and Contingent Teaching (CT)

The enabling of QDI and CT through the use of ARS in classes was identified in Kay and LeSage (2009a). The enabling of QDI through the use of ARS was highlighted in Hunsu et al. (2016). This has significant relevance to this research as the use of feedback from students via APODs can enable a lecturer to adapt teaching based on the feedback that students respond with. This theme was also present in the benefits of using ARS and APODs and as a consequence has been moved to section 2.3.9 on page 36.

2.5.6 Instructional Design

Chien et al. (2016) identified the importance of instructional design in being able to use ARS effectively in the classroom. This was based largely on the concept that the success of ARS is not in the use of ARS, but in the way ARS is used. This importance of instructional design was also highlighted in Hunsu et al. (2016) and Han (2014).

The importance of instructional design, when it comes to the incorporation of ARS into teaching and learning, has been highlighted (Chen & Lan, 2013), with this being partly based on the idea that the use of the technology does not make for better teaching and learning on its own, and that this can only happen if it is being used effectively (Eilks & Byers, 2010).

The use of ARS to facilitate high level learning based on Bloom's evaluation-level thinking was identified as possibility in Gould (2016).

2.5.7 Learning Styles and Cultures

The importance of understanding the range of learning styles and cultures in a class was identified as being a significant factor in the effective use of ARS (Hunsu et al., 2016), with the need to consider how different people respond to the use of ARS based on gender, grade level, age and learning styles needing to be considered (Kay & LeSage, 2009a).

The concept that culture can have an impact on students' willingness to ask questions in class and hence be more interactive when it comes to the use of ARS has been identified (Holtbrugge & Mohr, 2010; Hwang & Francesco, 2010; Latham & Hill, 2014). This has been extended to include the concept of a power distance ratio where students from a culture where there is a higher power distance ratio between lecturers and students may be less likely to ask questions of the lecturer than when the power distance ratio is lower (Hwang & Francesco, 2010; Latham & Hill, 2014). Students in one study who were from a culture with a higher power distance ratio commented that they felt more comfortable responding to questions because of the anonymous nature of their responses (Latham & Hill, 2014).

One of the consequences of this has been the need to consider different learning styles and cultural practices when considering the adoption of and how to most effectively use ARS (Kay & LeSage, 2009a; Latham & Hill, 2014).

2.5.8 Optional or Mandatory Use

The issue as to whether the use of ARS should be optional or mandatory for students was a deployment strategy identified in Carnaghan et al. (2011). This has significant relevance to this research as the goal was to be able to use devices that students already owned and for this to be in a small group context meaning that it would not be mandatory for each individual student to own the device that was being used.

This consideration ties into a number of other aspects that have been identified, including whether the ARS is being used to track attendance (Caldwell, 2007; Kay & LeSage, 2009a); whether the ARS is being used for summative assessment (Caldwell, 2007; Kay & LeSage, 2009a); and issues surrounding whether every student in the class has a device that they can participate with (Caldwell, 2007; Kay & LeSage, 2009a; Reay et al., 2005).

2.6 Cost and Simplicity of Devices Relating of the Use of ARS

In the initial set of themes there was little attention paid to the cost and simplicity of devices related to the use of ARS although they were alluded to. A number of the studies reviewed paid specific attention to the cost and simplicity of devices. This section provides an analysis of themes relating to the cost and simplicity of devices when it comes to the use of ARS that were identified. This analysis relates to the fourth sub-question of the overarching research question of "How do issues relating to the cost and simplicity of devices impact on the use of applications on personally owned devices to engage with students in lectures and how can these issues be addressed?" Four particular themes emerged as being significant.

2.6.1 Cost for Students

Flies and Marshall (2006) commented on the use of wireless devices as ARS and within that context identified that more students were starting to own such devices and as such may not need to purchase devices or have devices purchased for them. Carnaghan et al. (2011) identified that students may resist the cost associated with the use of ARS in their lectures, with Castillo-Manzano et al. (2016) also identifying the cost to students as being a particular issue that needs to be addressed. The costs to students have been identified as a potential barrier for their willingness to use ARS when students are required to purchase their own devices for use in the classroom (Freeman & Blayney, 2005; Kennedy & Robson, 2008), with some of this having been addressed by having students work in groups (Flies & Marshall, 2006; Kennedy & Robson, 2008).

The cost to students has been a motivation for some studies to adopt approaches that could be used on devices that many of the students already own, which could include mobile phones (Scornavacca et al., 2007) or other devices such as smart phones, tablets, and laptops (Dunn et al., 2013; Shishah et al., 2013). Some identified the costs of sending SMS messages as being a potential barrier (Scornavacca et al., 2007; Shishah et al., 2013). Cost to students was also identified as a potential challenge in Gould (2016).

2.6.2 Cost for Lecturers and Their Institutions

Castillo-Manzano et al. (2016) identified that costs for lecturers and their institutions is an issue that needs to be considered when adopting ARS. These costs include maintenance contracts; the provision of internet access; software purchases and the cost of updates.

The cost to lecturers and their institutions has been identified as a potential stumbling block for their adoption of ARS in the classroom. In one study, the cost of ARS to the institution was the motivator for finding a system that would run on mobile phones as most students already had one (Scornavacca et al., 2007), and in another case with the cost of tablets purchased by the institutions from an external grant was a potential stumbling block for a study to be extended (Kennedy & Robson, 2008).

2.6.3 Ease of Use for Students

Flies and Marshall (2006) commented on the use of wireless devices as ARS and within that context identified that more students were starting to own such devices and as such the issue of ease of use for students would start to diminish. Ease of use for students was identified as being one of the challenges for the adoption of ARS (Carnaghan et al., 2011, Keough, 2012).

Ease of use for students has been identified as an important factor in the adoption of ARS (Beekes, 2006; Chen & Lan, 2013; Dunn et al., 2013; Elliot, 2003; Heaslip et al., 2014; MacArthur & Jones, 2008), with this extending to them being fun to use (Chen & Lan, 2013; MacArthur & Jones, 2008). A consequence of this is that students may need time to grow accustomed to using an ARS (Chen & Lan, 2013).

Issues associated with the ease of use for students include that there can be a steep learning curve associated (Carnaghan et al., 2011) and that some systems have numerous options that can overwhelm some users (Carnaghan et al., 2011). The concept of using systems that students are already familiar with to make them easier to use has also been identified (Dunn et al., 2013).

2.6.4 Ease of Use for Lecturers

Ease of use for lecturers was identified as being one of the challenges for the adoption of ARS (Carnaghan et al., 2011), and included in this was the range of functions and the steep learning curve that can be associated. This challenge was also identified in Keough (2012). The work of Blood and Cluchak (2013) identified the relative ease with which ARS can be set up for use in the classroom, which may suggest that it is not as significant issue as it had been previously.

The ease of use for lecturers was an issue of a significance that was commented on in four of the meta-studies that were reviewed (Blood & Gluchak, 2013; Carnaghan et al., 2011; Flies & Marshall, 2006; Keough, 2012), with this extending to the importance of lecturers having time to become accustomed to the use of the ARS (Chen & Lan, 2013). This can be due to the steep learning curve that can be associated with ARS (Carnaghan et al., 2011; Hatch et al., 2005; Keough, 2012; Lincoln, 2009; Sprague & Dahl, 2010;) and in some cases the range of options that are available within an ARS (Carnaghan et al., 2011). Ease of use for lecturers was also identified as being a potential issue in the study conducted in Farag et al. (2015) who went on to identify the importance of lecturers who saw ease of use as being an issue of having good on campus support available. Ease of use for lecturers was also identified as being a potential challenge in Gould (2016) as some lecturers will adapt to using the technology faster than others.

2.7 Themes Arising from Analysis of Literature

The themes arising from the analysis of the literature and how they relate to the sub questions of the overarching research question are shown Table 4. This table was constructed using the initial set of themes, and by first adding "making learning more enjoyable a benefit; second by adding students with disabilities as a challenge; third by combining the challenges of summative assessment, recording attendance for grades and identifying students into one theme of "summative assessment/identifying students" because of these themes being highly inter-related. Fourth and finally, a further change was to combine the theme in the pedagogical issues of contingent teaching and question driven instruction into the theme with the same name in the benefits of using APODs.

Sub-Question of Research Question	Themes Identified
SQ1. What are the benefits of using applications on personally owned devices to engage with students in lectures (from a range of different perspectives and across a range of different contexts)?	• Attendance • Anonymity for Students • Student Participation • Student Engagement • Student Attention • Making Learning More Enjoyable • Student Interaction • Student Discussion • Contingent Teaching and Question Driven Instruction • Learning Performance • Quality of Learning • Feedback • Formative Assessment • Comparing Student Responses
SQ2. What are the challenges involved in using applications on personally owned devices to engage with students in lectures (from a range of different perspectives and across a range of different contexts) and how can these challenges be addressed?	• Students not Having or Bringing Device • Technology not Functioning Correctly • Responding to Student Feedback • Coverage of Course Content • Development of Effective Questions • New Method of Teaching for Students • Discussion of Topics Causing Confusion • Too Much Effort Required by Students • Summative Assessment/Identifying Students • Negative Feedback • Students with Disabilities
SQ3. What are the pedagogical implications involved in using applications on personally owned devices to engage with students in lectures?	• Good Teaching Strategies • Specifically Identified Pedagogical Issues • Large Class Issues • Constructivism • Instructional Design • Learning Styles and Cultures • Optional or Mandatory Use
SQ4. How do issues relating to the cost and simplicity of devices impact on the use of applications on personally owned devices to engage with students in lectures and how can these issues be addressed?	• Cost for Students • Cost for Lecturers and their Institutions • Ease of Use for Students • Ease of Use for Lecturers

Table 4 – Themes Arising from Analysis of Empirical Studies and Meta-Studies

2.8 Relevant Pedagogical Issues Surrounding Teaching and Learning

Several pedagogical issues surrounding teaching and learning in general have relevance to this research. These include the characteristics of effective learning (Goodyear, 2002); Social Learning Theory (Vygotsky, 1978); Constructivist Theory (Bruner, 1973); Andragogy (Knowles, 1984); Adult Learning Theory (Cross, 1981); and Authentic Learning Activities (Reeves et al., 2002). These issues are reviewed in this section and their relevance to this study are highlighted.

With the focus of this research being on the enhancement of student engagement, it is appropriate to analyse the literature as it relates to student engagement as it relates to good practice in a higher education context in general, and not just from the perspective of the use of ARS in a higher education context. Chickering and Gamson (1987) identified seven (7) principles for good practice in higher education and this model is used as a starting point for this analysis of the literature.

Two other models that have direct relevance to this research are the TPACK Framework (Koehler & Mishra, 2008) and Forms of Engagement (Fredricks et al., 2004). These models are also reviewed in this section and their relevance to this study is explained.

Constructivist learning theories (Bruner, 1973), in which students utilise their experiences and contexts to learn and fill in gaps in their knowledge, have relevance to students answering questions using their APODs that relate to examples of things that they know about already, as do students asking questions of the lecturer using their APODs. Other learning theories that have relevance to this research include Andragogy (Knowles, 1984) and Adult Learning Theory (Cross, 1981) in which the prior experience and knowledge of the students is utilised, with Andragogy being particularly relevant to adult learners. Social learning theory (Vygotsky, 1978) also has relevance with the idea that students discussing answers to questions prior to submitting their responses would be part of this research.

Small group discussion as a pedagogy has direct relevance to this research, with its value being seen in the work of Boud, Cohen and Sampson (1996); Dillenbourg, Baker, Blaye and O'Malley (1996); Jones (2007); Pollock (2004); and Pollock (2007).

These all have relevance to this research as the overall aim is to explore how to best use APODs to enhance student engagement, interaction and participation, and as a consequence have a positive impact on their learning experience.

2.8.1 Student Engagement and Good Practice in Higher Education

Chickering and Gamson (1987) developed a model for good practice in undergraduate education that included seven guiding principles. The guiding principles are shown in Table 5.

Encourage contacts between student and faculty
Develops reciprocity and cooperation among students
Uses active learning techniques
Gives prompt feedback
Emphasises time on task
Communicates high expectations
Respects diverse talents and ways of learning

Table 5 –Good Practice Principles in Undergraduate Education (Chickering & Gamson, 1987)

The intention of these principles is to provide guidelines that aim to improve teaching and learning. The principles that have the most relevance to this research are encouraging contacts between students and faculty; developing reciprocity and cooperation among students; using active learning techniques; giving prompt feedback; and respecting diverse talents and ways of learning.

This model of Chickering and Gamson (1987) has been cited by several studies related to the use of ARS in a higher education context (Dufresne et al., 1996; Fifer, 2012; Jain & Farley, 2012; Neustifter, Kukkonen, Coulter & Landry, 2016; Rovai, 2003; Scott & Stanway, 2015).

Jain and Farley (2012) cited the work of Chickering and Gamson (1987) when describing how the use of ARS could enhance student engagement and facilitate feedback, and especially improve the speed at which the feedback happens, and noted the comment of Chickering and Gamson (1987) that the feedback also needed to be frequent.

Scott and Stanway (2015) in outlining the importance of student engagement cited the seven principles for good practice in higher education of Chickering and Gamson (1987), and noted that Kuh (2009) suggested that each of these principles is a form of engagement. Scott and Stanway (2015) also went on to cite Kuh (2009) as having characterised the notion of engagement in higher education having two elements which are academic (in class) and non-academic (outside class). Kuh

(2009) and Chickering and Gamson (1987) also highlight the relationship of engagement to interaction with instructors and peer interaction (among others).

In the findings of the study conducted Kuh (2003) it was suggested that a step that could be taken to improve undergraduate education was to identify students who were disengaged and involve them in activities to increase their engagement. Kuh (2003) goes on to outline how a well designed and implemented collaborative learning activity would improve the engagement of students by building in opportunities for peer evaluation; lecturer feedback on individual contributions and lecturer observations. Kuh (2003) went on to say that in the rush to attempt to implement this sort of collaborative learning at undergraduate level it is likely that good practice would lag behind the implementation of the activity.

In the study conducted by Terenzini et al. (2001) it was stated that one of the constraints or limitations in the research was that it relied on students' self-reporting of cognitive and psychosocial changes rather than on more objective measures. Terenzini et al. (2001) went on to suggest that the self-reported measures of learning are appropriate and valid indicators of educational gains to be used as valid as objective measures to the extent that the self-reported measures reflect the content of the learning outcome under consideration.

In part of the conclusions of the study by Terenzini et al. (2001) it was identified that students taught using active and collaborative approaches to teaching design reported statistically significant advantages in a variety of learning outcomes, with these including design skills, communication skills and group skills.

Terenzini et al. (2001) went on to suggest that structuring classroom activities to include activities that promote gains in communication skills, design skills and group skills are by their nature quite complex, and that the effort required raises issues about how this effort is compensated. The conclusions of Terenzini at al. (2001) provided empirical support regarding the effectiveness of active and collaborative learning compared with traditional approaches.

Pedagogies of Engagement

Smith, Sheppard, Johnson and Johnson (2005) cited the work of Edgerton (2001) who stated that "… *the core issue, in my view, is the mode of teaching and learning that is practiced..*". Smith et al. (2005) also refers to the work of Chickering and Gamson (1987) regarding the seven principles for good practice in undergraduate education, with specific reference being made to the principles that relate to pedagogies of engagement, with these being that good practice encourages student-faculty contact; cooperation amongst students; and active learning.

Smith et al. (2005) also cited the work of Christensen, Garvin and Sweet (1991) in stating "… to teach is to engage students in learning…" and goes on to propose that the responsibility of engaging students in their learning resides with the teachers. They suggest that the role of lecturer moves to the of designer and to the uncovering of content as opposed to the covering of content.

The pedagogies of engagement model is about the concept of moving from a model where "…the information passes from the notes of the professor to the notes of the student without passing through the minds of either…." (Smith et al., 2005), with the comment also being made that the pedagogies of engagement model can be likened to moving from a model of "pour it in" to a model of "pour it around".

Smith et al. (2005) outline the concept of Problem Based Learning (PBL) as "… the learning that results from the process of working towards the understanding of or resolution of a problem…".

Barrows (1996) identified six (6) core features of PBL with three (3) of these having direct connection to Question Driven Instruction (QDI) as per Beatty et al. (2006) and Contingent Teaching (CT) as per Kay and LeSage (2009a). First that learning is student centered; second that learning occurs in small student groups; and third that teachers are facilitators or guides. It was noted in Smith et al. (2005) that the classroom practices needed for cooperative learning and PBL are complex to design, implement and manage.

The concept of Informal Cooperative (Active) Learning (ICAL) was discussed in Smith et al. (2005) who cited Johnson (1991) in describing ICAL as "…having students work together to achieve a joint learning goal in temporary ad-hoc groups that last from a few minutes to one class period…" Smith el al. (2005) goes on to explain how the use of ICAL can ensure that misconceptions; incorrect understandings; and gaps in understanding are identified and corrected resulting in learning being personalised. This concept has links to the concepts of QDI (Beatty et al., 2006) and CT (Kay & LeSage, 2009a).

In Smith et al. (2005) a call to action was cited that accompanied the results of the National Survey of Student Enagement (NSSE) by James Duderstadt: "It could well be that the faculty members of the twenty-first century will find it necessary to set aside their roles as teachers, and instead become designers of learning experiences, processes and environments…" (Smith et al., 2005)

Smith et al. (2005) goes on to conluide that classroom-based pedagogies of engagement can help break the mold of the traditional lecture and that one of the keys to this was to not allow students to remain passive while they are learning. They point out that one way to do this is to structure cooperative interaction into classes.

The final conclusions of Smith et al. (2005) suggest that it is vital for students to have peer support and to be active learners so that they learn content at a deeper level; get to know their classmates better; and build a sense of community within the class.

Forms of Engagement

The concept of engagement in learning has been the subject of much research in an attempt to address student motivation in learning situations (Fredricks et al., 2004). Three types of engagement that have been identified are behavioural engagement, emotional engagement and cognitive engagement (Fredricks et al., 2004).

Behavioural engagement relates to positive conduct and following rules and norms (Finn, 1993; Finn, Pannozzo, & Voelkl, 1995; Finn & Rock, 1997). Emotional engagement refers to students' affective reactions in the classroom, including interest, boredom, happiness, sadness, and anxiety (Connell & Wellborn, 1991; Skinner& Belmont, 1993). Cognitive engagement refers to psychological investment in learning, a desire to go beyond the requirements, and a preference for challenge (Connell & Wellborn, 1991; Newmann, Wehlage & Lamborn, 1992; Wehlage, Rutter, Smith, Lesko & Fernandez, 1989). Cognitive engagement includes flexibility in problem solving, preference for hard work, and positive coping in the face of failure (Connell & Wellborn, 1991).

The nature of engagement referred to in this research is predominantly that of cognitive engagement, in particular that the "student's psychological investment in an effort directed toward learning, understanding, mastering the knowledge, skills or crafts that the academic work is intended to promote" (Newmann et al., 1992). The aspect of cognitive engagement that relates most specifically to this research centres on the concept of cognitive engagement and whether there are ways of encouraging students to think more deeply about the content that is being covered in lectures. This relevance is picked up in aspects of the questionnaires that are completed by students in the fourth phase of this research.

2.8.2 Fomative Assessment

The importance of formative assessment was identified in Yorke (2003) and Chickering and Gamson (1987) and is relevant to this research and was identified in the earlier thematic analysis (section 2.3.13 on page 43).

2.8.3 Characteristics of Effective Learning (Goodyear, 2002)

Goodyear (2002) identified five characteristics of effective learning, with these being summarised in Table 6. The active characteristic is particularly relevant to this research in that it requires students to make overt responses in large lectures instead of remaining passive, which was one of the motivations for a number of pieces of research, as cited earlier in the literature review, including Barak et al. (2006); Buckley et al. (2004); Gray et al. (2010); and MacGeorge et al. (2008). The nature of questions that students are asked to respond to using their APODs can result in learning being cumulative, and by allowing students to ask questions using their APODs, learning can be individualised to an extent.

Characteristic of Effective Learning	**Brief Description**
Active	Learning includes a combination of cognitive activity and psychomotor activities, with the combination of these contributing to create personalised learning that is more meaningful to the learner.
Cumulative	Utilising previous learning is significant in enabling learners to make sense of new information; create links between old and new ideas and to enhance existing knowledge.
Individual	All learners are different in the way they learn and in the past experiences they bring to each new learning experience.
Self-Regulated	At advanced levels learners can have an awareness of how they learn best and as a consequence can organise aspects of their own learning, in particular how the learning fits into different contexts.
Goal Oriented	Learners need to see why they are doing what they are doing and how it contributes to some sort of overall goal.

Table 6 – Summary of Characteristics of Effective Learning from Goodyear (2002)

The relevance of the characteristics of effective learning (Goodyear, 2002) to this research relates to the overall aims of the study being based on it being desirable to increase student interaction, engagement and participation in large lectures and that this can flow on to learning being more effective. As a consequence, what constitutes effective learning should be a significant part of how APODs should be used with this also connecting to the importance of designing effective questions for their use (Beatty et al., 2006).

The concept of self-regulated learning was touched on in the work of Ludvigsen et al. (2015) and related to how the use of ARS in lectures could enable students to monitor and self-regulate their own learning.

2.8.4 Social Learning Theory (Vygotsky, 1978)

One of the main concepts driving the work of Vygotsky (1978) was that social interaction has an important part to play when it comes to cognition development. Tying student engagement into a form of social activity relies on the idea that learning has a social nature. This has been well established in Social Learning Theory (Vygotsky, 1978) and has been evident in studies involving the use of technology in education. This is particularly noted when the technology being used by the students is also used by the students for social communication being a key ingredient for the students using the technology as part of their learning (Nesbit, 2008).

Another aspect of this that has direct relevance to this research is that part of the impetus for the study stemmed from a desire to have students feeding back what they had discussed in small groups, which in itself is a social activity.

2.8.5 Constructivist Theory (Bruner, 1973)

The constructivist theory framework developed by Bruner (1973) is founded on three principles: (a) teaching needs to be related to the experiences and contexts that enable the student to be willing and able to learn, (b) teaching needs to be organised so that it can be easily grasped by the student, and (c) teaching should be designed to facilitate extrapolation and or fill in the gaps. One of the main themes in the constructivist framework is that learning should be active and that those learning should be able to construct their own ideas and concepts based on knowledge that they already possess.

In defining constructivism Rovai (2004) stated that "… from the constructivist viewpoint, the learner is viewed as an active processor of information …", which is on contrast to scenarios "… in which the learner is viewed as a passive recipient of information…". In this research, the adoption of APODs is viewed as an attempt to move from a traditional lecture scenario where the learner is in passive mode to being in an active mode where the learner is processing information and making responses to questions and asking questions.

Rovai (2004) goes on to state that a "… more pragmatic view of constructivism is to maintain that knowledge is the product of many learner-centered processes, to include the social process of communication and negotiation (the construction of reality)…" In this research into the use of APODs learners processing information and making responses transforms the traditional lecture experience into a more learner-centered experience. In addition to this the use of small group discussions prior to responses being made is a social process of communication and with appropriately constructed questions, there will be an element of negotiation (or social construction of reality).

Rovai (2004) also identifies the implications of constructivism as including the utilisation of students' prior knowledge and the tailoring of strategies to suit student background and experiences. Rovai went on to indicate the importance of a lecturer being aware of students' misunderstandings to provide a context in which they can learn as being part of the pragmatic view of constructivism. In this research the use of APODs, particularly at the start of a topic, can be used to gain a picture of the background and levels of prior understanding of the students in a manner consistent with formative assessment, contingent teaching and question driven instruction.

The relevance to this research is that APODs could be used in a manner that enables a constructivist framework. This could be done where students are asked to consider situations and respond to them based on what they already know using APODs, with the critical element being the design of the questions (Beatty et al., 2006) and authentic learning activities (Reeves et al., 2002).

2.8.6 Andragogy (Knowles, 1984)

Four principles of Andragogy have been identified (Knowles, 1984). The first is that for adult learners it is more important to be playing an active role in their learning experience and to have an opportunity to provide feedback on how they perceive their learning. The second principle of Andragogy is that experience should be the basis of learning. The third principle relates to the importance of real life examples and applications, and the fourth principle is that adult learners tend to need more time to absorb information through applying it to scenarios.

The relevance of Andragogy to this research is that as the context is within higher education, students will demonstrate more characteristics of adult learners than those still in secondary school, and in addition to this, there can be a significant number of students enrolled in higher education who are older than students that have only recently left the secondary school system.

The implications of this are that the four principles of Andragogy should be considered as one of the possible approaches to using APODs in lectures due to the presence of adult learners, with this potentially having an impact on the way in which APODs can be used to make the biggest difference for adult learners.

Rovai (2004) and Knowles, Holton and Swanson (2014) highlighted how issues relating to adult learners are consistent with a constructivist approach to learning.

2.8.7 Adult Learning Theory (Cross, 1981)

Four principles were identified as being significant in Adult Learning Theory (Cross, 1981). The first of these was that the experience of learners should be capitalised on and made use of. Second, the activities involved should adapt to the limitations of the students. Third, learners should be challenged to move to more advanced stages of development. Fourth, that learners should have as much choice as possible in the way in which their learning is organised.

Key to this model of Adult Learning Theory (Cross, 1981) were two classes of variables which were personal characteristics (age, developmental stages etc) and situational characteristics (part time or full time study, optional or compulsory study).

The relevance of this model to this research is significant in several respects. First, small group discussion models utilise the experience of learners. Second when it comes to the decision about whether participation should be optional or mandatory, this relates to the concept of adult learners having choice. Third, the use of APODs to increase cognitive engagement (Fredricks et al., 2004). Fourth, the awareness of personal characteristics which can extend beyond what is suggested in this model and include age, gender, level of introversion/extroversion and language background.

The relevance to this research in this context also relates to the work of Rovai (2004) regarding a pragmatic view of constructivism. This includes the particular importance of being able to gain a picture of student prior-understanding and background, and in the particular context of this research, the use of APODs to help enable this picture to be gained.

2.8.8 Authentic Learning Activities (Reeves, Herrington & Oliver, 2002)

A model containing 10 characteristics of authentic activities has been developed for an online learning context (Reeves et al., 2002) and has relevance to this research. The characteristics are set out in Table 7.

Have real-world relevance i.e. they match real-world tasks
Are ill-defined (students must define tasks and sub-tasks in order to complete the activity) i.e. there are multiple interpretations of both the problem and the solution
Are complex and must be explored over a sustained period of time i.e. days, weeks and months, rather than minutes or hours
Provide opportunities to examine the task from different perspectives, using a variety of resources i.e. there is not a single answer that is the "best" one. Multiple resources require that students differentiate between relevant / irrelevant information
Provide opportunities to collaborate should be inherent i.e. are integral to the task
Provide opportunities to reflect i.e. students must be able to make choices and reflect on those choices
Must be integrated and applied across different subject areas and lead beyond domain-specific outcomes i.e. they encourage interdisciplinary perspectives and enable diverse roles and expertise
Seamlessly integrated with assessment i.e. the assessment tasks reflect real-world assessment, rather than separate assessment removed from the task
Result in a finished product, rather than as preparation for something else
Allow for competing solutions and diversity of outcome i.e. the outcomes can have multiple solutions that are original, rather than a single "correct" response

Table 7 – Authentic Learning Activities from Reeves et al. (2002)

The concept of authentic learning activities has direct relevance to this research and has strong connection to the importance of designing effective questions (Beatty et al., 2006). Several of the aspects have particular relevance: first the importance of tasks having real world relevance relates to the questions that are answered using the APODs having a high level of matching to relevant problems that exist in the real world, with this being connected to the real experience of learners that is part of Andragogy (Knowles, 1984) and Adult Learning Theory (Cross, 1981).

Second, if the tasks or questions being considered by students as part of the APODs based activity are not well defined, this creates more space in which learning can take place. This relates to a third highly relevant aspect of concepts being viewed from multiple perspectives, with these multiple perspectives enabling students to see the wider issues involved with the content. A fourth related aspect is allowing for competing solutions, some of which may result from the different perspectives that may be held.

A fifth aspect lies in the opportunities for collaboration that are present when small group discussions are used as part of the APODs based activities. Finally, the opportunities to reflect can be enabled through the use of activities using APODs for students to identify the most important content covered in a lecture, similar in concept to the one-minute paper (Hattie, 1987) where students are asked to identify the most important content that has been covered in a lecture and have the opportunity to ask questions about the content that has been covered in a lecture.

2.8.9 TPACK Framework developed in Koehler and Mishra (2008)

The TPACK Framework developed in Koehler and Mishra (2008) and adapted in Harris et al. (2009) is shown in Figure 5 . The main concept behind the TPACK Framework is that it can be used to help understand the knowledge that teachers need to integrate technology into their teaching. The framework focuses on the connections between technology, content and pedagogy, and how they can interact with each other. The three components are all required by teachers integrating technology into their teaching. The interactions are important to ensure that, for example, the introduction of technology is not at the expense of good pedagogical approaches and that the technology instead supports good technological approaches.

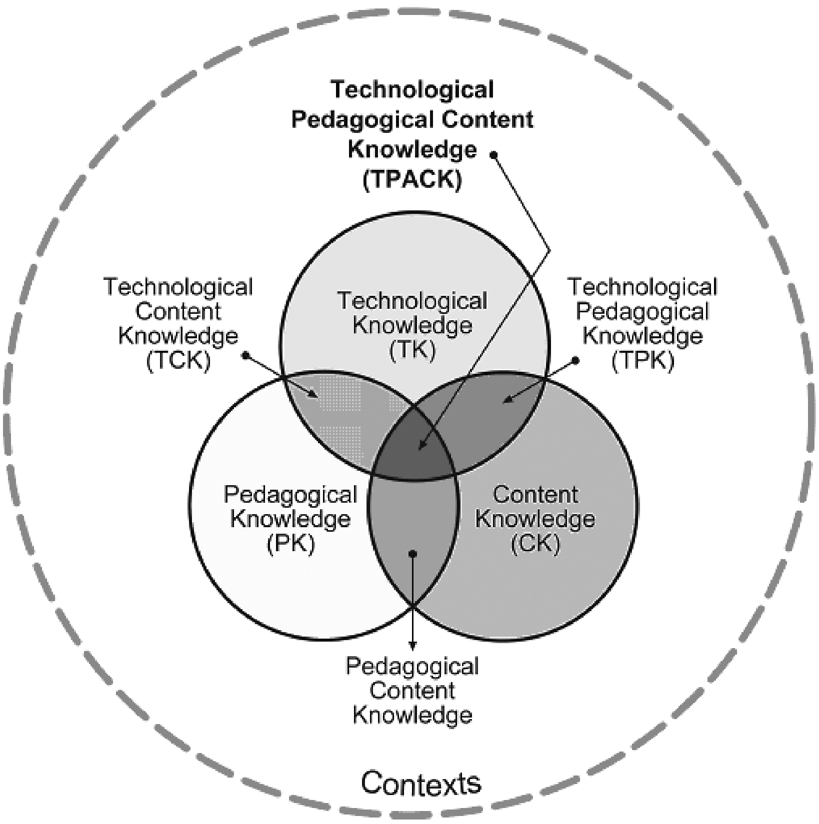

Figure 5 – TPACK Framework (Koehler & Mishra, 2008; Harris et al. 2009)

The relevance of the TPACK framework for this research resides in the need for all three aspects of the framework to be addressed, with a particular focus on the PK (pedagogical knowledge) component of the framework as the focus of the research is on how best to use APODs (the technology) to enhance the engagement and experience of students. The enhancement of engagement and experience requires a platform of how students learn and student experience to be understood.

The relevance of the TPACK framework to this research is significant in that first, lecturers will need to be able to use the APODS (TK), with this having some connection with the challenges faced by lecturers and the cost and simplicity of devices. Second, the APODs need to be used in such a way that enhances the student experience during lectures (PK), which requires an understanding of how the use of APODs can impact on student interaction and engagement. Third, the importance of content knowledge (CK) which is an important requirement for anyone who is teaching. All of this translates into the use of APODs during lectures in a manner that is about pedagogically sound approaches to student learning.

2.9 Summary of Literature Review and Identification of Gaps for this Research

The literature review has analysed the findings of a number of meta-studies and empirical studies using thematic analysis to produce a model (see Table 4 on page 62) based on the four (4) sub questions of the overarching research question. The model that has been created can be used as a basis for evaluating the findings of the research, with the aim of addressing the overarching research question and associated sub questions. A number of pedagogical issues surrounding teaching and learning are included in the literature review as they also provided a basis for analysing the findings of the research.

There are four significat aspects of the literature to take forward to the analysis and discussion of findings. First the benefits and challenges arising from the use of APODs in large lectures as depicted in Table 4 (page 62). Second how these benefits can be attained and the challenges addressed through pedagogically sound use of APODs. Third a special emphasis on the importance of developing effective activities for use with APODs. Fourth a special emphasis on issues relating to the cost and simplicity of devices.

The importance of these four aspects is that developing a fuller picture of each aspect and how the aspects relate to each other will enable the development of comprehensive models relating to the use of APODs to enhance student engagement in large lectures in manners that are pedagogically sound so that the benefits of using APODs can be attained and the challenges in their use can be addressed.

3 Methodology

3.1 Introduction

With this research being conducted across several phases the overall process is consistent with that of a multiple case study design. Across the phases of the research the unit of analysis moves from lecturers to learning advisers to students.

This chapter commences with an exploration of the appropriateness of a range of paradigms and associated epistemologies, ontologies, questions and methodologies as they relate to this research. The conclusion is that for this research the decision regarding the design is to adopt a pragmatic paradigm with an associated epistemology of "the best method is one that solves problems" (Maxcy, 2003), and an ontology of "truth is what is useful" (Crick, 1999; Easton, 2010). This includes addressing questions that seek to determine whether interventions will improve learning and teaching based on the concept that "the studies that teachers found to be most persuasive, most relevant, and most influential to their thinking were all studies that addressed the relationship between teaching and learning" (Kennedy, 1999).

Following from this is the identification of a mixed methods methodology and/or design-based research as being appropriate for this research, which is seeking an answer to the overarching research question which is reproduced from chapter one where it was broken down into four (4) sub-questions:

"When and how should applications on personally owned devices be adopted for use in large lectures to enhance student engagement so that the benefits of their use can be achieved while addressing the challenges relating to their use?" The four (4) sub-questions can be found in section 1.4 on page 8.

The chapter continues with a more in-depth analysis of the appropriateness of adopting a pragmatic paradigm using a mixed method methodology for this research, and how aspects of a design-based research methodology also have relevance for this research. The chapter concludes with a short section identifying the limitations of the research.

3.2 Paradigms, Epistemologies, Ontologies and Methodologies

As outlined in the introduction and background chapter, the impetus for this research lay in the problems associated with students not being willing to verbally share responses from small group discussions with the rest of their class as class sizes increase. The researcher identified an approach to solve and address this problem that involved students being able to use personally owned technologies to share their responses anonymously. The devices evolved during the period of the research from text-capable mobile phones to applications running on smart phones, tablets or laptops.

In discussing a range of research paradigms, ontologies, epistemologies and methodologies Anderson (2013) produced a summary (Table 8), which will be used to analyse the approach taken in this research.

Paradigm	**Ontology**	**Epistemology**	**Question**	**Method**
Positivism	Hidden rules govern teaching and learning process	Focus on reliable & valid tools to uncover rules	What works?	Quantitative
Interpretive/ constructivist	Reality is created by individuals in groups	Discover the underlying meanings of events & activities	Why do you act in this way?	Qualitative
Critical	Society is rife with inequalities and injustice	Helping uncover injustice & empowering citizens	How can I change this situation?	Ideological review, Civil actions
Pragmatic	Truth is what is useful	The best method is one that solves problems	Will this intervention improve learning?	Mixed Methods, Design-Based

Table 8 – Paradigms, Ontologies, Epistemologies and Methodologies (Anderson, 2013)

While the research used the pragmatic paradigm, there were aspects of the research that were positivist in nature, with other aspects being interpretive/constructivist in nature, with others being more critical in nature based on the brief descriptions in Table 8. The research methods that were used in each aspect were consistent with that aspect.

Positivist Aspect

The goal of the positivist paradigm is to describe and measure what takes place, suggesting that there are aspects of this research that could be conducted from a positivist aspect as there is a need to discover what governs aspects relating to teaching and learning that take place when APODs are used in the classroom. The ontology relating to this research includes that there are hidden rules governing the teaching and learning process, with an epistemology focussing on how to uncover these rules. In this research it included surveying students during the pilot study about the mobile devices that they own. The sections of the student surveys that asked students to indicate their level of agreement with a range of statements could also be seen as coming from a positivist perspective, but were bordering on post-positivism as there was an emphasis on measuring from a number of perspectives.

The requirements of the research dictated the development of tools to measure observations, partly with a view to determining "What works to produce valued education outcomes?" (Howe, 2009) and the development of quantitative methodologies to analyse the responses.

Interpretivist/Constructivist Aspect

The interpretivist/constructivist paradigm relates to an epistemology of discussing the underlying meanings of events and activities. This interpretivist/constructivist aspct has relevance to parts of this research that seek to understand and provide a deeper understanding of issues surrounding student engagement in large lectures from a number of different perspectives. This is consistent with an ontology of what is real being constructed by individuals in the groups that they are in. This helps with answering questions such as why people act in the way that they do in certain situations (such as choosing not to engage in activities in the classroom). These questions can be addressed from a range of different perspectives using qualitative methodologies, hence the use of interviews of lecturers and learning advisers and conducting focus groups with students (particularly with the need for the focus groups emerging after the interviews and surveys had taken place).

Critical Aspect

Dealing with injustice and empowering citizens is one way of describing the epistemology of a critical paradigm (Lynch, 1999), with this being shown in Table 8. This critical aspect relates well to an ontology of inequalities and injustices in society (Lynch, 1999). Within the context of this research this would include students who are naturally introverted or shy about sharing their views with the rest of the class, and the potential for students who are unable to participate in classroom based activities because they do not own an appropriate device. The survey of students regarding device ownership, the experiments in the pilot study, the use of small group discussions, and the concept of institutions providing devices were integrated into this research and are consistent with the critical paradigm.

Pragmatic Paradigm

The epistemology relating to a pragmatic paradigm can be summarised as "the best method is one that solves problems" (Maxcy, 2003), with questions that can follow from this including whether or not particular interventions will improve aspects of learning. This pragmatic approach leads on to a mixed methods approach, which considers the range of what works (from a positivist perspective), understanding why people react the way that they do (from an interpretivist/constructivist perspective), and how scenarios and situations can be changed (from a critical perspective). The ontology connected with the pragmatic paradigm and the concept that "the studies that teachers found to be most persuasive, most relevant, and most influential to their thinking were all studies that addressed the relationship between teaching and learning" (Kennedy, 1999). Within the context of this research the truth that it would be useful surrounds approaches to the use of APODs that will increase student engagement in large lectures.

The epistemology surrounding the pragmatic paradigm of "the best method is one that solves problems" is consistent with the findings that the interventions of technology that made the biggest difference to learning were those that identified a problem in a teaching and learning scenario, and sought to solve the problem (Draper, 1998). When this is coupled with the call for researchers to identify weak teaching practices and explore how technologies could be used to address them (Draper & Brown, 2004) it becomes apparent how consistent this is with the pragmatic paradigm.

In addition to the use of mixed methods research approach in the pragmatic paradigm, the usefulness and relevance of design-based research is also identified (Anderson, 2013). The key elements of design-based research have been outlined particularly as they relate to technology-enhanced learning environments (Wang & Hannafin, 2005) and within the context of psychological experimentation (Barab & Squire, 2004).

3.3 Pragmatic Paradigm and Mixed Methods Research

In discussing the appropriateness of the pragmatic paradigm and the mixed methods research methodology it is helpful to adopt a definition of a mixed methods research approach such as: "… the class of research where the researcher mixes or combines quantitative and qualitative research techniques, methods, approaches, concepts or language into a single study" (Johnson & Onwuegbuzie, 2004)

The paradigm of pragmatism has been aligned as a natural partner of mixed methods research (Johnson & Onwuegbuzie, 2004) and is seen as a paradigm that attempts to "shed light on how research methods can be mixed fruitfully" (Hoshmand, 2003; Johnson & Onwuegbuzie, 2004). This is inextricably tied to the concept that "research approaches should be mixed in ways that offer the best opportunities for answering important research questions" (Johnson & Onwuegbuzie, 2004). Johnson and Onwuegbuzie also put forward the concept that a mixed methods approach aims to answer research questions rather than constraining the researcher's choices to a single research methodology. They go on to identify that the most fundamental step is to define the research questions, and that the methods used should follow the research questions. It follows from this that if the research questions that are driving the research are best answered by different research methods, then this in itself is a justification of mixed methods research.

3.3.1 Characteristics of Pragmatism in this Research

A set of general characteristics of pragmatism were developed by Johnson and Onwuegbuzie (2004). The following is a discussion of the characteristics that are relevant to this research. First there was recognition of the existence of the real world in terms of the changing patterns of device ownership that led to the survey regarding device ownership in the pilot study. In conjunction with this was also the recognition that human elements such as language and subjective thoughts of students regarding willingness to share verbally have relevance to the student surveys and the analysis of the results.

The interviews of lecturers focussed on their real experiences as lecturers and the surveys of students focus on their real experiences of students in order recognise the reality and influence of human experience in action.

Recognition of Johnson and Onwuegbuzie's characteristic that knowledge is viewed as being constructed and based on the reality of the world we live in is evident in the interviews of lecturers and learning advisors and focus group discussions when it comes to the construction of knowledge, and in the reality of the world that emerges from the student surveys. In a similar way, the characteristic of human enquiry alongside experimental and scientific enquiry can be seen in the combination of the interviews and focus groups (human enquiry) and the surveys of students (experimental and scientific enquiry).

That part of the focus of the study was to answer research questions about what the best ways are to use APODs is evidence of the characteristic of having an empirical basis as the path to determine what works, with most of this being evident in the use of the student surveys. This aspect of determining what works best was also evident in the aim of developing a theory about what works best when it comes to the use of ARS. In the general sense of the term "pragmatic", this research provides an approach that enables lecturers to make choices about whether to use, or how to use, ARS in a range of contexts.

Overall, the pragmatic paradigm, in which there is an epistemology of where an issue or problem can be identified, the best method is one that solves the issue or problem, resonates strongly with the findings of Draper (1998) that the interventions of technology that made the biggest difference to learning were those that identified a problem in a teaching and learning scenario, and sought to solve the problem. As outlined in section 1.3 on page 6, the observation made during the interviews of lecturers that some lecturers see that lack of interaction in lectures is a problem or issue that needs to be addressed, with this being one of the motivators for this research to be conducted. This was coupled with the implication for researchers to identify weak teaching practices and explore how technologies could address the weaknesses (Draper & Brown, 2004).

3.3.2 Addressing the Weaknesses of Pragmatism in this Research

A set of weaknesses of pragmatism were identified by Johnson and Onwuegbuzie (2004) with a discussion of the relevant weaknesses and how they been addressed in this research follows. First there is the time that it can take to produce useful and practical results. This weakness was addressed in this research because the research was conducted in a number of phases and the results of some of these earlier phases were presented at conferences (and thus were available to inform other researchers and practitioners).

The weakness of pragmatism promoting incremental change rather than revolutionary change was not evident in the study, particularly from the perspective of the lecturers and the learning advisers who were interviewed as the changes experienced by most of them were seen as being valuable for them incrementally. Also of relevance was the changes in technology available for ARS moving from clickers to text messaging to applications on mobile devices.

The weakness identified by researchers from a transformative-emancipatory framework suggests that pragmatic researchers sometimes fail to provide a satisfactory answer to "For whom is a pragmatic solution useful?" (Mertens, 2003). This is addressed in the interviews of lecturers and learning advisers by ascertaining the motives and goals for using APODS and determining whether these motives and goals were being achieved. This relates to the weakness of researchers not defining what *useful* means. However, in this study, as set out in the introduction and background, *useful* entails providing some evidence about the benefits of using ARS and the range of ways in which they can be used to increase student interaction and engagement.

When it comes to the weakness of pragmatic theories of truth having difficulty dealing with the cases of useful but non-true beliefs and non-useful but true beliefs, the multi-faceted nature of this study has been able to deal with these situations by exploring and investigating the issues from a number of different perspectives including those of lecturers, students and learning advisers.

The philosophical and ethical disputes that are in the background to this study of reduced funding of higher education resulting in increasing student numbers in lectures has not addressed in this study, but is acknowledged as one of the driving forces behind the need for the study to be conducted.

3.3.3 Strengths of Mixed Methods Research in this Study

A set of strengths of mixed methods research was also identified by Johnson and Onwuegbuzie (2004) and a discussion of the relevant strengths and how they apply to this research follows.

The reality that words can be used to add meaning to numbers, and numbers can be used to add precision to words was present in this study. This is particularly true with the move from a survey in the pilot study to interviews of the lecturers, to surveys of the students and finally with the focus groups. This was also evident in the focus group itself with the statement ranking exercise prior to the discussion part of the focus group.

The strength of mixed methods research identified by Johnson and Onwuegbuzie (2004) of it being able to answer a broader range of research questions was one of the major reasons why this mixed methods approach was appropriate for the overall study. The strength of using different phases of a study (that used different methods) to inform later stages of a study was very much a part of this research design. The strengths of one approach overcoming weaknesses of another approach were present in this study with examples including the use of surveys to test out ideas from the lecturer interviews and the use of the focus groups to test out results emerging from the surveys.

The final strength mentioned by Johnson and Onwuegbuzie (2004) was that of providing stronger evidence for conclusions through corroboration of findings and this was one of the drivers for adopting the range of approaches in this study.

3.3.4 Addressing the Weaknesses of Mixed Methods Research in this Study

The weaknesses of mixing qualitative and quantitative research into one study that been identified (Johnson & Onwuegbuzie, 2004), with these being addressed by different aspects of this study.

The weakness of it being difficult for a single researcher to carry out qualitative and quantitative research concurrently (Johnson & Onwuegbuzie, 2004) was to a large extent addressed by the different phases of the research being conducted sequentially. The researcher, through having published research prior to this research had been exposed to a combination of different research methods, which addresses the weakness of the researcher needing to learn about multiple methods.

While methodological purists might argue that researchers should confine themselves to working in one paradigm (Johnson & Onwuegbuzie, 2004), the nature of this study and the varied nature of the research questions and perspectives involved suggest that the methods chosen for each phase of the study should be what is appropriate for the perspective being investigated.

The weaknesses of expense due to the mixed methods approach being more time consuming (Johnson & Onwuegbuzie, 2004) was not a significant factor in this research, as the research was being spread over a number of years on a part time basis, with the work being completed as part of the researcher's employment.

While the weakness of interpreting conflicting results (Johnson & Onwuegbuzie, 2004) is acknowledged, within the context of this study, and from a design-based research perspective (Barab & Squire, 2004; Wang & Hannafin, 2005), the final phase of the student focus groups was used to address and gain some better understanding of what was initially seen as being some slightly anomalous results.

3.4 Design-Based Research

Design-based research has been identified as an appropriate methodology (along with mixed methods research) in a pragmatic paradigm (Anderson, 2013) as depicted in Table 8. This section explores the nature of design-based research (Barab & Squire, 2004; Wang & Hannafin, 2005) and goes on to analyse its usefulness in the context of this study.

3.4.1 *Design-Based Research (Wang & Hannafin, 2005)*

Wang and Hannafin (2005) outlined how design-based research has demonstrated potential to be a methodology suited to the research and design of Technology-Enhanced Learning Environments (TELEs). Wang and Hannafin (2005) go on to set out the essential characteristics for design-based research, and how it draws from several different methodologies. Wang and Hannafin (2005) identified five characteristics of design-based research (shown in Table 9).

Characteristic	**Brief Description**
Pragmatic	Research refines both theory and practice. The value of theory is based on the extent to which principles improve and inform practice.
Grounded	Design is theory-driven and grounded in relevant research, theory and practice. Design is conducted in real-world settings. The design process is embedded in, and studied through, design-based research.
Interactive, iterative and flexible	Designers involved in design process and work with participants. Processes are an iterative cycle of analysis, design, implementation and redesign. Initial plan usually insufficiently detailed so that designers can make changes when necessary.
Integrative	Mixed methods used to enhance credibility of ongoing research. Methods vary during different phases as new issues arise. Rigour intentionally maintained and discipline applied appropriately to the development phase.
Contextual	Research process, research findings, and changes from the initial plan are documented. Research results are connected with the design process and the setting. Content and depth of generated design principles vary. Guidance for applying generated principles is needed.

Table 9 – Characteristics of Design-Based Research (Wang & Hannafin, 2005)

The importance of design-based methodologies for technology enhanced learning environments (TELEs) was also described in Wang and Hannafin (2005), particularly as design-based methodologies have often been developed using contradicting and incompatible foundations (Hannafin, Hannafin, Land & Oliver, 1997). This highlights the need for alternative approaches to align learning environments with their fundamental assumptions (Hannafin et al., 1997) and encourages flexibility as well (Schwartz, Lin, Brophy & Bransford, 1999). A number of aspects of design-based research consistent with TELE design theories were identified by Wang and Hannafin (2005), suggesting that these aspects have application into contexts where design-based research methods are being used.

There are three important aspects. First, there is encouraging continuous synergy – the idea that the everyday synergy between research and practice can be used to enable simultaneous refinements between theory and practice, and as a consequence educational approaches and theory emerge reciprocally (Bell, 2004). This synergy was evident in Sandoval and Reiser (2004) where an intervention guided student inquiry, but that it did not support student ideas or help in interpreting data. The particular intervention was revised to address these issues.

The second aspect is refining TELE theory – the concept that design-based research should help in refining theory relating to TELEs. The Type 1 research and Type 2 research proposed in Richey, Klein and Nelson (2003) are both emphasised in design-based research. Type 1 research is described as being context specific that can involve conclusions in the form of lessons learned in the development of a product and factors that improve the effectiveness of the product. This can also include specific problems and issues relating to a particular product. Type 2 research is involved with producing generalisable design principles and procedures that can take the form of principles, procedures and frameworks that provide guidance that is in general more useful.

The third aspect is encouraging socially responsible and responsive inquiry and practice – the idea that theory should be linked usefully to practice, and that the perspectives of different stakeholders, including both teachers and students, be taken into account. Wang and Hannafin (2005) set out nine principles of Design-Based Research that are followed in this research (see Table 10).

1.	Support design with research from the outset, so that better insights can be gained into the prevailing issues.
2.	Setting practical goals for theory development and developing an initial plan so that the goals of the research are clear and that the required resources are available.
3.	Conducting research in representative real-world settings, so that there is a clear link from the results of the research to the real world, and into the particular contexts in the real world where it can be applied.
4.	Collaborating closely with participants to gain better insights into the issues that are facing them.
5.	Implementing research methods systematically and purposefully.
6.	Analysing data immediately, continuously, and retrospectively to enable flexibility in the research, which may require additional experiments to be conducted.
7.	Refining designs continually.
8.	Documenting contextual influences with design principles so that their applicability to a range of contexts can be better understood and so that findings can be applied to those contexts that are appropriate.
9.	Validating the generalisability of the design to ensure that the findings can be applied to other contexts.

Table 10 – Nine Principles of Design-Based Research (Wang & Hannafin, 2005)

3.4.2 Design-Based Research (Barab & Squire, 2004)

A challenging aspect of design-based research in an educational setting that Barab and Squire (2004) identified was the need to characterise the complexity, fragility, messiness and eventual solidity of the design in such a way that it is useful to others, whether they be researchers or practitioners. They go on to suggest that this requires the researcher to understand the relevance of the findings to other contexts, and not just to the context that was being focussed on in a particular intervention.

The distinction between design-based research and evaluation in the learning sciences is seen by Barab and Squire (2004) as being (a) the continual connection of interventions with theory; (b) the generation of new theories as opposed to testing existing theories; and (c) that for some research questions the context within which the research is carried out means that it may not be possible to replicate the research.

A comparison of psychological experimentation and design-based research was carried out by Barab and Squire (2004), which was adapted from Collins (1999). This comparison identified a number of key aspects of design-based research that distinguish it from psychological experimentation and have relevance to this research. These key aspects include that design-based research occurs in real life settings where most learning takes place; involves many dependent variables; focussed on characterising the context the research is taking place in; involves flexible research design; and involves looking at multiple aspects of design (Barab & Squire, 2004; Collins, 1999).

Barab and Squire (2004) also highlighted that design-based research requires more than showing that a particular design works, but requires the researcher to generate evidence based claims relating to theoretical issues and further the theoretical knowledge in the field.

A further significant aspect of design-based research highlighted in Barab and Squire (2004) is that the value of a theory lies in its ability to produce change in the real world, with this being related to the idea that theories are not judged by their claims to be true, but by how they work in the real world (Dewey, 1938 as cited in Barab and Squire, 2004). The goal of applied researchers engaged in design-research is stated by Barab and Squire (2004) as being to "directly impact practice, while advancing theory that will be of use to others".

"Design-based research involves more than simply describing the design and the conditions under which it changed" (Barab & Squire, 2004). Similarly, diSessa and Cobb (2004) as cited in Barab and Squire (2004) suggest that the designs should be contexts, through which theory can be advanced, and as such will be iterative with the ultimate goal of refining theory to produce "ontological innovations" (diSessa & Cobb, 2004).

The "teaching experiment" approach (Barab & Squire, 2004; Cobb, diSessa, Lehrer & Schauble, 2003) relates to the problem of the intervention of the researcher as a participant. In this situation, the issues that arise from such an intervention are accounted for and integrated into existing theory, as opposed to the researcher having a "hands off role" as mentioned in Barab and Squire (2004) who go on to encourage researchers to not remain detached from their research, but to use interventions as "opportunities to examine core theoretical issues and explore learning".

Systematic experimentation is described in Barab and Squire (2004) as being what makes design-based research a valuable methodology for learning science research, and they go on to highlight the responsibility of the design-based researcher to remember and acknowledge that their conclusions and claims are based on researcher influenced contexts, and as a consequence may not be generalisable.

3.4.3 Relevance of Design-Based Research to this Research

The approach adopted for much of this research is consistent with design-based research as it is consistent with the nine principles of design-based research identified in Wang and Hannafin (2005) as shown Table 10, and the seven categories of design-based research outlined in Barab and Squire (2004) after being adapted from Collins (1999).

The design of the research is supported with research from the outset (Wang & Hannafin, 2005) with this being evident in some of the literature that was reviewed prior to students being surveyed. Clear goals were in place for sets of questions used in the student surveys (Wang & Hannafin, 2005). The data was gathered in real world settings (Barab & Squire, 2004; Wang & Hannafin, 2005) as the data collected related to real world experiences of students and lecturers.

The interviewing of lecturers and learning advisers as well as holding focus groups with students ensures there is close collaboration with the participants (Barab & Squire, 2004; Wang & Hannafin, 2005). This close collaboration was able to inform later phases of the research at a number of points (Barab & Squire, 2004; Wang & Hannafin, 2005). As each part of the research was designed with a clear aim in mind, this assisted to ensure that the research methods are implemented systematically and purposefully (Wang & Hannafin, 2005).

The contextual influences that exist within each phase of the study will need to be documented clearly (Barab & Squire, 2004; Wang & Hannafin, 2005) so that the results of each phase can be better understood, and have a greater chance of generalisability to other contexts (Wang & Hannafin, 2005). This will ensure that the complexity of different variables is understood (Barab & Squire, 2004).

One of the consequences of following an interative process such as design-based research (Wang & Hannafin, 2005) is that the findings from earlier phases of the research can generate the need for later phases of the research. One of the implications for this is that the findings of this research are presented across three chapters: First, the findings from the pilot study are presented in chapter four. Second, the findings from the interviews are presented in chapter five. Third, the findings from the student survey and focus groups are presented in chapter six.

3.5 Phases of the Study and Methods Used

The phases of the study and the methods used within them are set out in Table 11, with this showing that the pilot study (aside from the development of the texting based system) was largely quantitative, with this being followed by two phases that were completed using a qualitative approach (the interviews of the lecturers and learning advisers). This was then followed by a largely quantitative phase in the surveying of students, noting that the surveys did include some open-ended questions. The final phase then moved back to a qualitative approach in the form of the student focus groups that were used to gain a deeper understanding of what appeared to be some anomalous results surrounding the importance of anonymity.

Phase	Method
Pilot Study - Development/trial of a texting based system. - Surveying students regarding use of texting based system. - Surveying students regarding mobile device ownership. - Exploratory survey of students using smartphone based application in lectures.	 Experimental Quantitative Quantitative Quantitative
Interviews of Lecturers	Qualitative
Interviews of Learning Advisors	Qualitative
Surveys of Students	Quantitative (some qualitative)
Student Focus Groups	Qualitative

Table 11 – Phases of Study and Methods Used

The manner in which the methods were applied in the phases of the study is explained in the following sections.

3.5.1 Methods used in Pilot Study

The methods used in the pilot study are set out in the chapter covering the findings from the pilot study which is organised as a standalone piece of work. This includes describing the process taken in the construction of the text messaging based system, the questions that students responded to after the initial use of the text messaging based system, the questions that students were asked in the survey regarding device ownership, and the questions that students were asked regarding their use of a smart phone based application.

3.5.2 Methods used in Interviews of Lecturers

Twelve lecturers were interviewed about their experiences in using APODs (or in some cases ARS generally) in their lectures, with the lecturers being from six different universities or institutes of technology from New Zealand and Australia. The participants were selected by contacting the eLearning support department in the universities and institutions to gain recommendations of lecturers who could be contacted to participate in the study. The interviews were semi-structured.

The participants were provided with information sheets setting out what would take place during the interviews, along with an assurance of anonymity and consent forms that were signed prior to the interviews taking place as evidence that they had consented to be part of the study. Ethics approval was sought for the interviews from the University of Canterbury Educational Research Human Ethics Committee. Copies of the consent form and covering letter are included in Appendix A. A copy of the letter from the committee granting approval is included in Appendix B.

The approach taken to analyse the interviews is consistent with the concept of thematic analysis (Braun & Clarke, 2006) that was used in the literature review. As indicated in the literature review thematic analysis has been defined as being "*a method for identifying, analysing, and reporting patterns (themes)* within Data" (Bruan & Clarke, 2006). A summary of thematic analysis is shown in Figure 4 on page 20.

The initial set of themes used in the analysis of the interviews were those that emerged at the end of the empirical studies in the literature (see Table 4 on page 62) that related to the sub-questions of the overarching research question. A grid showing one line for each theme and a column for each of the lecturers was created. As the transcript and summary of each interview was reviewed the strength of feeling relating to each theme for each lecturer was recorded in the corresponding cell on the grid by use of different colours. Where there was a link between two of the themes for a lecturer, a different coloured line was drawn linking the two themes. A scenario where this took place was when the way in which the APOD/ARS was used to achieve a benefit (sub-question 1) addressed one of the challenges (sub-question 2).

Where comments of significance from lecturers did not relate to any of the recorded themes, additional themes were added to the grid. The summaries and transcripts were formally reviewed a second time to check if these additional themes had been alluded to in earlier interviews. The grid was then used to write the analysis of the findings of the interviews based on the themes.

3.5.3 Methods used in Interviews of Learning Advisers

The decision to interview the learning advisers was made after the lecturers had been interviewed and it became apparent that nearly all of the lecturers were quite positive about their experiences of using APODs and ARS and did not appear to be held back by any of the challenges to any extent.

As indicated in the introduction chapter, the decision to interview learning advisers was based on some of the literature regarding the personal characteristics of innovators and early adopters when it came to the use of educational technologies (Elgort, 2005; Moore & McKenna, 1999; Rogers, 1995), and in particular the concept that early adopters of technologies would not be held back by the challenges that some of the later adopters may experience and that this would eliminate some of the potential bias in the findings from the lecturer interviews. The aim of interviewing the learning advisers was to find out more about the challenges of using APODs and how some of these challenges could be dealt with.

Six learning advisers were interviewed about their experiences, perspectives and observations from having supported lecturers who were using or contemplating using APODs and ARS in their lectures. The six learning advisers who were interviewed were from three different universities and institutes of technology in New Zealand and Australia. The interviews were semi-structured.

The participants were identified by contacting eLearning support departments in the different universities and institutes of technologies to gain recommendations as to who could be invited to participate in the study.

The participants were provided with the same information sheets and consent forms that were provided to the lecturers who participated, and the ethics approval for these interviews were covered by the same approval for the lecturers from the University of Canterbury Educational Research Human Ethics Committee.

The approach taken to analyse the findings of the learning adviser interviews was that of thematic analysis (Braun & Clarke, 2006) using the themes that resulted from the analysis of the lecturer interviews.

3.5.4 Methods used in Student Surveys

Students in five courses across two institutions were surveyed about their experiences and perspectives when it comes to the use of APODs in lectures. These courses, the level of the course and their institution are shown in Table 12.

Course	Title	Level	Institution
AMAP500	Accounting Principles	1st Year	Christchurch Polytechnic
COSC368	Humans and Computers	3rd Year	University of Canterbury
ECON105	Introduction to Macroeconomics	1st Year	University of Canterbury
INFO243	Accounting Information Systems	2nd Year	University of Canterbury
MPAC607	Information Systems	Masters	University of Canterbury

Table 12 – Courses Surveyed

The AMAP500 course was a reasonably small introduction to accounting course that was taught in the evening with the majority of the students who were enrolled being part time students who were in full time employment. In this course, the application was used for multiple choice questions at different times during the classes, with students being encouraged to discuss questions with the people sitting at the same table as them. The lecturer would go over the answers to the questions and particularly focus on questions where the percentage of correct answers was not as high as the others. There were no marks awarded for participation with the questions all being of a formative assessment nature.

The COSC368 course was a third year computer science course where the application was used for both formative and summative assessment during lectures. The students were asked to respond to questions throughout the lecture. The lecturer gave feedback on the answers, particularly focussing on the questions where there were not a high percentage of correct answers. The students were awarded marks towards the course grade for participating with the application.

The ECON105 class was a large first year economics course, with typically 200-250 students at each lecture. The application was used for multiple choice questions at various stages throughout the lectures. The lecturer gave feedback on the answers, particularly focussing on the questions where there was not a high percentage of correct answers. The lecturer would go over the answers to the questions and particularly focus on questions where the percentage of correct answers was not as high as the others. There were no marks awarded for participation with the questions all being of a formative nature.

The INFO243 class was a second year accounting information systems class with typically 100-120 students at each lecture. The application was used for open ended responses in three forms: students discussing questions in small groups with one member submitting the group response; at the end of a lecture students discussing and submitting what they thought was the most important thing covered in the lecture and submitting that; and at the end of a lecture students discussing what question they would most want to ask about the content and submitting the question. There were no marks awarded for participation with the questions all being of a formative nature.

The MPAC607 class was an accounting information systems course in a professional masters degree with 45 students enrolled and typically 40 students at each lecture. The application was used for open ended responses resulting from students having discussions in small groups. There were no marks awarded for participation with the questions all being of a formative assessment nature.

In these five courses, APODs have been used in four different modes with the modes being shown in Table 13 along with the courses that they were used in.

Mode	AMAP500	COSC368	ECON105	INFO243	MPAC607
Asking students multiple choice questions	✓	✓	✓		
Students discussion questions in small groups and submitting open ended answers				✓	✓
Students submitting what they thought was the most important content from the lecture				✓	
Students asking questions at the end of the lecture				✓	

Table 13 – Modes of Application Use by Course

The surveys were completed online and were created using the online survey tool Qualtrics. As it was not possible in this scenario to give the students a physical covering letter and ask them to sign a physical consent form, the first page of the survey included content that would have been on the information sheet. At the bottom of this first page the students were asked if they consented to taking part in the study, and if they selected the option to indicate that they consented the survey commenced. If a student indicated that they did not consent, the survey did not continue. A screen shot of the first page of the survey for students in INFO243 is included in Appendix C.

Ethics approval was sought for the survey with the survey being personalised for each course. For the three courses where the researcher was the lecturer (AMAP500, INFO243 and MPAC607) there was an extra paragraph which included the following text:

> "Even though I am the lecturer for this course, I assure you that it will not be possible to connect any of you with your individual responses. As a result of this, it will not be possible for your answers to any of the questions to have an impact on your results for the course. If you would like to see a summary of the results of the survey, please send me an email".

This was an additional requirement for approval from the University of Canterbury Educational Research Human Ethics Committee over and above what was required for the courses where the researcher was not the lecturer. A copy of the letter from the University of Canterbury Educational

Research Human Ethics Committee, granting approval of the survey is included in Appendix D. In addition to this approval, ethics approval was also sought and granted from the Christchurch Polytechnic Institute of Technology (CPIT) to use the same survey with the CPIT course where the researcher was also the lecturer. A copy of the letter granting this approval is included in Appendix E.

Blocks of questions were developed for each mode in which the APODs were used. Only the relevant blocks were included in the survey that was administered to a particular course. Each block of questions included questions asking the students to rate their level of agreement or willingness to do a particular activity with an APOD or verbally on a five step Likert Scale. At the end of each block the students were asked open-ended questions relating to their perspective of the use of the APODs.

A complete copy of the questionnaire including the blocks of questions for all of the modes is included in Appendix F. Some of the blocks of questions included questions about whether discussing the responses with the people sitting next to them helped their learning with the reasons for these questions relating to social learning theory (Vygotsky, 1978) and constructivism (Bruner, 1973).

Questions that asked whether the ways in which the applications encouraged more thinking about the content were based on this being a measure of increased cognitive engagement (Fredricks et al., 2004). Questions that asked whether seeing the responses from other students were based on social learning theory (Vygotsky, 1978) and constructivism (Bruner, 1973), these also being connected with the importance of feedback (Blood & Gulchak, 2013; Calma et al. 2014; Camacho-Minano & del Campo, 2014; Dunn et al., 2013; Heaslip et al., 2014). This latter point regarding feedback also applied to the questions relating to the lecturer giving feedback on responses in the form of confirming the correct answers or answering student questions.

Questions asking whether the use of the application made the lectures more enjoyable related directly to the concept of the use of APODs making learning more enjoyable (Blood & Gluchak, 2013; Camacho-Minano & del Campo, 2014; Chen & Lan, 2013; Innes & Main, 2013; Stewart & Stewart, 2013) and the questions asking whether the use of the application resulted in feelings of more engagement related directly to the concept of the use of APODs increasing student engagement (Calma et al., 2014; Dunn et al., 2013; Habel & Stubbs, 2014; Stewart & Stewart, 2013).

Responses to these questions relating to the students' perception of how the use of the APODs impacted on their learning enable analysis to be conducted on what aspects of the use of the application benefitted students the most relative to the other aspects. In addition to this, the demographic questions enabled analysis of the responses based on different groupings of the students.

The questions regarding whether being able to participate anonymously or non-anonymously was a driver behind participation related directly to the importance of anonymity (Blood & Gluchak 2013; Heaslip et al., 2014; Innes & Main, 2013; Landrum, 2013; Latham & Hill, 2014).

Demographic questions at the start of the survey asked the students to identify themselves by gender, age, and English language background with this being partly based on the conclusions of Kay and LeSage (2009a). Students were also asked to identify what devices they owned to give a picture of the level of device ownership in each course.

Statistical Tests Used

The analysis of the statistical analysis of the survey results was conducted using a combination of Mann-Whitney U-Tests and Difference in Means Tests with these being followed by a series of Spearman's Rho correlation tests. The decision to use this combination of tests was based on the following discussion.

Allen and Seaman (2007) outline the differences between four types of data that are commonly collected with Likert scale type questions in surveys with these being nominal; ordinal; interval and ratio data, with their definitions being shown in Table 14.

Nominal Data	The weakest level of measurement representing categories without numerical representation.
Ordinal Data	Data in which an ordering or ranking of responses is possible but no measure of distance is possible.
Interval data	Generally integer data in which ordering and distance measurement are possible.
Ratio data	Data in which meaningful ordering, distance, decimals and fractions between variables are possible.

Table 14 – Definitions of Nominal, Ordinal, Interval and Ratio Data (Allen & Seaman, 2007)

There is much debate in the literature as to what are the most appropriate statistical tests to use for Likert scale data, with part of the debate surrounding whether parametric or non-parametric tests should be used. Parametric tests are described as being inappropriate for Likert scale by some researchers (Jamieson, 2004; Gardener & Martin, 2007) with others stating that they can be used (Norman, 2010) and Murray (2003) stating in their conclusion that parametric tests can be conducted on Likert scale data without invalidating conclusions.

Those that consider the use of parametric tests to be inappropriate have done so on the basis of it not being possible to assume equidistance with Likert scale data (Lantz, 2003), which refers to whether the respondents to a survey perceive the gaps between the different points on the Likert scale as being the same distance apart. With a 5 point Likert scale using strongly agree; agree; neutral; disagree; and strongly disagree, Lantz (2003) concluded that assumption of equidistance between the steps along the scale was unlikely to be the perception of the respondents.

Jamieson (2004) has also commented that the intervals between the values on a Likert scale cannot be assumed to be equal and as such, they fall into the ordinal level of measurement. Jamieson (2004) points out that many researchers have invalidly assumed that the values on the Likert scale can be assumed to be equal. The appropriate tests identified in scenarios where the intervals cannot be assumed to be equal include, amongst others, the Mann-Whitney U-test (Jamieson, 2004).

Jamieson (2004) goes on to conclude that non-parametric tests like the Mann-Whitney U-test should be used when the data is ordered (like in a Likert scale) and where intervals can not be assumed to be equal.

Where two or more groups of students were combined a Cronbach-Alpha (Cortina, 1993; Tavakol & Dennick, 2011) test was conducted to measure the internal consistency of the results of the survey.

The questions asked in the surveys are included in Appendix I.

Analysis of Open Ended Questions

The analysis of the open-ended questions in the surveys was conducted using thematic analysis (Braun & Clarke, 2006), in a manner similar to how the analysis of the two groups of interviews were conducted.

3.5.5 Methods used in Focus Groups

Students in two of the courses that were surveyed where the researcher was the lecturer (INFO243 and MPAC607) were sent an email inviting them to participate in the two focus groups that were held. The academic results for both courses had been released prior to the invitations being sent to the students and at the time the researcher was not involved in teaching any courses that the students were enrolled in. The only exception to this was five of the students in MPAC607 whose internship projects were being supervised by the researcher, and to address this, these particular students were not invited to participate in the focus groups.

The students who accepted the invitation were sent a covering letter and a consent form, with the consent form needing to be signed before they participated in the focus group. Copies of the covering letter and the consent form are included in Appendix G. A copy of the letter from the University of Canterbury Educational Research Human Ethics Committee granting approval of the survey is included in Appendix H. A total of seven students were present across the two focus groups with four being from INFO243 and three from MPAC607.

During the focus groups, the students were asked to individually rank fifteen (15) statements in order based on how strongly they agreed with them, with this being followed by a more general discussion with the aim of gaining a deeper understanding of issues relating to the use of APODs from a student perspective.

Details of the focus group protocol and the source of the statements are included in chapter six which presents the findings of the student surveys and focus groups.

3.6 Limitations of the Research

Limitations of this research include: (a) the lecturers who were interviewed were predominantly early adopters and active experimenters and have tended to have positive experiences; (b) four of the five courses surveyed were business related and as a consequence the findings are not generalisable to other subject areas; (c) three of the courses surveyed were being taught by the researcher; and (d) that the research was conducted in a New Zealand context with the exception of some of the lecturers and learning advisers who were interviewed being from Australia, and as a consequence the findings may not be generalisable to other contexts.

The limitation of the lecturers predominantly being early adopters and active experimenters resulting in them having mainly positive experiences was addressed by interviewing learning advisers. As indicated in the introductory chapter this decision was consistent with the characteristics of innovators and early adopters (Elgort, 2005; Moore & McKenna, 1999). The purpose of the interviews of the learning advisers was to gain insights into the challenges that may be faced by lecturers who adopt APODs.

The limitation of four of the five courses where students were surveyed being business courses with the consequence of findings not being generalisable to other subject areas is acknowledged. This limitation is common in design-based research and is dealt with by fully describing the context in which the research is taking place (Barab & Squire, 2004).

The limitation of three of the five courses where students were surveyed being taught by the researcher is acknowledged. One way in which this was addressed was in the design of the survey which included: (a) students who had questions about the survey being asked to email them separately and not ask the as part of the survey, and (b) that there was an extra assurance included in the information page of the survey relating to the students not being identifiable. The issue of the researcher being part of the research is also common in design-based research and needs to be accounted for as opposed to the researcher having a "hands off role" (Barab & Squire, 2004). This is also addressed in design-based research where there is encouragement for researchers to not remain detached from their research, but to use interventions as "opportunities to examine core theoretical issues and explore learning" (Barab & Squire, 2004).

The limitation of the research being conducted predominantly in a New Zealand context is acknowledged. In design-based research this type of limitation is dealt with by documenting the contextual influences, so that they can be better understood to enable the findings to be applied to appropriate contexts (Wang & Hannafin, 2005) as per Table 10 (page 90).

Data collected from participants about their perceptions and as such this was data from first person responses. Another layer of research could to measure the effects of APODs on learning but that is beyond the scope of this research. This research serves as a step towards being able to measure the effects on learning using experimental design.

The focus of the study was on the use of APODs in lectures with a possible extension to this research being to analyse at a deeper level the courses that were being taught. However, the focus is on courses in general to enable the findings to be more relevant across more disciplines.

3.7 Summary

The research methods adopted for this research was a mixed methods research approach that is consistent with design-based research. This is due to the most appropriate paradigm for the research being a pragmatic paradigm, based on an ontology of "truth is what is useful" and on an epistemology of "the best method is one that solves problems" (Maxcy, 2003).

In terms of how the research was carried out there were a range of different perspectives that were explored that were based on a range of different research questions. Some of these different perspectives were consistent with a positivist paradigm leading to quantitative research methods, while others were consistent with an interpretivist/constructivist paradigm leading to qualitative research methods. A consequence of these different perspectives leads to the need for a mixed methods research approach.

The pragmatic, flexible, integrative and contextual nature of the research resulted in an approach that is consistent with the characteristics of design-based research (Wang & Hannafin, 2005).

4 Findings from Pilot Study

This chapter presents the results of a four-stage pilot study at the University of Canterbury in Christchurch, New Zealand. The pilot study investigates the use of applications on personal owned devices (APODs) to increase student engagement in large lectures. The four stages of the pilot study are shown in Table 15.

Stage	Description
A	The development and initial trial of a system that enabled students to send text messages and allowed the lecturer to display selected messages on the screen at the front of the class.
B	A more extensive trial of the texting based system developed in Stage A over a number of weeks and an analysis of the students' responses to the user of the system.
C	The survey of a cross section of students regarding their ownership of mobile devices to measure the changing rates of ownership of smart phones, tablets, and laptops.
D	In response to the results of Stage C this stage presents an analysis of students' responses to the initial use of a mobile web based application to facilitate student interaction in a process similar to that used with the texting based system used in Stage A and Stage B.

Table 15 – Four Stages of the Pilot Study

The research method for each stage is described with the results of each stage being presented along with an analysis and conclusions including directions in which the research can be extended.

4.1 Research Methods Used in Pilot Study

This section covers the research methods that were used in the four stages of the pilot study

4.1.1 Research Method for Stage A

The development of a text messaging based system is briefly described. The outcomes of four experiments using the system that were conducted with a first year information systems course at the University of Canterbury with approximately 250 students enrolled are presented, along with implications for later phases of the research.

Experiment #1

Students were asked to send a text message containing their name and favourite colour as an initial test to check that the system captured the messages so that they could be displayed on the screen at the front of the class. This also helped the students understand how the system worked.

Experiment #2

Students were asked to discuss in small groups how many entities (between 1 and 6) they thought would be in the entity relationship diagram based on small narrative and to have one student in each group text the number to the system. A graph showing the responses was displayed on the screen at the front of the class.

Experiment #3

Students were given another small example to discuss in small groups of 3-4 with this including the need for a bridging entity because of a many-many relationship, with the question asking whether there were 3 or 4 entities and why. One person from each group was asked to text their answer with the lecturer displaying a cross section of the answers.

Experiment #4

Students were asked to discuss why some people choose to not purchase things online, and one person from each group texted their answer, with the lecturer displaying a cross section of the answers.

4.1.2 Research Method for Stage B

Stage B involved surveying the students in a second-year accounting information systems course at the University of Canterbury with approximately 170 students enrolled where the text messaging based system was used in three different ways:

- Students asking questions of the lecturer
- Students answering open ended questions that had been asked by the lecturer
- Students giving feedback from small group discussions during the lecture

In the survey, the students were asked to indicate how often they would be likely to participate in each of the manners shown in Table 16. The contents of the first column were verbal interactions without the use of an APOD and the second column is based on using the system.

Interrupting the lecturer to ask a question	Texting the lecturer to ask a question
Answering a question asked by the lecturer	Texting the answer to a question asked by the lecturer
Telling the rest of the class what their group had talked about in a small group discussion	Texting what their group had talked about in a small group discussion
Asking questions about a test/exam during a review session	Texting questions about a test/exam during a review session

Table 16 – Manners of Participation in Phase B

The results of this phase of the study are presented and analysed later in this chapter and the implications for future research are identified.

4.1.3 Research Method for Stage C

In the conclusions to Stage B of the pilot study it was identified that a growing number of students owned smart phones, tablets, and laptops, and that there were some technical issues relating to the use of the texting based system that had been developed. To determine whether the research could move from the text messaging based system to applications based on devices such as smart phones it was decided to survey students at the University of Canterbury with the aim of measuring the changing patterns of device ownership. The students were asked which of the devices shown in Table 17 they personally owned at the end of 2010, 2011 and 2012.

Device
Text Capable Mobile
iPhone
Android Smart Phone
Windows Smart Phone
Laptop with Windows
Apple Laptop
Android Tablet
iPad
iPod Touch

Table 17 – Devices Students Asked To Indicate Ownership Of

The responses where collated and analysed later in this chapter to show the changing patterns and the importance of the analysis for the following phases of the research.

4.1.4 Research Method for Stage D

An application developed for mobile devices that allows a similar level of interaction (as the text messaging based system) between students and lecturers was used during a large first year commerce course at the University of Canterbury in 2013. In a survey at the end of the course students were asked to indicate how often they would be likely to participate in each of the manners shown in Table 18 (based on the questions asked in Stage B).

Interrupting the lecturer to ask a question	Using the system to ask the lecturer question
Answering a question asked by the lecturer	Using the system to answer a question asked by the lecturer
Telling the rest of the class what their group had talked about in a small group discussion	Using the system to share what their group had talked about in a small group discussion

Table 18 – Manners of Participation in Phase D

4.2 Results and Findings from Pilot Study

This section presents the results from the pilot study.

4.2.1 Results for Stage A – Development of Text Messaging Based System

The system allows for text messages to be sent by students from their phones to a mobile phone that is plugged into the USB port of a computer. The computer sees the mobile phone as being a GSM modem and when a text message arrives on the phone an SQL command is executed to insert the contents of the message into an Access database.

The lecturer can display all of the responses on the lecturer's personal screen. From this, the lecturer can select which responses to display to the class, as shown in Figure 6, and then display the selected responses on the screen at the front of the class, as shown in Figure 7.

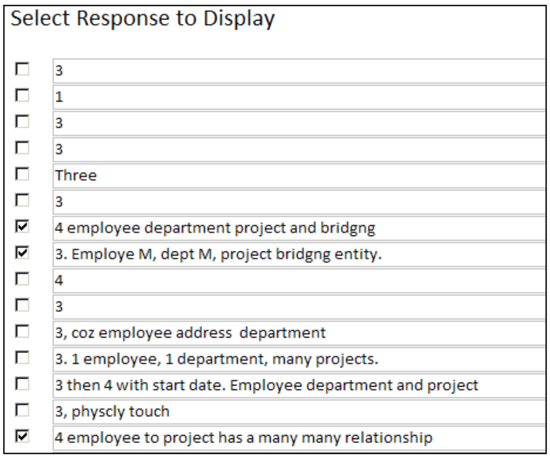

Figure 6 – Selecting Responses to Display to the Class – Screen Shot

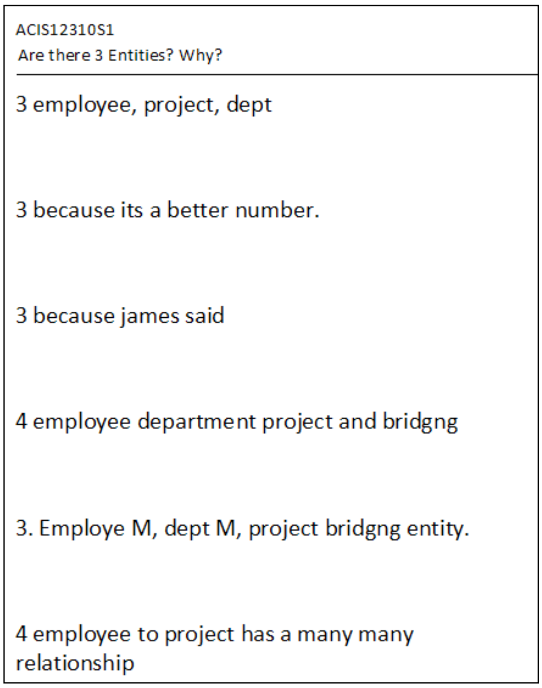

Figure 7 – Displaying the Selected Responses to the Class on the Screen – Screen Shot

It is possible to have more than one mobile phone plugged in to different USB ports and have the system recognise all of the phones and process text messages from any of them at the same time. This allows students a choice of which mobile network to text would enable more students to participate at no cost as at the time there was an additional cost involved in sending text messages between mobile networks.

4.2.1.1 Results of Experiment #1

The purpose of the experiment was to test whether the system was working, and within 2 minutes 148 responses (out of approximately 250 students in the lecture) had been inserted into the Access database with some being selected and displayed. The result of this experiment was successful as it demonstrated that the system would work as expected.

4.2.1.2 Results of Experiment #2

This experiment was in essence a multi-choice question, with 3 being the correct answer. The graph generated by the system is show in Figure 8 indicates that the majority of the students were correct (39 out of 60 responses were correct). Given that the 60 responses were from students working in groups of approximately 3, the responses were from approximately 180 of the approximately 250 students at the lecture which is a participation rate of approximately 70%. The lecturer went on to explain why 3 was the correct answer.

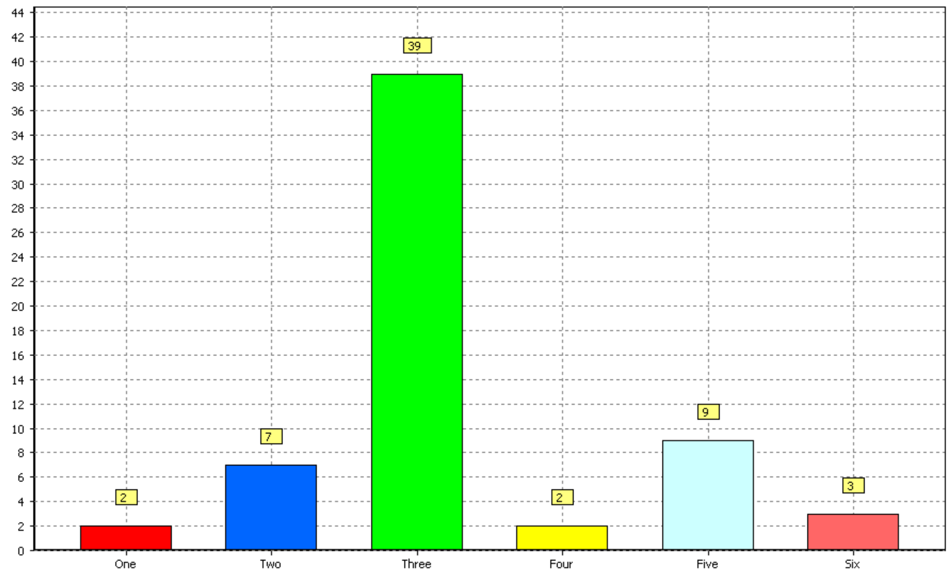

Figure 8 – Graph of Responses from Experiment #2

4.2.1.3 Results of Experiment #3

Of the 76 responses, there were 20 that included more than just the number of entities, and included a reason why. These 20 responses were displayed for the class to see. With the 76 responses being from students working in approximately groups of 3 and there being approximately 250 students in the lecture, this is participation rate in excess of between 80% and 90% although it was possible for students to respond more than once). The correct answer was 4 due to the need for a bridging entity because of a many-many relationship. The lecturer was able to explain why 4 was the correct answer and highlight the valid reasons for this. One response was "3 because James said" and resulted in a light hearted moment. Some students were heard to say "oh, I get it now" when they saw the responses that were displayed and the reasons associated with the correct answer.

4.2.1.4 Results of Experiment #4

This experiment resulted in 48 responses being received with two of them being "U r going to fast [sic]" and "Speak a liltle louder cnt hear at the back [sic]". Of the other 46 responses, 13 were shared with the class. These responses (see Figure 9) indicated that the students collectively had a good understanding and the lecturer used this as a basis for the lecture as it continued.

Security and trust. :)
Lack of trust
Security and payment method
Security reasons and cant test out th good
Fear of security, unfamiliar with technology
Dnt have a credit card or the security of the payment nt safe
Security
Risk- cant c the actual product so dont no what its really like
1- to see quality 2- payment dificulties
Might not be a safe transacting (in terms of sending their credit card details). They cant see the physical product, it could be faulty, differnt or non existent
Because may be some old people dont know how to drive competer
Clothes sizes might not fit cant try on before purchase. Postage costs might be high
Trust ISSUES AND phyical COMPONENT,,

Figure 9 – Responses from Students Shared With Class – Screen Shot

4.2.1.5 Observations of Lecturers

Observations of the lecturers included that many more students would participate by sending text messages than talking out loud as it would be very unusual to have 76 students respond verbally in a lecture of approximately 250 students.

It was also observed by one of the lecturers in the weeks following these experiments that students appeared to interact more verbally at that stage of the course than they had in the previous semesters for that part of the course. This could point to the idea of students sharing anonymously and not being judged as being an approach to increasing the trust, willingness and confidence to share verbally.

The system was seen by the lecturers as being somewhat *"clunky"* to use as (a) there times when the system had not been used for a period of time that the laptop needed to be restarted and (b) the system was not particularly user friendly for the lecturers using it.

4.2.1.6 Feedback from Students

At the end of the lecture where experiment #4 was conducted, the students were asked to text in their perceptions of the system. There were 7 responses sent in, which is too small a sample size to make generalisations about, however these responses were all positive and are shown in Table 19.

Easy communication.
Its awesome. Saves speaking out in lectures
It is good
easy way
Its good cuz alot of pple dnt lik speaking up in lectures bt wif this they can still hav there say
It is good
Its a brilliant idea! I can say things and no one will know its me and its not out loud.

Table 19 – Responses from Students about Their Perceptions of the System

4.2.2 Analysis and Discussion for Stage A

In Stage A of the pilot study there was clear evidence of a number of the themes from the literature review. These include what was observed to be increased attendance, participation, engagement and enjoyment of learning relating to classroom environment benefits. There was also increased interaction and discussion, and the scope for approaches such as CT and QDI from the learning benefits themes. When it came to the assessment benefits themese there were aspects of formative assessment, feedback, and the ability to compare responses present.

In the technology based challenges themes, the issue of not all students having a device with them was addressed through the students working in small groups, and the issue of the technology not functioning was addressed by two lecturers being present as the system was seen as being somewhat *"clunky"*. The second lecturer's role was to ensure that the system kept working during the lecturer as there were some issues with the operation of the system that occasionally required the laptop to be reset. Issues related to lecture based challenges were not evident in this stage of the pilot study. When it came to the student based challenges, students appeared to have little problem adapting to using the system as there was a high degree of familiarity with texting.

When it came to pedagogical issues, the lecturers found that the approach was a good teaching strategy in that it addressed some of the issues relating to large classes, and had the potential for being used in a CT and QDI context.

When it came to cost and ease of use for students, there appeared to be few issues, however at the lecturer end the system was seen as being *"clunky"*, and quite a lot of time had been spent developing the system that had been funded by a teaching grant.

4.2.3 Results for Stage B – Trial of the Text Messaging Based System

Of the 170 students enrolled in this course, 63 of the students responded to the survey, which is a response rate of 37.1%. The comparison of how willing the students were to interrupt the lecturer to ask questions and how willing they were to text questions to the lecturer is shown in Table 20, and indicates a marked increase in willingness to text questions rather than interrupt the lecturer to ask verbally.

	Often	Occasionally	Hardly Ever	Never	Total
Interrupting the lecturer to ask a question	1	2	8	52	63
Texting the lecturer to ask a question	20	24	12	7	63

Table 20 – Frequency of Responses Comparing Orally Asking & Texting to Ask

The comparison of how willing the students were to answer a question asked by the lecturer and how willing they were to text answers to questions asked by the lecturer is shown in Table 21, and indicates a marked increase in willingness to answer questions by sending a text message as opposed to answering verbally.

	Often	Occasionally	Hardly Ever	Never	Total
Answering a question asked by the lecturer	2	15	27	19	63
Texting the answer to a question asked by the lecturer	19	20	14	10	63

Table 21 – Frequency of Responses Comparing Orally Answering & Texting to Answer

The comparison of how willing the students were to tell the rest of the class what was talked about in their small group discussion, and how willing they were to text what their small group had talked about is shown in Table 22. The average response is based on "often" being 4 through to "never" being 1. This indicates a marked increase in willingness to send a text message to share the group's response than to share it verbally.

	Often	Occasionally	Hardly Ever	Never	Total	Average
Telling the rest of the class what their group had talked about in a small group discussion	2	10	26	25	63	1.83
Texting what their group had talked about in a small group discussion	15	19	13	16	63	2.52

Table 22 – Frequency of Responses - Orally & Texting Responses from Small Groups

The comparison of how willing the students were to ask questions in a test/exam review session and how willing they were to text questions during a text/exam review session is shown in Table 23. The average response is based on "often" being 4 through to "never" being 1. This indicates a marked increase in willingness to send text messages to ask questions about a test/exam than to ask the questions verbally.

	Often	Occasionally	Hardly Ever	Never	Total	Average
Asking questions about a test/exam during a review session	7	22	20	14	63	2.35
Texting questions about a test/exam during a review session	29	18	9	7	63	3.10

Table 23 – Frequency of Responses - Orally & Texting Questions in Review Sessions

4.2.4 Analysis and Discussion for Stage B

The results shown in Table 20 demonstrate that a much higher proportion of students would use the text messaging system to ask questions (44 out of 63 occasionally or often) as opposed to interrupting the lecturer to ask questions (3 out of 63 occasionally or often). The results shown in Table 21 demonstrate that a much higher proportion of students would use the text messaging system to answer questions (39 out of 63 occasionally or often) as opposed to verbally answering a question (17 out of 63 occasionally or often).

The results shown in Table 22 demonstrate that a much higher proportion of students would use the text messaging system to share the outcome of their small group discussion (34 out of 63 occasionally or often). The results shown in Table 23 demonstrate that a much higher proportion of students would use the text messaging system to ask questions during a revision session (29 out of 63 occasionally or often) as opposed to doing so verbally (7 out of 63 occasionally or often).

This analysis is consistent with a number of the classroom environment benefits themes from the literature review. Of particular relevance was that there was clear evidence that the use of the text messaging system resulted in increased student engagement, interaction and participation, with these all being aspects of the classroom environment benefits themes, irrespective of the mode that the system was used in.

The perception from the lecturers that the system was somewhat "clunky" for them to use remained an issue. This relates to the ease of use for lecturers' theme from the literature and the technology not functioning theme from the literature.

There was a growing awareness that increasingly large numbers of students owned smartphones and tablets and that some applications were becoming available that would offer similar functionality to the text messaging system without being quite as "clunky" for the lecturers to use. While this would address the ease use for lecturers' theme, it would bring into question whether sufficient students owned a device that the application would run on. This is an example of the students not having or bringing a device theme from the literature and the cost to students' theme from the literature.

Whether sufficient students owned smart phones or tablets was something that would need to be tested. One issue that had been overcome for lecturers relating to the use of clickers was no longer needing to have a process to distribute clickers to students which relates to the technology based challenges of the literature review.

4.2.5 Results for Stage C – Survey of Students Regarding Device Ownership

The students were asked which of the devices shown in Table 24 they personally owned at the end of 2010, 2011 and 2012, with the numbers of responses for each device also being shown. The data shows marked increase in the ownership of the smart phones, tablets, and laptops.

Device	**2010**	**2011**	**2012**
Text Capable Mobile	225	231	231
iPhone	14	49	76
Android Smart Phone	26	61	97
Windows Smart Phone	8	8	10
Laptop with Windows	131	157	174
Apple Laptop	33	44	53
Android Tablet	2	6	9
iPad	4	22	45
iPod Touch	38	51	54
Total	**237**	**237**	**237**

Table 24 – Changing Ownership Patterns of Devices 2010-2012

The analysis of these responses follows.

4.2.6 Analysis and Discussion for Stage C

The results of the survey regarding device ownership in Table 24 were further analysed to determine how many of the students owned at least one of a smart phone, tablet or laptop with this being shown in Table 25. This shows the percentage of students owning smart phones growing from 19.0% to 72.2% and the percentage owning any mobile web-enabled device growing from 73.0% to 96.6% from the end of 2010 to the end of 2012. The 96.6% figure is only marginally behind the 97.5% of students owning a mobile phone that was capable of texting, which means that there is no significant benefit in access to technology by students between using smartphone capabilities and text messaging.

A consequence of this was that if there were suitable applications available for mobile web-enabled devices that were freely available that it would be possible to use them instead of the text messaging based system. This would address the theme of students not having or bringing a device from the literature and the costs of devices theme from the literature.

Device	2010		2011		2012	
Text Capable Mobile	225	94.9%	231	97.5%	231	97.5%
Smart Phone	45	19.0%	108	45.6%	171	72.2%
Laptop (Windows or Apple)	156	65.8%	191	80.6%	214	90.3%
Tablet	44	18.6%	75	31.6%	92	38.8%
Mobile Web-enabled Device	**173**	**73.0%**	**218**	**92.0%**	**229**	**96.6%**
Total	**237**	**100.0%**	**237**	**100.0%**	**237**	**100.0%**

Table 25 – Device Ownership Grouped by Device Type

4.2.7 Results for Stage D – Trial of Smartphone Application

Of the 380 students enrolled in this course, 55 of the students responded to the survey with valid responses for a response rate of 14.5%. The comparison of how willing the students are to interrupt the lecturer to ask questions and how willing they are to use the application to ask questions of the lecturer is shown in Table 26.

	Very Often	Often	Occasionally	Rarely	Never	Total
Interrupting the lecturer to ask a question	-	3	4	13	35	55
Using the system to ask the lecturer question	8	12	9	11	15	55

Table 26 – Frequency of Responses - Orally Asking Questions or Using an App

The comparison of how willing the students are to answer a question asked by the lecturer and how willing they are to use the application to send answers to questions asked by the lecturer is shown in Table 27.

	Very Often	Often	Occasionally	Rarely	Never	Total
Answering a question asked by the lecturer	-	1	12	13	29	55
Using the system to answer a question asked by the lecturer	24	14	8	6	2	55

Table 27 – Frequency of Responses - Orally Answering Questions or Using an App

The comparison of how willing the students are to tell the rest of the class what was talked about in their small group discussion and how willing they are to send what their small group had talked using about the application is shown in Table 28.

	Very Often	Often	Occasionally	Rarely	Never	Total
Telling the rest of the class what their group had talked about in a small group discussion	1	8	14	13	19	55
Using the system to share what their group had talked about in a small group discussion	10	11	10	10	13	55

Table 28 – Frequency of Responses -Orally or Using an App to Share Group Responses

The analysis of these responses is presented in the analysis and discussion section that follows the results of the four stages of the pilot study.

4.2.8 Analysis and Discussion for Stage D

The results shown in Table 26 demonstrate that a much higher proportion of students would use the application to ask questions (20 out of 55 often or very often) as opposed to interrupting the lecturer to ask questions (3 out of 55 often or very often). The results shown in Table 27 demonstrate that a much higher proportion of students would use the application to answer a question (38 out of 55 often or very often) as opposed to verbally answering questions (1 out of 55 often or very often). The results shown in Table 28 demonstrate that a much higher proportion of students would use the application to share the outcome of their small group discussion (21 out of 55 often or very often) as opposed to sharing the outcome verbally (9 out of 55 often or very often).

This analysis demonstrates that irrespective of which mode the application was used in, that a much higher proportion of students will use it to engage, interact and participate during lectures in comparison to doing so verbally. This analysis is consistent with a number of themes from the literature review. Of particular relevance was that there was clear evidence that the use of the application resulted in increased student engagement, interaction and participation, which are all themes from the literature.

4.3 Conclusions of Pilot Study

Stage A and Stage B of the pilot study showed that the concept of using a text messaging based APOD would allow students to respond anonymously during large lectures and demonstrated some of the key aspects of the literature including: increased interaction, participation and engagement; low cost and simplicity of use for students; and without the need to find a process for distributing devices to students.

Changing the focus of the pilot study from the text messaging system (Stage A and Stage B) to one based on an application running on a mobile web-enabled device (Stage D) was partly in response to usability issues for lecturers which relates to the ease of use for lecturers theme from the literature. This decision was only made after consideration of the challenges of not all students having or bringing a device and the issue of cost of devices for students. This decision was enabled by the results of the survey regarding ownership of devices (Stage C).

Stage D of the pilot study demonstrated that the classroom environment benefit of increasing student interaction, participation and engagement that was experienced when using the text messaging based system (Stage B) was also present when using an application based on a mobile web-enabled device.

Based on the findings of this pilot study the use of APODs in large lectures can result in increased student interaction, participation and engagement.

4.4 Implications for Further Study

While the results of the pilot study are successful, there are a number of implications and opportunities for further research including:

- Whether the benefits apply to all students or whether there are some groups of students that will benefit more from the use of APODs than other groups (for example based on age, gender, language and level of study).
- How to best use APODs in lectures in manners that are pedagogically sound.
- How to best address the challenges and issues in the use of APODs that relate to students, lecturers and technologies.

From the pilot study, it was determined that these issues need to be explored from a range of perspectives including lecturers (through interviews), students (through surveys and focus group) and those supporting lecturers in the adoption of APODs (through interviews of learning advisers).

The subsequent findings chapters address these implications for further research.

5 Findings from Interviews

This chapter presents the findings from interviews of lecturers and learning advisers.

First, the findings from the interviews of lecturers are presented. This includes a description of how the interviews were conducted; a summary of each interview; an analysis of the interviews based on a thematic analysis (Bruan & Clarke, 2006) approach using the themes emerging from the literature review; and the implications for later phases of this research.

The findings from the interviews of the learning advisers are presented in the same format as the interviews of lecturers with the addition of comparing the findings from the lecturer interviews. The implications for later phases of this research are also presented.

5.1 Interviews of Lecturers

This section introduces the overall aims of the twelve lecturer interviews, followed by a summary of each of the interviews. This is then followed by an analysis of the interviews using a thematic analysis approach as outlined in the methodology chapter. Implications for later stages of the research are outlined at the end of the section. The interviews were semi-structured and mostly covered the issues or questions that are shown in Table 29, which is reproduced from the methodology chapter.

Your reason(s) for using this product (and other similar products) as part of your teaching
How you have used this product (and other similar products) in the past
How you use this product (and other similar products) currently
How you plan to use this product (and other similar products) into the future
The benefits to the students from your perspective
The benefits for you personally
Key success factors in using the product well
Potential issues that arise from using the product

Table 29 – Issues and Questions Covered in Interviews of Lecturers

With the motivations, practices and experiences of the interviewees varying, the interviews in some cases followed different paths. Some of the responses resulted in further probing to gain a deeper understanding of the experiences and perspectives of the interviewee. Examples of this occurred in the interviews with Lecturer 6 and Lecturer 11, both of who, had been involved in teacher education for a number of years. In these two interviews some time was spent probing issues relating to teaching pedagogy, which did not take place in the other interviews. This probing was consistent with the interpretivist and constructivist aspects of the research that the interviews related to.

5.1.1 Summary of Interview of Lecturer 1

The lecturer adopted the use of an application that had been developed by a group of computer science students at the university where they are employed. The application was used in the lecturers for a first-year business related subject. The application was developed as a web application that runs on smart phones as well as tablets and laptops. The application allows for interaction between the lecturer and students in multiple ways during a lecture. These include:

- Students answering questions of a multiple-choice nature using the application, with a histogram of the results displayed to all the students
- Students answering open ended questions, with their answers being displayed to all the students
- Students asking questions or making observations and the lecturer answering the questions, with the questions potentially being displayed to all the students

The lecturer has used this application and the learning management system (LMS) that has been adopted by the university across several semesters to increase student engagement in large lectures, partly through the use of the "Flipped Classroom" concept (Tucker, 2012). There are typically more than 200 students at each lecture in the course, with many of the students having studied the content prior to enrolling in the course. The students are asked to read some content prior to coming to the lectures and the lectures typically commence with students answering multi-choice questions using the application. This allows the lecturer to determine which particular content needs to be addressed in more detail as the lecture commences. The students can discuss their answers with other students before responding, which allows students to participate even if they do not have a mobile web-enabled device with them.

The lecturer commented that "I don't want to spend time covering content that they already know".

Students are also encouraged to ask questions or make comments using the application during the lecture. The lecturers commented that their perspective some of the comments made are of a humorous nature and that this can create a good atmosphere for learning. Some of the questions have been "are we supposed to know this already?" or similar and have resulted in lecturer needing to re-explain the nature of the "Flipped Classroom" approach that has been adopted. Other questions about content have helped the lecturer become aware of concepts that may need more explaining.

One of the key aspects identified by the lecturer in how well the approach has worked is that of anonymity, as the responses made using the application are anonymous, which can result in students asking questions that they would not normally ask. There is no requirement for students to participate in the use of the application and there are no marks associated with participating, which addresses the issue of some students not owning a device that the application can run on. To partly address this, the students are encouraged to discuss questions with the people sitting next to them. This lecturer also commented on the challenge of creating effective questions, particularly where the incorrect answers to multiple choice questions create opportunities for clarifying common misconceptions.

Of particular interest to the lecturer are the discussions that take place between the students when answering the questions and whether or not that is aiding the students' learning. A visually impaired student has commented to the lecturer that they gain a lot from listening to the discussions of the other students about the content that is being talked about. The response from the students in these classes to the lecturer has been very positive about the approach that has been taken and that they feel it is student led and student focussed.

In this case the application was used for formative assessment purposes only, with no marks being awarded for participation or attendance.

Based on the reasons for this lecturer adopting APODs for their lectures, they could be classified as an innovator using the model in Elgort (2005) and Rogers (1995).

5.1.2 Summary of Interview of Lecturer 2

The lecturer adopted the use of an application that is freely available for all to use. The lecturer uses the application during the lectures for a first year business studies related course at the university where they are employed. The application runs on smart phones as well as tablets and laptops.

The application allows for interaction between students and the lecturer in many of the same ways that were described above in the summary of Lecturer 1's interview. The lecturer uses the application to increase student engagement in large lectures and had also previously used clicker technology for the same purpose. In the first year course that is the focus of this interview there are typically in excess of 200 students at each lecture.

The lecturer uses the application to get students to answer multiple choice questions about content as it is covered, with the aim of keeping the students involved and also to check their understanding about concepts as they are being covered. The students are encouraged to discuss the questions with the people they are sitting next to, and the lecturer believes that there is some benefit to the students in doing this. There is no requirement and no marks associated with students participating with the use of the application, which addresses the potential concern of students who do not own a device that the application can run on. The students appear to enjoy the use of the application in this way and the lecturer believes that this may also help their learning, but does not have any hard evidence to prove that this is the case. The lecturer believes that one of the keys to the success of this approach is the idea of anonymity.

The lecturer commented that "I want to know what is going on inside the student's heads" and "what are they understanding and not understanding?"

As indicated earlier, the lecturer had previously used clicker technology for the same purpose. The main difference between using clickers and using an application like the one used is that the vast majority of the students have a device that the application runs on, whereas previously the clicker devices had to be purchased by the university and also had to be given out at the start of the class and collected in at the end of the class.

In this case the application was used for formative assessment purposes only with no marks being awarded for participation or attendance.

Based on the reasons for this lecturer adopting APODs for their lectures, they could be classified as an innovator using the model in Elgort (2005) and Rogers (1995).

5.1.3 Summary of Interview of Lecturer 3

The lecturer adopted the use of an application during lectures for a second year business and information systems course at the university where the lecturer is employed. The lecturer uses the application (which runs on smartphones, tablets and laptops) with the aim of increasing student interaction and engagement in large lectures. In the second year course that is the focus of this case there are typically 120-150 students at each lecture. The lecturer uses the application in a number of ways in the lectures including:

- Students discussing (in small groups) questions that need open ended answers, then having one person in each group submit the answer for that group so that the lecturer can display the responses to all the class and give feedback on them.

- Students being asked at the end of the lecture to discuss (in small groups) either (a) what the most important concept covered in the lecture was or (b) what is the one thing from the lecture they would like to have explained again. In both cases one person in each group submits the response for the group so that the lecturer can display the responses to all of the class and give feedback on the responses.

The lecturer commented “I want to make sure that the students are getting the tricky concepts before moving on”.

The main driver for this lecturer in adopting this technology was to enable small group discussion to take place about the content, and to get feedback about what the students understand about the content that has been covered. Given that this was the motivation for adopting the technology, the use of small group discussion avoids much of the issue surrounding individual students not having a device to participate with as only one student per group would need a device. The lecturer sees anonymity as being one of the keys to the success of this approach as well as students being able to see a range of different responses to the questions.

This lecturer has used the application for multiple choice questions and discovered by chance that an ambiguously written question that can be interpreted in a number of ways can be a good way to create teaching points during a lecture.

The lecturer also commented that “these ambiguous questions are tricky to create intentionally, with some of the best ones happening by accident”.

A challenge identified by this lecturer is the potential for overuse of the approach as there were times when the use of the application did not appear to be as effective as other times as there would be occasions when there was a much lower response rate.

In this case the application was used for formative assessment purposes only with no marks being awarded for participation or attendance.

Based on the reasons for this lecturer adopting APODs for their lectures, they could be classified as an innovator using the model in Elgort (2005) and Rogers (1995).

5.1.4 Summary of Interview of Lecturer 4

The lecturer adopted the use of an application during classes for a pre-degree level computing, communications and business course at the institute of technology where the lecturer is employed. The main motivation for the lecturer in this case was to improve the student interaction during classes, with the classes generally having between 20 and 25 students in attendance.

The application (which runs on mobile web-enabled devices such as smartphones, tablets and laptops) was used by the students to submit answers to open ended questions. If the students were required to respond verbally, the lecturer would normally have 2-3 responses, whereas when the application is used over half of the students would typically respond. The lecturer believes that feedback on the responses is vital, particularly accentuating the good parts of answers that may not be completely correct, and that there is also some real benefit in the students seeing what each other are thinking. The benefits to the lecturer are that the approach encourages students to think about the questions more, with the lecturer commenting that "it makes it easier to see where the class is at".

The application has also been used for students to answer questions like "are there any more questions?" and "do you want to go over this again?" and it has been observed that the students are more responsive than if they had been asked to do these things verbally. The feedback from the students has been positive, including comments like "it is cool". Keys to the success of the approach are seen by the lecturer in this case as being the anonymity of responses. The lecturer went on to comment that “the devices have almost become ‘prosthetics’ for many of the students in that they are almost permanently attached to them”.

In this case the application was used for formative assessment purposes only with no marks being awarded for participation or attendance.

Based on the reasons for this lecturer adopting APODs for their lectures, they could be classified as an early adopter using the model in Elgort (2005) and Rogers (1995).

5.1.5 Summary of Interview of Lecturer 5

The lecturer in this case was part of a team of six lecturers that adopted the use of clickers during lectures in a large first year university statistics course that typically had twelve lecture streams per year with 400 students in each stream. The motivation behind the use of clickers was to increase the participation and engagement of students during lectures. The team of lecturers had volunteered to be part of a trial at their university in 2009 with the trial commencing in 2010. The clickers were still being used at the time of the interview in late 2014.

The lecturer saw anonymity as being a key benefit to students. There was no tracking of which students participated and which students were correct with their answers, with participation being voluntary and not part of the assessment regime for the course. The students borrowed the clicker devices for the duration of the course at no cost from the library which (being a library) has a system in place for tracking who has borrowed items so that they can be followed up on if they are not returned. Typically 50% of the students have a clicker with them at each lecture.

The clickers are used so that the students can practice exam style (multi-choice) questions, although some use was for non-exam related questions. Once the students have completed a question or a block of questions they are given feedback about the results, particularly when a number of the students had provided an incorrect answer.

The benefits to the lecturers have included that there is increased engagement from the students and that a much broader range of students respond to questions than if the clickers had not been used. The lecturer comment that "there was also some element of surprise for some of the lecturers involved about what parts of the content the students had misconceptions about", and went on to comment that "by discovering those misconceptions the lecturers were able to address them immediately". One of the dangers of using the clickers that was identified by the lecturer was that there was still the need for open-ended questions, and they did not want to become too dependent on the use of clickers. There were some issues of the software for the clickers failing in the early days of the trial.

The students who were not using clickers in lectures appeared to engage and complete the questions so that they could see how well they were doing relative to the rest of the class, and in many cases they paired up with someone who had a clicker and worked on the questions together. The lecturer commented that "one of the most important factors relating to the success of the trial was the importance of having the right types of questions". This includes ensuring that the answers corresponding to common errors were one of the potential answers so that it could be discovered whether the common mistakes were being made, and as a consequence of this feedback could be given about those particular concepts.

In this case the clickers were used for formative assessment purposes only with no marks being awarded for participation or attendance.

The lecturer has considered using apps running on devices such as smart phones, laptops or tablets but this was some way off due to the number of students owning smartphones and the need for seamless integration with PowerPoint.

Based on the reasons for this lecturer adopting APODs for their lectures, they could be classified as an early adopter using the model in Elgort (2005) and Rogers (1995).

5.1.6 Summary of Interview of Lecturer 6

This lecturer has been involved in school teacher education for over ten years, and mergers and funding pressures have resulted in class sizes dramatically increasing from approximately 30 to having lectures (in some cases) of 200 or more students. A significant issue that faced this lecturer came about with one of the topics that they were required to cover was "the importance of having an interactive classroom" and that doing a traditional university lecture on this topic resulted in the lecturer "feeling like a fraud". The lecturer commented that much of this feeling "was related to the importance of modeling good teaching practice when teaching about good teaching practice". This issue also raised the question for the lecturer of "what is the purpose of a lecture and whether it is to deliver content only, or to provide a learning experience?".

The lecturer investigated a number of tools that could be used to create some degree of interactivity, and settled on an application that would run on smart phones, tablets, and laptops that would enable students to answer multi-choice questions and short answer open ended questions, as well as allowing the students to ask questions. The lecturer has been able to use the application as a diagnostic tool to check whether or not students are understanding concepts. The use of open ended questions, and in some cases the multi-choice questions, has been useful in "provoking teaching moments" based on the interaction that takes place. This lecturer also commented on the importance of creating the right types of questions to maximise the effectiveness of the approach.

The application also allows the students to complete an "exit-ticket" at the end of the class where the student can be asked what the important things from the lecture were; if they have any questions they would like to ask; and if there is one thing that they would like to try out as a result of the lecture. The lecturer sees this as being important as it encourages the students to reflect on the content that has just been covered. Where students in the class do not have a device with them that the application can run on, they are encouraged to pair up to discuss their responses first, and the lecturer sees there is likely to be some value to the students in the discussion that they have prior to submitting.

In this case the application was used for formative assessment purposes only with no marks being awarded for participation or attendance.

The lecturer commented that the use of such an application has enabled the lecturers to move from a transmission mode to a transformative mode.

Based on the reasons for this lecturer adopting APODs for their lectures, they could be classified as an innovator using the model in Elgort (2005) and Rogers (1995).

5.1.7 Summary of Interview of Lecturer 7

The lecturer in this case was encouraged to become part of a trial using a web based application that was best designed to run on tablets and laptops (as opposed to smart phones) for a nursing course that typically had 100-120 students enrolled. The lecturer commented that their motivations "were to make the lectures more user friendly, keep up to date with new technology, and to make the lectures more interactive". The application allowed for multi-choice questions to be asked along with free response or open ended questions, and also allowed for the students to ask questions of the lecturer. The anonymity of student responses was also one of the selling points for the lecturer adopting the application. One question that worked particularly well was asking the students "What percentage of U.S. nurses are adopting a healthy life style?" and sharing the student responses before presenting the results of a study that included the answers. This sort of approach was useful in using the application to identify where the class is.

Unfortunately, the trial had a number of teething problems because not enough students had access to a device that the application worked well on, as the application did not function particularly well on smart phones. There were also occasions when the application did not work at all, with this being exasperated by what was perceived as lack of institutional support for the application. In spite of the frustrations experienced in the trial, this lecturer will be willing to try something like this again provided they had more time to get comfortable with the technology; had better institutional support for the application; and had more students with devices that could use the application during classes.

In this case the application was used for formative assessment purposes only with no marks being awarded for participation or attendance.

This suggests that this lecturer did not really fit in the category of being an innovator or early adopter (Elgort, 2005; Rogers, 1999) of ARS or APODs and fell more into the category of being an early majority adopter particularly with feeling the need for extra support due to some of the technology related issues that were experienced (Elgort, 2005; Rogers, 1999).

5.1.8 Summary of Interview of Lecturer 8

The lecturer that was interviewed in this case was teaching mechanics to a group of students studying at the equivalent of first year degree level. The lecturer used an application that would allow PowerPoint slides to be embedded in the application and would allow students to ask questions (anonymously) about the content. The application was similar to that used by Lecturer 7 in that it was really only designed for laptops and tablets due to the screen size, and not for the smaller screens on smart phones.

Tablets had been ordered for the students to use in lectures however, the tablets did not arrive in time, which resulted in many of the students using their own devices. The nature of the application, with the PowerPoint slides being embedded, made it difficult for the slides to be read on smart phones, which meant that participation was limited to students who had laptops and tablets with them.

The lecturer commented that the anonymous questions allowed the students "to ask questions that they would not normally ask", however the application delivered the questions to the lecturer via email in digest form, which meant that they could not be responded to in real time. The lecturer had been motivated to use the application because the lecturer likes trialing new technologies, and had liked the idea of students being able to ask anonymous questions so that it was possible to see what concepts the students were understanding and not understanding. One aspect relating to anonymity that was commented on by this lecturer was that "it would reduce the shyness barrier that prevents many students from asking questions in classes".

While this lecturer's experience was not successful due to the non-availability of the tablets and not being able to receive the student questions in time to provide timely feedback, the lecturer still believes that the concept is worth persisting with provided a greater percentage of students are able to use the application. Also, there is a need for the questions from the students to be received quickly so that the feedback that the lecturer receives about student progress is more timely.

In this case the application was used for formative assessment purposes only, with no marks being awarded for participation or attendance.

Based on the reasons for this lecturer adopting APODs for their lectures, they could be classified as an early adopter using the model in Elgort (2005) and Rogers (1995).

5.1.9 Summary of Interview of Lecturer 9

This lecturer had become involved in peer-instruction through using clickers during 2011, and had used clickers for the students to answer multiple choice questions, with students responding individually, and to generate class discussion about the concepts that were covered in the questions. The motivation to adopt clickers in this instance was due to a recommendation from a colleague, and the concept was seen as being somewhat intriguing. The lecturer required the students to purchase the clickers, as part of their usage was used for formal assessment purposes.

During 2013 the lecturer started using a web based application that the students were able to use at no cost, which was seen as being an advantage over the students being required to purchase clicker devices. The application also allowed students to send SMS text messages as an alternative way of interacting with the system, which would allow for students who did not have a web-enabled device to participate provided they had a mobile phone that could text. It is noted that the application being used was available commercially and that the lecturer had received a grant to cover the cost of using the application.

The advantage of using the application was seen as being that it was easier to share questions. Some of the critical success factors in using the system were commented on by the lecturer as being that “the students understood the system”, and that “a good indicator of the success was the noise level in the class when questions were being discussed”.

The application is used to monitor attendance and participation at lectures, with some course marks being allocated for the level of participation. This resulted in increased attendance at lectures compared with other courses in the same department. When asked about the issue of students not having a suitable device with them, it turned out this was not an issue, with the course being a third year computing and information technology course where all of the students had a device (and in some cases multiple devices) that they could use.

The questions used are typically based on readings that students are required to do prior to the lectures, although not all students do that reading. Another important factor in the success of the approach was commented on by the lecturer as being the need to “design questions in such a way that the incorrect answers to the questions create discussion points”. Related to this is the concept that if the questions are too easy, there is little room for discussion around them. The issue of losing time that could be spent covering content had been considered by the lecturer, however it was seen that the correct design of questions would result in the questions and the ensuing discussion being able to cover all of the content.

The lecturer also believes that the success of implementing an approach like this depends largely on the enthusiasm of the lecturer. Anonymity for the students (from each other) is also seen as being an important factor, with this going some way to explaining the increased levels of engagement in comparison to not using an application of this sort or clickers.

Based on the reasons for this lecturer adopting APODs for their lectures, they could be classified as an innovator using the model in Elgort (2005) and Rogers (1995).

5.1.10 Summary of Interview of Lecturer 10

The lecturer in this case was using an application that could be accessed using the browser on smart phones, tablets, or laptops etc., as well as having previously used clickers. This lecturer's motivation for using clickers included a desire to engage more with the students in the class, and the fact that they were something novel and a bit different. The clickers were used in an introductory social sciences course for second year students, and typically had 75-100 students enrolled. When clickers were being used the lecturer had a class set of clickers that were distributed to the students at the start of a lecture and collected again at the end. One of the main motivations for this lecturer was "to find out what the students are thinking".

Some of the main benefits experienced by the lecturer from the use of clickers for multi choice questions in lectures were being able to talk about the answers to questions, particularly when there had been a level of disagreement over the answers to the questions. The lecturer commented that "there appeared to be more participation from the students" and went on to comment that they were "uncertain as to whether they were more engaged with the material or not". There was no requirement for the students to participate.

There were few issues relating to the use of clickers from a technical perspective and the lecturer found that they were relatively easy to use. There were some occasions when there was a shortage of clickers and in these cases the students were asked to pair up and work on the questions together.

This lecturer then moved on to the use of an application that could be accessed using the browser on smart phones, tablets, or laptops. The lecturer commented that using applications such as these was "like using clickers on steroids", with part of the benefit being the ability to ask different types of questions. The particular application that was adopted allowed the students to perform a number of tasks including drawing lines on a graph, answering open ended questions with text answers, and matching patterns. The lecturer made most use of the open ended questions with text answers. The different types of questions that could be asked would require the students to think differently for them, which was seen as being an advantage over using clickers.

There was more preparation required to use this application in comparison with the clickers, and more thought needed to be given to the style of questions. These needed to be balanced with the time saving from not having to distribute the clickers to the students.

Where the students did not have a device to use the application on, the students paired up in a similar way to when there were not enough clickers to go around. For this particular class, anonymity did not appear to be a large issue with most students being prepared to include their name with the response, although there were some who did not include their names.

In some cases students made inappropriate responses to open ended questions. With one of the topics in the course being related to social norms, these situations have been able to be used to demonstrate how inappropriate behaviour can be dealt with in a way that blended in with the content of the course.

The lecturer has also used an application that allows students to post messages on what is in effect a web based white board. This application has allowed students to express a range of different opinions and perspectives about topics, with the lecturer commenting that the students appeared to enjoy this.

In this case the application was used for formative assessment purposes only with no marks being awarded for participation or attendance.

Based on the reasons for this lecturer adopting APODs for their lectures, they could be classified as an innovator using the model in Elgort (2005) and Rogers (1995).

5.1.11 Summary of Interview of Lecturer 11

This lecturer has been involved in teacher education over a number of years. As a result of mergers, the increased need for lecturers to produce research outputs, and funding pressures, the lecturer has seen class sizes for a number of courses increase from 30 to 60, and then again to having lectures of 150-170 students. The lecturer commented that the classes being taught had gone from being "all about interaction" to being "a sea of faces", and that they had ended up "lacking the personal touch" that had been present previously. A consequence of this had been that it had become difficult to engage the students in good teaching practice, which was of concern to the lecturer who was teaching about the adoption of good teaching practices. As a result of this the lecturer set out to find ways of modeling good teaching practice when teaching large groups.

The lecturer had become aware of the use of clickers, but had some concerns relating to the distribution of clickers to the students, whether through the students purchasing the clickers (increased cost to the students), or the lecturer distributing the clickers at the start of the lecture and collecting them afterwards (loss of lecture time). The lecturer experimented with a number of ways to increase student interaction in the classroom. One experiment was to have an activity every 12-15 minutes during the lecture, perhaps through peer discussion or the showing of a short video clip with questions to be discussed. This would then be followed by students answering questions by holding up different colored cards corresponding to the different possible answers to the questions. This appeared to have more students engaging and interacting than getting them to raise their hands

At the same time as this the lecturer had colleagues who were becoming increasingly frustrated with students sending and receiving mobile phone messages during lectures. For this particular lecturer, it raised the question of how the presence of the mobile phone messages could be turned around to increase student engagement and interaction.

The lecturer started using a freely available web based application that runs on smart phones, tablets, and laptops emerged that allowed for asking multi-choice questions and short answer questions, and also enabled students to ask the lecturer questions. This application has been used across two years and has worked well for quizzes throughout the courses. It was particularly useful in a session that was conducted to cover the requirements for an assignment, and enabled students to seek clarification (anonymously) about different aspects of the assignment. There was good feedback from the students relating to this particular session.

The lecturer typically got the students to pair up to discuss questions before submitting their answers, as it was felt that the discussion would help the students' learning. The lecturer commented that "the pairing up also addressed the issue of some of the students not having a device" One of the courses where the application was used was also being taught at a distance. The distance students were able to view the lecturer in real time, which enabled them to participate in ways that they would normally not have been able to which also resulted in the distance students feeling more part of the overall course.

Some of the key things to emerge for the lecturer were the importance of trying to improve outcomes for students, and the importance of giving students something to do in large lectures. The lecturer commented that adopting approaches like this would "keep the lecturer interested" in that the lecturer needed to pay more attention to considering how they would deliver content. The lecturer also commented that "the instant feedback is very useful".

Some issues that were identified in adopting this sort of approach include not overusing it, and issues of equity for students who do not have their own device and for distance students who are not able to view the live lecture due to time constraints.

Other points raised by the lecturer included the importance of the conversations between students that would enable:

- The construction of knowledge
- The negotiation of interactions
- Increasing the vocabulary of students
- Reinforcement of learning

The anonymity of responses was seen as being significant for receiving unbiased responses, although there was the risk of receiving inappropriate responses to open ended questions. This latter point is able to be dealt with by viewing the responses on a private screen and removing any inappropriate ones before displaying them to the entire class.

A course evaluation completed by the students included the following comments:

- "I really appreciated and was surprised by the variety of teaching styles, resources and instruments. Especially things like the online quiz during the lecture and hoe the teacher made use of this"
- "The feedback from the engagement tasks was encouraging and motivated me to do more each time"

In this case the application was used for formative assessment purposes only with no marks being awarded for participation or attendance.

Based on the reasons for this lecturer adopting APODs for their lectures, they could be classified as an innovator using the model in Elgort (2005) and Rogers (1995).

5.1.12 Summary of Interview of Lecturer 12

This lecturer was originally using a web-based application that allowed students to vote or indicate their answers to multi-choice questions using their mobile phones. The particular application that had been used is now no longer available, and the lecturer has started using an online survey tool for the same purposes. The application was used to provide feedback on student presentations where one student would be presenting and other students would use the application to give feedback. The application was also used to get student opinion on key issues to facilitate student discussion. Occasionally the lecturer used a small group discussion first, with group members providing feedback to the rest of the class using the application so that the range of opinions in the class could be seen prior to initiating an in-class discussion.

The benefits of using the application for multi-choice questions were commented on as being "an efficient way to collect the opinions and responses from the students", which enabled the student to measure their responses relative to the other students, and for the lecturers to "get a picture of where the class is as a whole" when it comes to their opinions and their level of understanding of the concepts being covered. When it came to the use of the application for students answering open ended questions, the benefits to the students were seen as being that it allows them to comment on ideas in a lecture that allows them to find a voice in what can be a passive learning experience, and also allows for concerns and misunderstandings to be addressed quickly. From the perspective of lecturers, when it came to the use of open ended questions the benefits were commented on as being that "it creates a much more interactive and dynamic environment", as well as allowing for formative feedback to be provided during lectures.

The concept of using the application to enable the students to ask questions of the lecturer was also touched on. From the perspective of the students this was seen as allowing the students to get clarification of points that they are not sure of and to provide some information to the lecturer so that formative feedback can be provided, with the opportunities to be able to provide formative feedback to the students also being seen as being the major benefit to the lecturer.

The lecturer was unsure about the benefit of anonymity, but did indicate that the approach may increase the willingness of individual student to come forward and ask questions face-to-face with the lecturer.

The advantages of applications on mobile devices over the traditional clickers was touched on, and it was felt that with smart phones being almost ubiquitous that there is little or no technical barrier and no additional cost as a consequence if a freely available application is being used. The applications are also seen as being more flexible than the clickers. The advantages of clickers over using applications on mobile devices was also touched on, including that there is unlikely to be complete 100% ownership of the mobile devices in most classes. This was seen as being able to be overcome by using discussion in small groups with one person from each group providing the response. There was also the possibility of there being some initial setup issues, however they can exist with clickers too.

The most important success factor identified by this lecturer was that of KISS ("keep it simple stupid!"). The lecturer commented on the importance of "not trying to do too much in a question and answer session" or in the lecture as a whole. It was seen as being better to have two or three interactions at the most during a one hour session, but to design them well so that they have real impact on learning as opposed to having lots of small interactions that do not amount to much, and therefore create confusion.

In this case the application was used for formative assessment purposes, only with no marks being awarded for participation or attendance.

Based on the reasons for this lecturer adopting APODs for their lectures, they could be classified as an innovator using the model in Elgort (2005) and Rogers (1995).

5.2 Analysis of Lecturer Interviews

The analysis of the interview of the lecturers is based on the themes relating to the sub-questions of the overarching research question that emerged from the literature review.

5.2.1 Benefits of Using APODs

There were fourteen (14) themes relating to the benefits of using APODs that emerged from the thematic analysis of the literature with these being reproduced in Table 30. These are related to the first sub-question of the overarching research question.

1	Attendance
2	Anonymity for Students
3	Student Participation
4	Student Engagement
5	Student Attention
6	Making Learning More Enjoyable
7	Student Interaction
8	Student Discussion
9	Contingent Teaching
10	Learning Performance
11	Quality of Learning
12	Feedback
13	Formative Assessment
14	Comparing Student Responses

Table 30 – Themes Relating to the Benefits of Using APODs from the Literature

The first theme in the benefits is increased attendance, and it was noted by one lecturer that there was increased attendance at lectures compared with other courses in the same department, although this may have been due to marks being awarded for participation (Lecturer 9).

The second theme of anonymity was seen as being significant by a number of the lecturers. The anonymous nature of the responses resulted in lectures perceiving that students were asking questions that they might not normally ask (Lecturer 1, Lecturer 8), with other lecturers commenting that this was the key to the success of what they had been doing (Lecturer 2, Lecturer 3, Lecturer 4). That students can attempt answers and not be disadvantaged because of their anonymity was seen as being an important factor (Lecturer 5), and can result in more unbiased responses (Lecturer 11). There were some cases it was not seen as being as important (Lecturer 12) including one where it was a second year course and the students already knew each other better (Lecturer 10).

The third theme of participation increasing due to the use of APODs was commented on (Lecturer 1, Lecturer 3) with lecturers identifying that students can become more responsive (Lecturer 4). A desire to increase participation in the class was also a motivating factor (Lecturer 5). One lecturer noted that the increased noise level in the class was a sign of increased participation, although this may be due to marks being awarded for participation (Lecturer 9), however this was also observed when there were no marks being allocated (Lecturer 10). It was also noted that the use of Internet based ARS in the form of applications on web-enabled devices enabled participation of distance students when lectures were broadcast in real time (Lecturer 11).

The fourth theme of engagement was noted in six the cases, with a desire to increase student engagement was commented on by a number of the interviewees as a motivating factor (Lecturer 1, Lecturer 2, Lecturer 3, Lecturer 10). Some lecturers commented on what they saw as being an increase in student engagement as a direct result of the use of ARS (Lecturer 5, Lecturer 10), with this particularly being the case when class sizes had increased significantly (Lecturer 11) and where students had access to the means of interaction (Lecturer 11).

The fifth theme was that of increasing the attention of students during lectures. The idea of maintaining student attention was commented on in the context of keeping students involved (Lecturer 2), and with more student attention being observed by one lecturer (Lecturer 3). The idea of “giving students something to do” was also commented on (Lecturer 11).

The sixth theme of making learning more enjoyable was commented on, with students appearing to enjoy the process of using ARS (Lecturer 2, Lecturer 10).

The seventh, interaction, was present in a number of the cases, with some lecturers using the application with the intention of creating or increasing interaction (Lecturer 1, Lecturer 2, Lecturer 4), and one lecturer observing that they had gone from small classes that were "all about interaction" to larger classes that were a "sea of faces", and so had the desire for interaction as a motivating factor (Lecturer 11).

The need to have an interactive classroom when teaching about the importance of interactive classrooms was the motivation for one lecturer (Lecturer 6), and that students would use mobile devices to interact with people outside the classroom created motivation for lecturers to find a way to get students to interact with lecturers using them inside the classroom (Lecturer 3, Lecturer 11).

In one instance that was not successful due to lack of devices, the lecturer is wanting to try again due to the importance of interaction (Lecturer 8).

The eighth theme, discussion between students, was noted in a number of cases where this was encouraged (Lecturer 1, Lecturer 2, Lecturer 6, Lecturer 11) partly due to not everyone having a device, but was seen as being beneficial for learning as well (Lecturer 1, Lecturer 2, Lecturer 6). A visually impaired student had commented to a lecturer that listening to the discussions aided their learning (Lecturer 1).

Discussing questions in small groups was the teaching approach that a lecturer wanted to adopt and needed ARS of some sort to enable this (Lecturer 3, Lecturer 12).

The importance of designing questions and activities that would enable discussion was also identified as being important (Lecturer 9, Lecturer 11).

The ninth theme, CT and QDI, emerged in a number of the cases. Both of these concepts are strongly connected to the idea of the "Flipped Classroom", which was partly being aimed for by one lecturer who used the student responses to determine what content to focus on (Lecturer 1).

The idea that questions and activities could be designed to create teaching points was seen as being important (Lecturer 3, Lecturer 6, Lecturer 9), and the extent of feedback given was dependent on the success of students in answering questions (Lecturer 5), with these approaches fitting in well with the idea of CT and QDI. In one case where students made inappropriate responses this created the opportunity to teach about social norms, which was part of the course (Lecturer 10). This is consistent with the concept of CT.

The 10th and 11th themes, learning performance and quality of learning, were referred to by a number of the lecturers, with students being perceived as having had their learning helped (Lecturer 2) and that pairing the students up appears to help learning (Lecturer 11), while the motivation was lecturers wanting to know where their students were so that they could improve their learning (Lecturer 12). The change in the nature of the lecture moving from transmission mode to transformative mode (Lecturer 10) was seen as improving the quality of the learning experience.

The 12th theme relating to the importance of the lecturer providing feedback to the students based on what their responses was highlighted by a number of lecturers (Lecturer 1, Lecturer 3, Lecturer 4, Lecturer 8, Lecturer 10, Lecturer 12), with the reasons including being able to correct any misconceptions that the students had about the content (Lecturer 5).

The 13th theme relating to the ARS for formative assessment was explicitly mentioned by some of the lecturers (Lecturer 1, Lecturer 12), with this being expressed as using the ARS as a diagnostic tool (Lecturer 6). While only three of the lecturers explicitly described using the ARS for formative feedback, eight of the remaining nine lecturers used the ARS in this mode, and only one (Lecturer 9) used the ARS for summative assessment and for awarding marks for participation.

The 14th and final theme was related to the usefulness of the students being able to see the responses from other students (Lecturer 3, Lecturer 4, Lecturer 9, Lecturer 10), with this including allowing the students to see how they are progressing relative to the rest of the class (Lecturer 5, Lecturer 7).

5.2.2 Challenges relating to the use of APODs

There were eleven (11) themes relating to the challenges of using APODs that emerged from the thematic analysis of the literature with these being reproduced in Table 31. These are related to the second sub-question of the overarching research question.

1	Students not Having or Bringing Device
2	Technology not Functioning Correctly
3	Responding to Student Feedback
4	Coverage of Course Content
5	Development of Effective Questions
6	New Method of Teaching for Students
7	Discussion of Topics Causing Confusion
8	Too Much Effort Required by Students
9	Summative Assessment/Identifying Students
10	Negative Feedback
11	Students with Disabilities

Table 31 – Themes Relating to the Challenges of Using APODs from the Literature

The first theme relating to students not having or not bringing a device for use with the ARS was commented on in many of the cases.

One common approach has been to get the students to discuss their responses in pairs or in small groups, and have only one response per pair/group (Lecturer 1, Lecturer 2, Lecturer 3, Lecturer 10, Lecturer 11), which allows for students to not have a device and fully participate, as well as being a sound pedagogical approach that addresses equity concerns (Lecturer 11).

Some of the lecturers who had used clickers commented that having class sets of clickers enabled everyone to have a device (Lecturer 2, Lecturer 12), although this can create issues with distribution and collection of the clickers (Lecturer 11), while another required the students to purchase their own clickers (Lecturer 10). This issue with clickers had been addressed in one case where the department had purchased the set of clickers and used their library's book lending system to lend them to students for the duration of the course (Lecturer 5). When there were sometimes not enough clickers for everyone in the class (sometimes because of flat batteries), students were asked to work in pairs (Lecturer 10). It was noted by one lecturer that there can be setup issues when using clickers or applications (Lecturer 12).

In the one case reviewed where the students were required to have a device with them that an application would run on because it was being used for attendance monitoring and summative assessment, this was not an issue due to the class being a third year computer science course where all of the students owned at least one device and would take them to lectures (Lecturer 9).

The concept of an application allowing students to send SMS text messages as opposed to using an application on their device was seen as dealing with issues surrounding poor WiFi in some institutions. The issue of the technology not functioning correctly was commented on by some of the lecturers as being an issue (Lecturer 5, Lecturer 7, Lecturer 10), with two of these relating to clickers and not APODs (Lecturer 5, Lecturer 10).

The second theme relating to the technology not functioning correctly was present in two of the cases where the application that was adopted worked best on tablets and laptops (but not smart phones), as larger screens were needed because PowerPoint slides were embedded in the application. This resulted in students with laptops and tablets being able to participate, but not those who only had a smart phone with them (Lecturer 7, Lecturer 8).

The third and fourth themes relating to responding to student feedback and the coverage of course content were not seen as being significant challenges by the lecturers, with some of the lecturers indicating that they would limit their use of APODs to a few questions so as to not take up too much time. This could be due to the lecturers participating in this part of the study being early and/or passionate adopters of the approach.

The fifth theme of the development of effective questions was commented on by a number of the lecturers with particular mention of it being time consuming to develop good questions (Lecturer 1, Lecturer 3, Lecturer 6, Lecturer 9, Lecturer 10). Where multiple choice questions are used it is important that the incorrect answers correspond to common errors so as to create teaching points (Lecturer 3, Lecturer 5, and Lecturer 9). Where questions are too easy there is little room for discussion (Lecturer 9).

One lecturer gave an example of inadvertently creating an ambiguous multiple choice question that could be interpreted in three ways, with each interpretation corresponding to one of the possible answers (Lecturer 3). This resulted in some confusion amongst the students until it was realised what had happened, which then created a very good teaching moment. Where multiple choice questions are used there may still be the need for open ended questions to promote deeper thinking (Lecturer 5). When using applications, the time to develop good questions for use with the applications can be balanced with the time to distribute and collect clickers (Lecturer 10).

The challenges that correspond to themes 6-10 were not part of the focus of the lecturer interviews.

The 11th theme of students with disabilities was discussed with one lecturer (Lecturer 1) who was concerned about the participation of a visually impaired student. In a discussion with this student it emerged that this student found significant value in being able to listen in to the discussions of the groups of students around them, which is something that would not have been possible if questions were being discussed in small groups prior to responses being submitted using the APOD.

A new 12th theme emerged relating to the potential for overusing ARS or APODS emerged from some of the lecturer interviews (Lecturer 3, Lecturer 11, Lecturer 12) with some of this relating to reducing the time to cover course content, with some of this relating to the importance of using ARS or APODS effectively.

5.2.3 Pedagogical Issues

There were six (6) themes relating to the challenges of using APODs that emerged from the thematic analysis of the literature with these being reproduced in Table 32. These are related to the third sub-question of the overarching research question.

1	Good Teaching Strategies
2	Specifically Identified Pedagogical Issues
3	Large Class Issues
4	Constructivism
5	Instructional Design
6	Learning Styles and Cultures
7	Optional or Mandatory Use

Table 32 – Themes relating to Pedagogical Issues from the Literature

The first theme of adopting good teaching strategies was explicitly noted by some of the lecturers (Lecturer 1, Lecturer 6, Lecturer 11), although the motivation for nearly all of those interviewed to increase or enhance student engagement was in itself a good teaching strategy. This was particularly important for the two lecturers who were involved in teacher education, as they felt it was important to model good teaching practice when conducting lectures to students training to be teachers (Lecturer 6, Lecturer 11).

There was little reference to the second theme that was identified in the literature, where issues had been specifically identified as pedagogical issues. However, pedagogical issues are addressed in many of the cases that relate to other themes.

The third theme specifically relating to large classes was noted by a number of the lecturers, with some explicitly stating the need to increase engagement due to the large classes (Lecturer 1, Lecturer 2, Lecturer 3, Lecturer 6, Lecturer 7, Lecturer 11). The two lecturers involved in teacher education had witnessed significant growth in class size because of mergers (Lecturer 6, Lecturer 11) and this had a direct bearing on their desire to adopt ARS of some sort.

The fourth theme of social constructivism was alluded to by many of the lecturers, with a number noting the importance of students discussing questions with each other prior to submitting responses (Lecturer 1, Lecturer 2, Lecturer 3, Lecturer 9, Lecturer 11, Lecturer 12), and one specifically highlighting the importance of discussions between students enabling the construction of knowledge (Lecturer 11).

There was little reference in the interviews to the fifth and sixth identified in the literature relating to the importance of instructional design and the consideration of different learning styles and cultures. These are however focussed on elsewhere in the issues relating to effective questions in the case of instructional design, and in later parts of the research in the case of different learning styles and cultures.

The issue of the seventh theme of essentially making participation mandatory by awarding marks for the participation had the impact of increasing attendance compared with similar courses in the same department (Lecturer 9).

5.2.4 Cost and Simplicity of Devices

There were four (4) themes relating to the cost and simplicity of devices that emerged from the thematic analysis of the literature with these being reproduced in Table 33. These are related to the fourth sub-question of the overarching research question.

1	Cost for Students
2	Cost for Lecturers and their Institutions
3	Ease of Use for Students
4	Ease of Use for Lecturers

Table 33 – Themes relating to Cost and Simplicity of Devices from the Literature

The first theme of cost to students is connected to the issue of whether students own devices like smart phones, tablets, and laptops, and was commented on by a number of the lecturers (Lecturer 1), with applications being free to use by students was also commented on (Lecturer 2). A key aspect to this was that if students are using devices that they already own the cost is low (Lecturer 3), and this extends to where a freely available application was being used on devices that the students already own (Lecturer 12).

Equity concerns are seen as being an issue if not all students have a device to participate with (Lecturer 11). Students pairing up to answer questions is a way of dealing with the cost issue for students who can not afford the devices (Lecturer 6). One lecturer had moved from using clickers that students were required to purchase to the use of applications on mobile devices that the students already owned, with the lower cost to the student being seen as an advantage of this (Lecturer 9). One situation saw students borrowing clickers at no cost from the university library as a way to address the issue of cost to students (Lecturer 5).

The second theme of cost to lecturers and their institutions was commented on by some of the lecturers. Some of the comments related to the cost to an institution (Lecturer 2) with the cost of clickers also being noted in some of the cases (Lecturer 2, Lecturer 9). Another comment related to the cost to the lecturer where the cost of a commercially available application was addressed through receiving a grant from their university (Lecturer 9).

The third theme of ease of use for students is seen as being important, with one lecturer saying the devices being used had almost become like “prosthetics” (Lecturer 4). The concept of ease was commented on by one lecturer who wanted to make lectures more user friendly through using an application (Lecturer 7), and that most students are familiar and understand the concept of applications on mobile devices (Lecturer 9). Clickers were seen as being easy to use from the student perspective, with this being a key ingredient (Lecturer 10), and the importance of keeping the process simple (KISS) was identified as being a key ingredient, and relates to the ease of use for students (Lecturer 12).

The fourth theme of ease of use for lecturers did not emerge significantly from the interviews of lecturers as many of the lecturers interviewed were early adopters and were more tolerant of usability issues as a result. Where the issue did emerge, the provision of better institutional support would address issues relating to ease of use (Lecturer 7) and the importance of applications being able to run on smart phones and not just laptops and tablets was noted by two lecturers (Lecturer 7, Lecturer 8).

Clickers were seen as being easy to use from a lecturer perspective (Lecturer 10), with applications that allow students to send SMS text messages addressing some ease of use issues, the difficulty of poor WiFi and students owning older mobile phones.

5.3 Summary and Implications for Later Phases of Research

There were no conflicting themes that emerged from the analysis of the lecturer interviews, although there was little attention paid to some of the themes, which in part gives rise to the need to interview learning advisers as has been discussed elsewhere.

The revised set of the themes resulting from the analysis of the interviews of lecturers are shown in Table 34, and within each sub-question the themes are sorted into descending order based on how many lecturers referred to the theme. (Note that some of the themes were identified by more than one lecturer and as such it is not appropriate to show a total at the foot of this table).

Sub-Question of Research Question	Themes Identified	#
SQ1. What are the benefits of using applications on personally owned devices to engage with students in lectures (from a range of different perspectives and across a range of different contexts)?	• Anonymity for Students	9
	• Student Discussion	7
	• Feedback	7
	• Student Engagement	6
	• Student Interaction	6
	• Contingent Teaching & Question Driven Instruction	6
	• Student Participation	5
	• Learning Performance	4
	• Quality of Learning	4
	• Formative Assessment	4
	• Comparing Student Responses	4
	• Student Attention	3
	• Making Learning More Enjoyable	2
	• Attendance	1
SQ2. What are the challenges involved in using applications on personally owned devices to engage with students in lectures (from a range of different perspectives and across a range of different contexts) and how can these challenges be addressed?	• Students not Having or Bringing Device	8
	• Development of Effective Questions	6
	• Technology not Functioning Correctly	4
	• Potential for Overuse	3
	• Responding to Student Feedback	Limited
	• Coverage of Course Content	Limited
	• New Method of Teaching for Students	-
	• Discussion of Topics Causing Confusion	-
	• Too Much Effort Required by Students	-
	• Summative Assessment/Identifying Students	-
	• Negative Feedback	-
	• Students with Disabilities	-
SQ3. What are the pedagogical implications involved in using applications on personally owned devices to engage with students in lectures?	• Large Class Issues	6
	• Constructivism	6
	• Good Teaching Strategies	3
	• Instructional Design	-
	• Learning Styles and Cultures	-
	• Specifically Identified Pedagogical Issues	-
	• Optional or Mandatory Use	-
SQ4. How do issues relating to the cost and simplicity of devices impact on the use of applications on personally owned devices to engage with students in lectures and how can these issues be addressed?	• Cost for Students	7
	• Ease of Use for Students	5
	• Ease of Use for Lecturers	3
	• Cost for Lecturers and their Institutions	2

Table 34 – Themes Emerging after Lecturer Interviews

A key issue to emerge was the importance of the motivation and enthusiasm of the lecturers, with the enthusiasm aspect of this being consistent with the literature (Mankin et al., 2004; Sternberger, 2012; Welch, 2013). Some of this motivation and enthusiasm is likely to be due to the nature of many of the lecturers who could be seen as being innovators or early-adopters of ARS/APODs technologies as per the seminal model for diffusion of innovation developed by Rogers (1995) and how the distribution of adoption over time can be represented by a bell curve as shown in Figure 10.

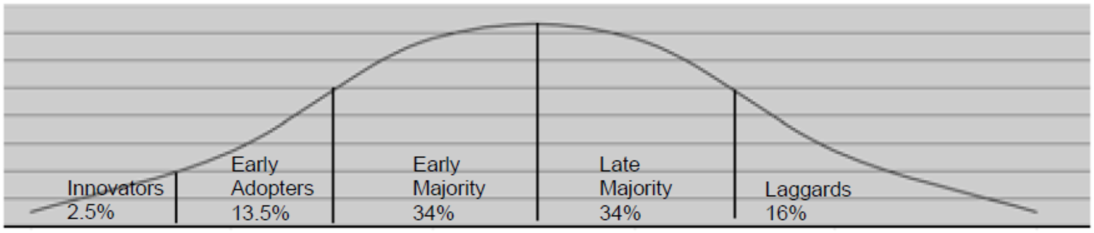

Figure 10 – Categories of Adopters of Innovation (Rogers, 1995)

The categories of adopters of innovation in the model are (a) innovators; (b) early adopters; (c) early majority; (d) late majority; and (e) laggards. Elgort (2005) looked at how e-learning is adopted in a higher education context and how this is influenced by a number of factor and focused mainly on the decisions that were made by teaching practitioners and how this impacted on the adoption of e-learning. Some of the Elgort (2005) study was based on the model developed in Rogers (1995) which is shown in Figure 10.

Elgort (2005) explains how the innovators are usually intrinsically motivated to use new technologies and tolerate ambiguity and setbacks well, with early adopters being opinion leaders or role models and have extrinsic motivation to adopt innovations. Elgort (2005) also cited Moore and McKenna (1999) who claimed that the early adopters were "… prepared to pay the price for being first and gaining competitive advantage while putting up with bugs and glitches…", whereas the early majority want innovations to "…work properly and integrate properly with their existing technology base…".

Elgort (2005) makes further reference to Rogers (1995) about the important factors influencing the adoption of innovations is the issue of whether the adoption meets a perceived need. Elgort (2005) points out that academic developers (or in the case of this research project, learning advisers) can build "…awareness in teachers about a wide range of strengths, weaknesses, potentials and strategies of eLearning…" and that this should be a focus for those working in the area of academic development.

The motivation of lecturers (Mankin et al., 2004; Sternberger, 2012; Welch, 2013) being a key factor is closely related to the concept of innovation and early adoption (Elgort, 2005; Rogers, 1995). Motivation was a driving factor in eleven (11) of the twelve (12) lecturers, with the twelfth lecturer (Lecturer 7) not fitting the definition of being an innovator or early adopter and being the only lecturer interviewed who appeared to need a degree of support with the technology. A consequence of this was that the decision was made to interview learning advisers as they would be more likely to encounter lecturers who, like Lecturer 7, were not innovators and early adopters, and therefore be more likely to be held up or have challenges that were not as easy to deal with. This would result in a more balanced view of the challenges involved in adopting APODs than was gained from interviewing a drop of predominantly innovators and early adopters. An analysis of where the twelve (12) lecturers fit based on Rogers' categories of adopters of innovation is shown in Figure 11.

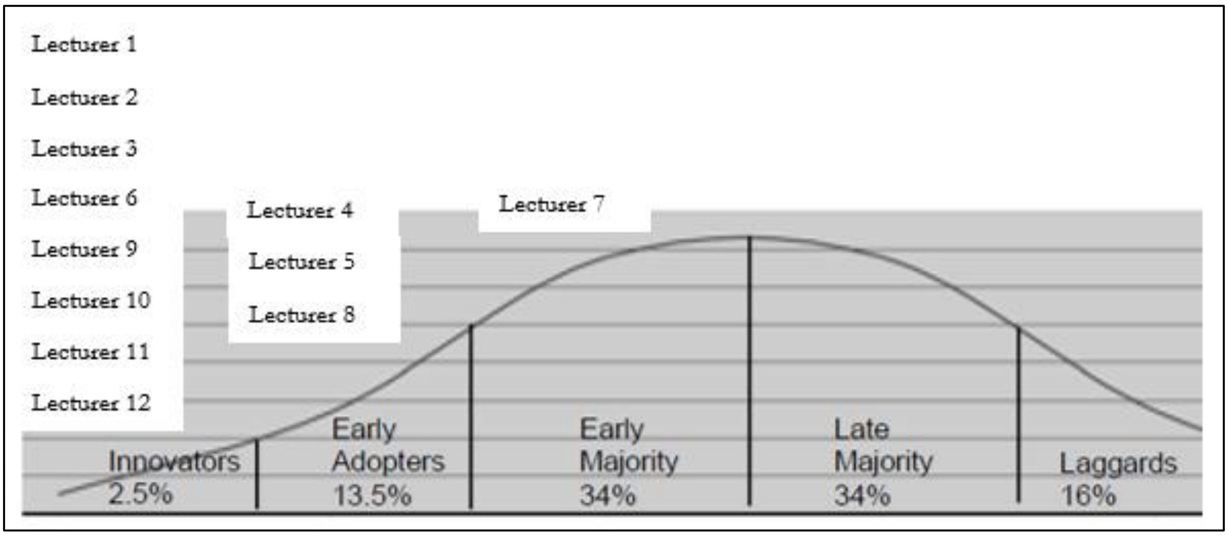

Figure 11 – Analysis of Lecturers Interviewed Based Rogers (1995)

Given this analysis of the lecturers interviewed based on Roger's categories of adopters of innovation a need to find a more objective view of the challenges faced by lecturers, particularly those in the early majority and late majority categories.

It was decided to interview learning advisers as proxies for lecturers who do not fit the innovators or early adopter categories in the Rogers model. This was based on learning advisers being the people that would be providing support to lecturers such as Lecturer 7 who had highlighted the need for additional support, and as a result would have some insight into the challenges that are potentially faced by these lecturers.

5.4 Interviews of Learning Advisers

This section introduces the overall aims of the learning adviser interviews, followed by a summary of each of the interviews. This is then followed by thematic analysis based on the themes that emerged from the analysis of lecturer interviews. Implications for later stages of the research are outlined at the end of the section.

The interviews were semi-structured and covered the issues or questions that are shown in Table 35 (which has been reproduced from the methodology chapter).

What do you see as being the motivations for lecturers adopting clickers and/or apps on mobile devices in lectures?
How have you seen these technologies being used?
What do you see as being the benefits to students?
What do you see as being the benefits to lecturers?
Key success factors in using the technologies well
Potential issues that arise from using the product

Table 35 – Issues and Questions Covered in Interviews of Learning Advisers

With some of the learning advisers there was discussion about issues involving providing support to lecturers who were using clickers although this is not a significant aspect of this research,

5.4.1 Summary of Interview of Adviser A

Adviser A had been part of a team working on a research project that looked at the use of applications that run on mobile web-enabled devices for performing quick polling in large finance lectures at undergraduate and post graduate levels. The main motivations seen by this adviser for using applications on mobile web-enabled devices are to enable students to have increased engagement with the subject matter; increased engagement in classes (particularly in large lectures); increased the levels of preparation prior to students coming to classes; and also for the promotion of active learning.

When it comes to the benefits of using applications for multi-choice questions the benefits from the perspective of the lecturers are seen as being that they:

- Are a quick way of testing content knowledge during lectures,
- Increase interest with the subject matter,
- Increase participation levels,
- Allow for results to be automatically summarised and available for further research and analysis, and
- Allow for knowledge gaps to be quickly identified and addressed straight away.

When it comes to the benefits of using applications for multi-choice questions the benefits from the perspective of the students are seen as being that:

- Students are able to compare their responses to their peers' responses,
- There is increased engagement with the subject matter due to competitive fun atmosphere of using the application,
- Students are able to self-monitor their progress,
- Students can see immediate feedback to their responses in a form of graphs generated by the application, and
- It is great preparation for the multiple choice mid-semester test.

Regarding the benefits of using applications for students to ask questions of the lecturer, the main benefit to the lecturer was commented by this adviser that "it is a good indicator of whether the students are engaged in the class and whether they understand the content that is being covered".

Regarding the benefits of using applications for students to ask questions of the lecturer, the main benefits to the students are seen as being increased engagement with the lecturer and that questions can be asked as they arise. Adviser A sees that anonymity of responses afforded by an ARS can be beneficial for shy students who would not engage in class otherwise.

The advantages of using applications on mobile devices instead of using clickers were seen by Adviser A as being:

- The ubiquitous nature of mobile devices meaning that students generally have at least one mobile device on hand during lectures,
- The cost of using available BYOD technology is significantly lower compared to using purposely designed clickers,
- The application that was used for the study was free and easily accessible on various platforms, including iOS and Android, and
- Responses are recorded and are available for analysis and research.

The disadvantages of using applications on mobile devices instead of using clickers were seen by Adviser A as being:

- Not all students have access to the application at all times due to a number of factors: bad internet connection, unsupported device, not having the device with them in class, etc., and
- An offline option of pen and paper to write down the answers meant that students who did not have access to the particular application could still participate.

A number of key success factors were identified for using applications on mobile devices in lectures, with these including:

- Lecturer preparation, as questions need to be prepared in advance of lectures and incorporated into the lecture material at strategic instances. These instances are determined on a case-by-case basis, depending on which subject is taught, whether it is undergraduate, or postgraduate, and various other pedagogical considerations,
- Student preparation, as the students in the study were required to read material in advance of the lectures taking place,
- The lecturer allowing the time needed during the lectures to receive the responses and provide immediate feedback to students, and
- The lecturer following up the analysis of responses from students with a view to amend the material based on knowledge gaps and engagement / participation levels during lectures.

5.4.2 Summary of Interview of Adviser B

Adviser B is in the role of an eLearning assistant and a significant part of the role involves providing training to lecturers who wish to adopt new technologies to enhance student learning. One of the main motivations for this adviser personally in encouraging lecturers to adopt applications that run on mobile web-enabled devices is that many of the current generation of students already own devices that the applications can run on and that it makes some sense to utilise what the students already have to enhance their experience.

This advisor is aware of lecturers who insist on students turning off their mobile devices (phones, tablets, laptops) and that as a consequence some student stop attending lectures, which has the effect of reducing the students' engagement in the course. However, this adviser believes that the appropriate use of technologies will serve to enhance student engagement. As a consequence of this Adviser B believes that it is better to "adapt to the life of the new generation, rather than fight it".

Adviser B has supported a number of lecturers in their moves to adopt an application that runs on mobile web-enabled devices, and sees the use of activities like the use of short multiplie choice quizzes as being something that will enhance the teaching and learning process, in particular students being able to see the correct answers for questions that they did not get correct, and getting feedback from the lecturer about why the correct answer is in fact the correct answer.

This particular application also allows for open ended questions to be asked by the lecturer, and Adviser B sees this as being a good way to check things like whether students are able to format references correctly and allows for common errors to be identified. In addition to this the adviser commented that "being able to ask questions that required more in-depth thinking is beneficial to the teaching and learning process" and it "produces more variation in responses giving the lecturer more idea as to what the students are thinking and understanding".

The adviser saw the benefits to students as being that it gives them a much wider perspective about the content that is being covered, particularly when used for open ended questions. The main benefit to lecturers is seen that it enables them to see what the students are thinking about and potentially develop new topic areas for discussion. The key factors for success are seen as the design of questions, and when they are multiple choice questions, the design of the possible answers, so that the range of responses from the students can prompt discussion and clarification of content.

The lecturers that Adviser B has worked with have not used the application for summative assessment purposes. When it comes to the issue of how to respond to the situation when not all students have access to a device, lecturers are encouraged to use the applications in conjunction with students working in groups so that students without the correct type of device are not disadvantaged relative to students who do have the correct type of device. A significant issue for the lecturers has been the increased preparation needed to design effective questions to be used when using the application.

At the institution where Adviser B is employed there have been some issues with good wireless network connectivity. This has created difficulties for lecturers wishing to adopt this form of technology in some of the lecture theatres.

When it comes to the issue of anonymity for the students, this adviser sees it being related to a combination of class size and the level of the students' studies. Two examples cited were a first year degree level course with 60 students where anonymity appeared to be a significant factor, but much less so in a second year degree level course with 30 students where the students appeared to be happy to record their names with the responses.

5.4.3 Summary of Interview of Adviser C

Adviser C is in the role of an eLearning adviser, and as part of the role has spent some time supporting lecturers in the use of ARS in the form of clickers and applications running on mobile web-enabled devices. This adviser sees the motivations for the use of ARS as being increasing engagement for both students and lecturers, with their use as a diagnostic tool, particularly for summative assessment, being quite valuable.

One of the main issues seen by Adviser C when it comes to the use of clickers is the battery life, particularly when the institution has class sets, whereas when the students have their own clicker device they end up having the responsibility for the batteries being charged. When it comes to the use of applications on mobile web-enabled devices, an issue that this adviser sees for some lecturers is that they do not want to have students using their phones for other purposes during lectures. In addition to this, the issue of whether all students have a device that the application runs on needs to be considered.

When it comes to the benefits to lecturers for the use of ARS, Adviser C identifies the increasing of engagement in the classroom this adviser commented that "lecturers are able to find out what the students are understanding and needing". When it comes to the benefits for students, the main benefits identified were that the students are in active mode as opposed to being in static mode; that they appear to feel more included in what is taking place in the classroom; and students appear to be having their needs met.

Adviser C suspects that anonymity is a factor that results in students being more willing to engage and interact when an ARS is being used. This adviser also sees feedback and communication as being the key factors to the successful adoption of both clickers and applications running on mobile web-enabled devices.

5.4.4 Summary of Interview of Adviser D

Adviser D is in the role of a learning adviser with roles that include assisting lecturers who wish to incorporate new technologies in to their teaching and has also been working on a project to identify an application that runs on smart phones, tablets, and laptops that their institution can adopt as a standard platform. The motivations that this adviser sees for the adoption of ARS (whether they be clickers or applications running on mobile devices) is twofold in that it provides a check on learning during the lecture for students and allows lecturers to respond to feedback immediately to potentially correct misconceptions that the students may have.

A less tangible benefit for lecturers was commented on by Adviser D as being that "the students can see that the lecturer has a plan and wants to know if the students are understanding and learning", with the adviser going on to say that this can give a positive impression to the students. One of the benefits for students is seen as being that in a traditional lecture, students who do not understand are not normally willing to say that they do not understand, but with the appropriate use of an ARS they can indicate this, with the anonymous nature of their responses being a factor that helps this.

Where an application running on a mobile web-enabled device is being used for students to answer open ended questions this can be seen as slowing down the lecture if the lecturer is waiting for all of the students to respond. In contrast to this, multiple choice questions are a lot quicker and would not hold up the lecture as much as it does not take students as long to respond to questions

Adviser D had been involved in supporting lecturers who were using clickers as their ARS. The institution had purchased class sets of clickers and lecturing staff were able to borrow them for lectures. A number of challenges emerged from this process, including the replacing of batteries in the hand held devices; the distribution of the hand held devices at the start of the lecture and collecting them at the end of the lecture; and lecturers forgetting to return the 'dongle' that had been plugged into their laptop.

When it comes to the use of applications on mobile web-enabled devices, Adviser D still sees most people in a trial mode with them. One of the issues identified is the time that it can take students to login to the application if logging in is required.

In the project that has been identifying a possible system based on applications running on mobile web-enabled devices, Adviser D has been using a number of criteria for assessing the possibilities including:

- Cost, both to the students and the institution,
- The features of the application, particularly including being able to ask questions 'on the fly',
- Whether it is possible to send SMS text messages as one of the ways of interacting with the system (so that students who have an older mobile phone only can still participate, although this issue is reducing in significance as the ownership of smartphones is now at a very high level), and
- Ease of use, both for the students and the lecturers.

One of the critical success factors seen by Adviser D in the institution adopting whichever system is chosen is the uptake of the system by the existing clicker users so that less time is needed to support them and maintain the equipment. Another significant issue identified for institutions adopting applications on mobile web-enabled devices for their ARS is the need for a robust wireless infrastructure.

5.4.5 Summary of Interview of Adviser E

Adviser E is in the role of a learning adviser with much of their role involving the support of lecturers wishing to adopt new technologies into their teaching, with a significant amount of this relating to supporting lecturers in the adoption and use of ARS in the form of clickers. The main motivations that this adviser has seen for lecturers adopting clickers has been to increase the interaction and engagement of students during lectures, particularly in large first year classes. The lecturers that the adviser worked with had found that the feedback from students was good, with lecturers saying that many of their students had commented that they wished all of the classes had taken a similar approach. Another motivation identified was a willingness to adopt new technologies in teaching.

Benefits to lecturers were commented on by Adviser E as being that "it was possible to see how students were getting on with understanding concepts that were being covered during the lecture", and for the students the main benefit identified was that they were more engaged with their learning. For both students and lecturers, the adoption of the clickers enabled feedback to happen in both directions which was seen as being another important benefit.

A number of issues were identified in the use of clickers as the ARS with these including that:

- The devices are now seen as being old technology and as such may not be compatible with newer technologies,
- The need to distribute the clicker devices at the start of each lecture and collect them back at the end of the lecture, with this being a consequence of the institution having purchased class sets of clickers and not requiring students to purchase their own, and

- The battery life of the clickers not being particularly long and devices being distributed to students in lectures where the batteries are flat.

When it comes to the move from clicker devices to applications running on devices such as smart phones, tablets, and laptops, Adviser E has identified a number of issues for some lecturers that may see them being resistant to the change. These have included lecturers not wanting to have students using their smart phones (and other devices) during lectures as they can create a distraction. Also identified was that clickers were perceived by some lecturers as being easier to use than the applications.

Other issues identified with moving from clickers to applications on mobile devices was the BYOD ('bring your own device') issue where not all students may have a device that the applications can run on. Approaches identified to dealing with this could include students being able to borrow devices and perhaps having some spare devices that the lecturer could distribute, with another approach to dealing with this being to get the students to work in groups. An additional approach was to find applications that would prevent multi-tasking.

When it comes to the use of ARS in general, Adviser E felt that the anonymity of responses was an important factor in students participating.

5.4.6 Summary of Interview of Adviser F

Adviser F is in the role of a learning adviser with much of the role involving the support of lecturers wishing to adopt new technologies into their teaching. A significant amount of this had previously related to supporting lecturers in the adoption and use of ARS in the form of clickers.

Some of the motivations that this adviser had seen for the adoption of clickers by lecturers included:

- Being able to change the tempo of a class by speeding it up or slowing it down based on the feedback the lecturer receives from students about the understanding of the content being covered,
- Getting students to consider more carefully the content that is being covered by using the ARS to ask questions about specific content, and
- Being able to assess where students are at with their understanding of content either through formative assessment or summative assessment.

The benefits to lecturers from using clickers that Adviser F has identified have included:

- Testing the understanding of key points,
- Encouraging discussion of the content amongst the students, and
- Breaking the traditional lecture model and getting students involved in what is happening in the lecture.

The benefits to students from using clickers that Adviser F has identified include:

- Having the opportunity to participate when they would not feel able to otherwise (particularly in large first year courses),
- Keeping them interested, provided they are used well, and
- The anonymous nature of the responses from each other, and from the lecturer if the clickers are not being used for summative assessment.

A disadvantage to using clickers that was identified is that students may get bored if they are over used. This adviser sees the applications as having an advantage over clickers in that they have a lot more functionality, in particular the ability to answer open ended questions. One of the keys to the successful adoption of clickers is seen by the adviser as being able to create and use questions that have an identifiable purpose.

When it comes to the concept of using applications on mobile web-enabled devices, Adviser F sees this as being the new way, particularly as there appears to be a much higher saturation or ownership of the devices that the applications run on. There is however the issue of lecturers requiring a much higher level of technical confidence to use them.

Issues identified relating to the adoption of applications on web-enabled devices were mainly related to the issue of dealing with students who do not own a device, or who do not have the device with them. Strategies identified by Adviser F to deal with this included use of group discussion, with only one member from each group submitting a response, and to not use it for summative assessment.

A generic issue that was identified relating to the use of any form of ARS is that some lecturers see that the activities based around them take up too much of the lecture time, thereby reducing the amount of content that can be covered during the lecture.

5.5 Analysis of Learning Adviser Interviews

The analysis of the interviews of the learning advisers is based on the themes that emerged from the lecturer interviews, with one additional theme being added to the technology related challenges with that relating to on campus WiFi issues.

5.5.1 Benefits of Using APODs

The benefits of using APODs that emerged from the lecturer interviews are reproduced in Table 36.

Attendance
Anonymity for Students
Student Participation
Student Engagement
Student Attention
Making Learning More Enjoyable
Student Interaction
Student Discussion
Contingent Teaching and Question Driven Instruction
Learning Performance
Quality of Learning
Feedback
Formative Assessment
Comparing Student Responses

Table 36 – Benefits of Using APODs from Lecturer Interviews

The use of applications on mobile devices to increase student engagement was identified in a number of the interviews (Adviser A, Adviser C, Adviser E), with increased student participation (Adviser A) and increasing student attention through keeping students interested (Adviser F) also being identified as potential classroom environment benefits.

Where some lecturers have insisted on students turning off their mobile devices during lectures this has resulted in decreased attendance (an observation that had been reported to one of the advisers by some lecturers), whereas using applications on mobile devices as part of the lecture would serve to reverse this and have the potential to increase student engagement (Adviser B).

The importance of anonymity, particularly as it relates to large lectures, was identified in three (3) of the interviews (Adviser B, Adviser D, Adviser E), being particularly useful for students who would not otherwise engage (Adviser A, Adviser C, Adviser F), with one commenting that the anonymity from the lecturer was only possible if the applications were not being used for summative assessment (Adviser F).

The increase in student interaction was identified in two of the interviews (Adviser C, Adviser E), with a third extending this to include that this involved a breaking of the traditional lecture model (Adviser F). A learning benefit not completely connected to the literature was that through the use of approaches such as this that the students can see that the lecturers have a plan and care about how well the students are learning (Adviser D). Depending on how the application is being used in class, students can end up preparing more before they come to class and as a consequence their learning performance is enhanced (Adviser B).

The concept that the use of applications may result in generating new areas for discussion was identified (Adviser B), with this being similar to the concepts of CT and QDI, as is the concept of lecturers using student responses to adjust the tempo of the class (Adviser F). The idea that students seeing that a lecturer has a plan to help student learning was also identified as being something that could impact on student learning (Adviser D).

Pedagogical issues that were specifically commented on in the interviews mainly related to the use of models similar to QDI and CT. These included allowing knowledge gaps to be identified and addressed (Adviser A), and identifying common errors in referencing and addressing them (Adviser B). Issues related to the use of applications in large classes were also specifically addressed, particularly as they related to the desire for anonymity as class sizes get larger (Adviser B, Adviser E).

That students are able to receive close to immediate feedback on their responses was highlighted in a number of the interviews (Adviser A, Adviser B, Adviser C, Adviser D, Adviser E), with the importance of students being able to see the correct answers for questions that they got wrong also being identified (Adviser B) along with the usefulness of students being able to see each others' responses (Adviser A).

The concept that the applications can be used as a check on students' learning was identified (Adviser D, Adviser E, Adviser F), with this being likened to being a diagnostic tool (Adviser C). These concepts of checking on learning and having a diagnostic tool are consistent with the idea of using the applications for formative assessment.

5.5.2 Challenges of Using APODs

The challenges of using APODs that emerged from the interviews of lecturers are shown in Table 37.

1	Students not Having or Bringing Device
2	Technology not Functioning Correctly
3	Responding to Student Feedback
4	Coverage of Course Content
5	Development of Effective Questions
6	New Method of Teaching for Students
7	Discussion of Topics Causing Confusion
8	Too Much Effort Required by Students
9	Summative Assessment/Identifying Students
10	Negative Feedback
11	Students with Disabilities
12	WiFi Issues on Campus

Table 37 – Themes Relating to the Challenges of Using APODs from Lecturer Interviews

The issue of students not having a device or not bringing a device with them is seen as declining while still remaining as an issue (Adviser A, Adviser B, Adviser C), particularly relating to the much higher saturation of ownership of smart phones and similar devices (Adviser F).

When it came to the use of clicker devices a number of challenges were identified including the distribution of clickers to the students (Adviser D, Adviser E), with this extending to the limited battery life when class sets of clickers were being used (Adviser C, Adviser D, Adviser E). An additional issue identified with the use of clickers is that they are now becoming a dated technology and some versions of them are no longer supported by their original vendors (Adviser E).

Dealing with the issue of not all students having a device through the use of group work was identified in a number of the interviews (Adviser B, Adviser E, Adviser F), with another alternative of being able to borrow devices also being identified (Adviser E). An alternative way of expanding the number of students with devices was identified as being the selection of an application where it was possible for the students to respond with SMS (text) messaging so that students with older phones could still participate with this being part of a selection criteria that was being used for a new application (Adviser D, Adviser E).

Increased lecturer preparation was identified in a number of the interviews particularly as it relates the development of effective questions (Adviser A, Adviser B, Adviser F), with the development of effective questions being identified as being one of the keys to success (Adviser F). Lecturers needing time during class to provide feedback was identified (Adviser A, Adviser F), with this being more so when the application is used for open ended responses (Adviser D).

Students using their own devices for other purposes during lectures was seen in some of the interviews as being a challenge for some lecturers (Adviser B, Adviser C, Adviser E), with the concept of developing applications that prevented multi-tasking being raised (Adviser E). Overuse of ARS leading to boredom, whether clickers or application on mobile devices, was identified as being a potential challenge (Adviser F).

There was little in the way of comments regarding the student based challenges in these interviews as the focus of these interviews was on the experiences of the learning advisers working with lecturers who were adopting ARS and APODs in their lectures.

A major challenge identified in two of the interviews was related to bad WiFi connectivity, which could result in many students choosing not to participate as the use of data through the cellphone network on their devices has the potential to be costly (Adviser B, Adviser D) with this theme being added to the themes relating to challenges of using APODs.

5.5.3 Pedagogical Issues

There were eight themes relating to pedagogical issues that emerged from the interviews of lecturers with this being shown in Table 38.

1	Good Teaching Strategies
2	Specifically Identified Pedagogical Issues
3	Large Class Issues
4	Constructivism
5	Instructional Design
6	Learning Styles and Cultures
7	Optional or Mandatory Use

Table 38 – Themes relating to Pedagogical Issues from the Lecturer Interviews

The comment of one interviewee that there is a need to adapt to the life of a new generation rather than fight it (Adviser B). This adviser stated that they viewed this as being connected to the concept of the digital native (Prensky, 2001) and that it relates to the addressing of differing learning styles and cultures. Aside from this, there was little focus on the pedagogical issues to emerge from this set of interviews.

5.5.4 Cost and Simplicity of Devices

There were four aspects of cost and simplicity of devices that emerged from the lecturer interviews with these being shown in Table 39.

Cost to students
Cost to lecturers and their institutions
Ease of use for students
Ease of use for lecturers

Table 39 – Cost and Simplicity of Devices – Adapted from Kay & LeSage (2009a)

The issue of cost to students emerged from one interview in that cost to students is less if students have their own device relative to cost of clickers (Adviser A), with one interview highlighting that the cost to students is one of the selection criteria for their institution in the selection of an application based ARS (Adviser D). The cost to the institutions was also one of the selection criteria for the selection of a new application based ARS (Adviser D).

When it comes to the ease of use for students this was also part of the selection criteria that was developed for the selection of a new application based ARS (Adviser D), and is connected to the almost ubiquitous nature of smart phones (Adviser A). It was also commented that applications that required students to login could be time consuming when it came to streamlining their use in lectures (Adviser D).

When it comes to the ease of use for lecturers, two of the interviewees saw their role as being to support lecturers to reduce this being an issue (Adviser B, Adviser D), while others saw lecturers being resistant to change as being a significant issue (Adviser E). A further interviewee saw the additional technical expertise required by lecturers as an issue when comparing the use of applications to the use of clickers (Adviser F). The issue of ease of use for lecturers was also part of the selection criteria that was developed for the selection of a new application based ARS (Adviser D).

5.6 Comparison of Lecturer and Adviser Perspectives

This section compares and contrasts the perspectives of the lecturers and the learning advisers that emerged from the interviews and is based on the themes from the literature review.

When it came to the learning environment themes the awareness of an increase of engagement and potential increase of attendance was similar across the lecturers and learning advisers. Areas that were commented on as being important by the lecturers, but received little or no attention in the learning adviser interviews, included increased attention and participation, along with learning becoming more enjoyable. A concept emerging from one learning adviser was that students seeing that a lecturer had a plan to improve student learning could in itself improve student engagement.

When the learning benefits themes are looked at, the lecturers and learning advisers were similar in commenting on the increase in interaction; discussion and the potential improvement of the quality of learning and learning performance. Comments in both sets of interviews alluded to the potential of using APODs for question driven instruction (QDI) and contingent teaching (CT).

In the assessment benefits themese, the lecturers and learning advisers were similar in that feedback was seen as being very important and that the use of APODs would help with formative assessment. However, when it came to seeing responses from other students, lecturers commented that they saw significant value in this whereas there was little or no comment relating to this from the learning advisers.

When it came to the technology based challenges there is similarity across the lecturers and learning advisers that the issue of students not having a device on which to use APODs is diminishing and that a good way to deal with this is to have students working in pairs or small groups. The issue of technology not functioning from the perspective of the learning advisers appears to be less for APODs when compared with ARS in the form of clickers, with this particular issue receiving little comment from the lecturers.

The lecturer based challenge of the design of effective questions was seen as being very important by lecturers and learning advisers with not overusing APODs receiving some comment by both groups interviewed. Neither group made comment regarding the challenge of lecturers responding to students. The challenge of covering course content was alluded to by learning advisers and received little comment from lecturers.

When it came to the student based challenges themes, there was little or no mention from either the lecturers or the learning advisers.

When the pedagogical issues themes are looked at, there is similarity across the lecturers and learning advisers regarding APODs addressing issues in large classes; the use of QDI and CT approaches; and the importance of learning styles and cultures. There were aspects where there was some comment from the lecturers, but little or no explicit comment from the learning advisers including specific mention of teaching strategies; constructivism; instructional design and whether student use of APODs should be optional or mandatory.

When it came to the cost and simplicity of devices themes, the lecturers and learning advisers saw the cost and ease of use for students as being potentially significant issues, but that the nature of APODs meant that for the vast majority of students there is little impact. The lecturers did not appear to see cost to them as being an issue as most adopted a free to use application, although some of the learning advisers saw the cost as being an issue where an institution was choosing to adopt a commercially available application. Ease of use for lecturers did not appear to be a significant issue for lecturers, although learning advisers saw it as a potential issue as it would be them that would be supporting lecturers with less experience and familiarity with technology.

It is noted that there were no conflicting views of any consequence emerging from the comparison of lecturer and learning advisers. The differences between the two perspectives were more related to the different lens that these lecturers and learning advisors view the issues through because of their distinct roles.

It was noted that the use of APODs had addressed some of the challenges relating to the use of clickers. These included issues surrounding the distribution of clickers and the technology not functioning correctly however the use of APODs placed more reliance of having a robust WiFi infrastructure.

5.7 Implications for Later Phases of the Research

Given the different perspectives of the lecturers and learning advisers, there are some aspects that need to be explored in the student surveys including student willingness to participate; whether APOD use makes learning more enjoyable; and whether seeing the responses from other students helps learning.

In addition to this, there was also little or no comment from the lecturers and learning advisers regarding student based challenges, and as a consequence of this, it was important for there to be an opportunity for student surveys that allowed students to comment on how they felt about using APODs during lectures.

The revised set of the themes resulting from the analysis of the interviews of learning advisers are shown in Table 40, and within each sub-question the themes are sorted into descending order based on how many learning advisers or lecturers referred to the theme. (Note that some of the themes were identified by more than one learning adviser or lecturer that as such it is not appropriate to show a total at the foot of this table).

Sub-Question of Research Question	Themes Identified	#
SQ1. What are the benefits of using applications on personally owned devices to engage with students in lectures (from a range of different perspectives and across a range of different contexts)?	• Anonymity for Students	15
	• Student Engagement	9
	• Student Interaction	9
	• Contingent Teaching & Question Driven Instruction	9
	• Student Discussion	7
	• Feedback	7
	• Student Participation	6
	• Learning Performance	5
	• Quality of Learning	4
	• Formative Assessment	4
	• Comparing Student Responses	4
	• Student Attention	4
	• Making Learning More Enjoyable	2
	• Attendance	2
	• Students Seeing Lecturer Cares about their Learning	1
SQ2. What are the challenges involved in using applications on personally owned devices to engage with students in lectures (from a range of different perspectives and across a range of different contexts) and how can these challenges be addressed?	• Students not Having or Bringing Device	8
	• Development of Effective Questions	6
	• Technology not Functioning Correctly	4
	• Potential for Overuse	3
	• WiFi Issues	2
	• Coverage of Course Content	1
	• Summative Assessment/Identifying Students	1
	• Responding to Student Feedback	Limited
	• New Method of Teaching for Students	-
	• Discussion of Topics Causing Confusion	-
	• Too Much Effort Required by Students	-
	• Negative Feedback	-
	• Students with Disabilities	-
SQ3. What are the pedagogical implications involved in using applications on personally owned devices to engage with students in lectures?	• Large Class Issues	6
	• Constructivism	6
	• Good Teaching Strategies	3
	• Instructional Design	-
	• Learning Styles and Cultures	-
	• Specifically Identified Pedagogical Issues	-
	• Optional or Mandatory Use	-
SQ4. How do issues relating to the cost and simplicity of devices impact on the use of applications on personally owned devices to engage with students in lectures and how can these issues be addressed?	• Cost for Students	7
	• Ease of Use for Students	5
	• Ease of Use for Lecturers	3
	• Cost for Lecturers and their Institutions	2

Table 40 – Themes Emerging after Lecturer and Learning Adviser Interviews

At this stage of the research the findings have accumulated through conducting the pilot study and interviews of lecturers and learning advisers. As such, these findings are predominantly from the perspective of the lecturers and learning advisers with some of the themes from the literature relating to a student perspective receving little attention. This is addressed in the next phase of the research through surveying students and conducting student focus groups.

6 Findings from Student Surveys and Focus Groups

This chapter sets out the findings resulting from the student surveys and student focus groups. The sections covering the student surveys commence with a description of the design of the survey and a brief description of how the findings were analysed (more details regarding the design of the surveys were covered in the methodology chapter). This is followed by the results of the demographics section of the survey, with the results being separated into questions relating to the use of APODS in different modes with a statistical analysis being embedded into the sections covering these different modes:

- Multiple choice questions (MCQ)
- Feedback from small group discussions (SGD)
- Students identifying most important content in a lecture (MIC)
- Students asking questions at the end of a lecture (QEL)

This is followed by an analysis of the responses to open ended questions and summary of the main findings from the survey, with the summary being drawn upon in the Analysis and Discussion chapter. Implications of the findings from the survey for later phases of this research are also identified.

The section covering the student focus groups includes the structure and organization of the focus groups; the results of the ranking exercise that was conducted; the results of the discussion that took place; and an overall summary of the findings from the focus groups.

The analysis of the Likert Scale questions included:

- Comparing the percentage of students willing to participate using the APOD with the percentage of students willing to participate non-anonymously

- Ranking the statements regarding different aspects of the use of the applications based on the average strength of agreement with the statement
- The responses to the questions from different demographic groups (gender, age and language) were compared using non-parametric tests in SPSS through the use of the Mann-Whitney test (Mann & Whitney, 1947). In each case the null hypothesis was that there was not a significant difference between the responses of the two groups of responses using a significance level of 5%.
- Where more than one course had APODs used in the same mode the Mann-Whitney test (Mann & Whitney, 1947) was conducted using SPSS to determine if there was a significant difference between the students in the courses at a 5% level. In these cases the null hypothesis was that there was not a significant difference between the students based on the courses they were enrolled in.

The responses to the open-ended questions at the end of each block were coded and analysed based on the themes emerging from the literature.

6.1 Internal Consistency of Survey

The internal consistency of the surveys was tested using the Cronbach Alpha test (Cortina, 1993; Tavakol & Dennick, 2011). In the version of the survey that was administered for each of the four modes of use of the APOD there was a group of Likert scale questions that related to the students' level of agreement with how different uses of the APOD impacted on their learning. These questions are shown in Table 112, Table 114, Table 116, and Table 118 respectively in Appendix I. The Cronbach-Alpha test was conducted on the responses to this group of questions. Where more than one class was surveyed about the use of the APOD, the Cronbach-Alpha test was conducted on all of the responses, and on the responses for individual classes. In the case where three classes were surveyed, the Cronbach-Alpha test was also conducted on the different groupings of two classes out of the three.

The Cronbach-Alpha tests that were conducted are shown in Table 41, which shows the resulting alpha scores for each test. In all cases the tests were conducted on groups of responses where an alpha score of a least 0.7 indicating a high level of internal consistency. The lowest alpha score from the test that were conducted was 0.763 indicating that there was a high level of internal consistency with all of the groups of responses that were analysed together.

Mode of Use	Responses Tested	Alpha
Multiple Choice Questions (MCQ)	AMAP500, ECON105 & COSC368	**0.763**
Responses from Small Group Discussion (SQD)	INFO243 & MPAC607	**0.847**
	INFO243 only	**0.871**
Most Important Content in Lecture (MIC)	INFO243 only	**0.839**
Asking Questions at End of Lecture (QEL)	INFO243 only	**0.777**

Table 41 – Cronbach-Alpha Tests Conducted

6.2 Demographic Results

6.2.1 Responses to Survey

The number of responses to the survey from the students in the courses along with the total number enrolled in each course and the response rate is shown in Table 42.

Course	Responses	Enrolments	Response Rate
AMAP500	10	24	41.7%
COSC368	29	55	52.7%
ECON105	27	315	8.6%
INFO243	42	145	29.0%
MPAC607	21	45	46.7%
Total	**129**	**584**	**22.1%**

Table 42 – Responses to Survey by Course and Response Rate

The gender breakdown of the respondents by course is shown in Table 43.

Course	Female	Male	Total
AMAP500	8	2	**10**
COSC368	4	25	**29**
ECON105	15	12	**27**
INFO243	16	26	**42**
MPAC607	14	7	**21**
Total	**57**	**72**	**129**

Table 43 – Responses to Survey by Course by Gender

The breakdown of respondents based on whether English is the student's first language by course is shown in Table 44.

Course	English as First Language	English not as First Language	Total
AMAP500	6	4	**10**
COSC368	24	5	**29**
ECON105	25	2	**27**
INFO243	35	7	**42**
MPAC607	13	8	**21**
Total	**103**	**26**	**129**

Table 44 – Responses to Survey by Course by English as First Language

The breakdown of respondents' age by course is shown in Table 45.

Course	17 & under	18	19	20	21	22-25	26-30	31-35	36 & older	Total
AMAP500	-	-	1	2	1	3	2	1	-	**10**
COSC368	-	-	-	8	8	9	4	-	-	**29**
ECON105	2	14	9	2	-	-	-	-	-	**27**
INFO243	-	-	11	15	6	7	1	-	2	**42**
MPAC607	-	-	-	-	1	4	7	5	4	**21**
Total	**2**	**14**	**21**	**27**	**16**	**23**	**14**	**6**	**6**	**129**

Table 45 – Responses to Survey by Course and Age

6.2.2 Ownership of Devices

The breakdown of ownership of smart phones by course is shown in Table 46.

Course	Total	Do not own a smart phone	Own a smart phone	Often have smart phone at lectures	Rarely have smart phone at lectures
AMAP500	**10**	1	9	7	2
COSC368	**29**	7	22	20	2
ECON105	**28**	3	24	24	-
INFO243	**42**	5	37	37	-
MPAC607	**21**	-	21	19	2
Total	**129**	**16**	**113**	**107**	**6**

Table 46 – Ownership of Smart Phones by Course

The breakdown of ownership of tablets by course is shown in Table 47.

Course	Total	Do not own a tablet	Own a tablet	Often have tablet at lectures	Rarely have tablet at lectures
AMAP500	**10**	5	5	3	2
COSC368	**29**	19	10	5	5
ECON105	**27**	19	8	2	6
INFO243	**42**	29	13	6	7
MPAC607	**21**	11	10	2	8
Total	**129**	**83**	**46**	**18**	**28**

Table 47 – Ownership of Tablets by Course

The breakdown of ownership of laptops by course is shown in Table 48.

Course	Total	Do not own a laptop	Own a laptop	Often have laptop at lectures	Rarely have laptop at lectures
AMAP500	**10**	4	6	-	6
COSC368	**29**	6	23	11	12
ECON105	**27**	1	26	9	17
INFO243	**42**	5	37	15	22
MPAC607	**24**	1	20	11	9
Total	**129**	**17**	**112**	**46**	**66**

Table 48 – Ownership of Laptops by Course

The data from Table 46 (showing ownership and possession of smart phones at lectures), Table 47 (showing ownership and possession of tablets at lectures), and Table 48 (showing ownership and possession of laptops at lectures) has been combined into Table 49 which shows the breakdown of ownership and possession of any of the types of devices at lectures.

Course	Total	Do not own a device	Own a device	Often have a device at lectures	Rarely have a device at lectures
AMAP500	**10**	1	9	8	1
COSC368	**29**	-	29	24	5
ECON105	**27**	-	27	25	2
INFO243	**42**	1	41	37	4
MPAC607	**21**	-	21	20	1
Total	**129**	**2**	**127**	**114**	**13**

Table 49 – Ownership of Any Device by Course

6.3 Multiple Choice Questions

This section presents the results of the questions relating to the use of the application for students answering multiple questions in the three courses where the application was used in this mode (AMAP500, COSC368 and ECON105).

The students were asked to rate their level of agreement with six (6) statements on a five step Likert Scale from strongly agree through to strongly disagree, with the statements being shown in Table 112 in Appendix I. The students were also asked to rate how frequently they would use the application for an activity or complete a corresponding activity non-anonymously with these questions being shown in Table 113 in Appendix I. The students were also asked an open-ended question of "How did you feel about using <name of application> in this way?" The analysis of the responses to this question provided deeper insight into the benefits and issues from a student perspective in the use of the application for answering multiple choice questions.

There was a total of 66 responses to the survey from students in these three courses. First the results are shown for all of the students as one group, with this being followed by a break down by course, by gender, by age and by whether the student has English as a first language or not.

As indicated in Table 41 on page 183 the results on the Cronbach-Alpha test (Cortina, 1993; Tavakol & Dennick, 2011) that was conducted on the responses from all three of these classes was 0.763 indicating a high level of internal consistency when it came to the responses to the questions relating to the students level of agreement with the statements relating to the impact of the use of the APOD as shown in Table 112 in Appendix I.

6.3.1 Results from All Students Where Application Used for Multiple Choice Questions

The summary of responses to the question asking the students to rate their level of agreement with the statements regarding the use of the application for students to answer multiple choice questions across the three courses where this was done is shown in Table 50. The statements are sorted into descending order based on the average rating for the statement (with 5 being strongly agree through to 1 being strongly disagree). The percentage of respondents strongly agreeing or at least agreeing with each statement is also shown. With all statements having either at least 40% of respondents strongly agreeing or at least 80% of respondents agreeing or strongly agreeing, overall there is a very high level of agreement with these statements.

Statement	Average Rating	Percentage Strongly Agreeing	Percentage Agreeing or Strongly Agreeing
MCQ-B	4.53	57.6%	97.0%
MCQ-D	4.47	62.1%	89.4%
MCQ-C	4.33	47.0%	89.4%
MCQ-E	4.14	28.8%	89.4%
MCQ-A	4.11	34.8%	84.8%
MCQ-F	4.03	42.4%	69.7%

Table 50 – Levels of Agreement with Use of Application for MCQs

The summary of responses to the question asking the students to rate how frequently they would use the application for multiple choice questions compared with hand raising is shown in Table 51. This table also shows the average rating for each activity (often = 5 through to never = 1) with an average of 3.00 where students are asked to raise their hands, through to 4.67 where the students are able to use the application. The table also shows the percentage of students indicating they would do each activity often or at least sometimes, with this showing a very large increase in willingness to use the application in comparison to raising hands.

	Activity	Average Rating	Percentage Indicating Often	Percentage Indicating Often or Sometimes
MCQ-G	Raising hands to answer MCQ question	3.00	12.1%	37.9%
MCQ-H	Using app to answer MCQ question	4.67	77.3%	93.9%

Table 51 – Frequency of use for MCQs Compared with Hand Raising

The data in Table 52 shows the students willingness to respond to multiple choice questions by raising hands and how this changes when they have the option to use the application that was used in class. The shaded cells in the table show students whose willingness increases when moving the use of the application with this covering 51 of the 66 students (77.3%), with 7 of the 66 students (10.6%) not changing from the often category thus giving 58 of the 66 students (87.9%) either having their willingness increase or their willingness not altering from the maximum level.

	Never Use App	Almost Never Use App	Occasi-onally Use App	Some-times Use App	Often Use App	Total
Never Raise Hand	-	-	1	-	6	**7**
Almost Never Raise Hand	-	1	1	2	15	**19**
Occasionally Raise Hand	-	-	-	3	12	**15**
Some-times Raise Hand	-	-	-	6	11	**17**
Often Raise Hand	1	-	-	-	7	**8**
Total	**1**	**1**	**2**	**11**	**51**	**66**

Table 52 – Willingness to Raise Hands or use App for MCQs

The responses to the open ended question of "How did you feel about using <name of application> in this way?" are shown in Table 135 in Appendix .

6.3.2 Results from Students by Course Where Application Used for Multiple Choice Questions

The average ratings for each statement by course are shown in Table 53 along with the difference between the ratings. The statements are sorted into descending order by the overall rating.

Statement	AMAP500	COSC368	ECON105	Overall
MCQ-B	4.50	4.38	4.70	4.53
MCQ-D	4.80	4.52	4.30	4.47
MCQ-C	4.40	4.24	4.41	4.33
MCQ-E	4.00	4.14	4.19	4.14
MCQ-A	4.30	4.10	4.04	4.11
MCQ-F	4.10	3.86	4.19	4.03

Table 53 – Average Ratings of Statements by Course

The average ratings for the question asking the students to rate how frequently they would use the application for answering questions compared with raising their hand grouped by course is shown in Table 54.

	Activity	AMAP500	COSC368	ECON105	Overall
MCQ-G	Raising hands to answer MCQ question	3.30	2.69	3.22	3.00
MCQ-H	Using app to answer MCQ question	4.70	4.59	4.74	4.67

Table 54 – Frequency of use Compared with Raising Hand by Course

Non-Parametric Tests were conducted using SPSS to test the significance of the differences in the responses from COSC368 and ECON105. The responses from AMAP500 were not included as there were only 10 responses from that class. The results of these tests are shown in Table 120 in Appendix J. The results of the tests show that the only statement where there was a significant difference between the courses was statement MCQ-B "Seeing the correct answers to questions that I got wrong helped my learning" indicating that there was a significantly higher level of agreement amongst the ECON105 students with that statement.

6.3.3 Results from Students by Gender Where Application Used for Multiple Choice Questions

The average ratings for each statement by gender are shown in Table 55. The statements are sorted into descending order by the overall rating.

Statement	Female	Male	Overall
MCQ-B	4.59	4.49	4.53
MCQ-D	4.63	4.36	4.47
MCQ-C	4.48	4.23	4.33
MCQ-E	4.11	4.15	4.14
MCQ-A	4.22	4.03	4.11
MCQ-F	4.56	3.67	4.03

Table 55 – Average Ratings of Statements by Gender

The average ratings for the question asking the students to rate how frequently they would use the application for answering questions compared with raising their hand, based on gender, is shown in Table 56.

	Statement	Female	Male	Overall
MCQ-G	Raising hands to answer MCQ question	2.89	3.08	3.00
MCQ-H	Using app to answer MCQ question	4.70	4.64	4.67

Table 56 –Frequency of use Compared with Raising Hand by Gender

Non-Parametric Tests were conducted using SPSS to test the significance of the differences in the responses based on the gender of the respondent. The results of these tests are shown in Table 121 in Appendix J. The results of the tests show that the only statement where there is a significant level of difference between the genders was statement MCQ-F (Answering questions anonymously using <name of application> is a reason why I would choose to use it to answer questions) with the female students' level of agreement being significantly higher than the male students' level of agreement.

6.3.4 Results from Students by Age Where Application Used for Multiple Choice Questions

For the purposes of the analysis by age the respondents were grouped into those under the age of 21 and those 21 and over. The average ratings for each statement by age are shown in Table 57. The statements are sorted into descending order by the overall rating.

Statement	Under 21	21 & Over	Overall
MCQ-B	4.61	4.43	4.53
MCQ-D	4.42	4.54	4.47
MCQ-C	4.37	4.29	4.33
MCQ-E	4.13	4.14	4.14
MCQ-A	4.16	4.04	4.11
MCQ-F	4.21	3.79	4.03

Table 57 – Average Ratings of Statements by Age

The average ratings for the question asking the students to choose how frequently they would use the application for answering questions compared with raising their hand by age is shown in Table 58.

	Statement	Under 21	21 & Over	Overall
MCQ-G	Raising hands to answer MCQ question	3.13	2.82	3.00
MCQ-H	Using app to answer MCQ question	4.74	4.57	4.67

Table 58 –Frequency of use Compared with Raising Hand by Age

Non-Parametric Tests were conducted using SPSS to test the significance of the differences in the responses based on the age of the respondent. The results of these tests are shown in Table 122 in Appendix J. The results of the tests show that the only statement where there was a significant difference was statement MCQ-F (Answering questions anonymously using <name of application> is a reason why I would choose to use it to answer questions) with the younger students having a much higher level of agreement with the statement.

6.3.5 Results from Students by English Language Background Where Application Used for Multiple Choice Questions

The average ratings for each statement by age are shown in Table 59. The statements are sorted into descending order by the overall rating.

Statement	English as 1st Language	English Not as 1st Language	Overall
MCQ-B	4.56	4.36	4.53
MCQ-D	4.53	4.18	4.47
MCQ-C	4.38	4.09	4.33
MCQ-E	4.18	3.91	4.14
MCQ-A	4.13	4.00	4.11
MCQ-F	4.09	3.73	4.03

Table 59 – Average Ratings of Statements by English Language Background

The average ratings for the question asking the students to rate how frequently they would use the application for answering questions compared with raising their hand, based on English language background, is shown in Table 60.

	Statement	English as 1st Language	English Not as 1st Language	Overall
MCQ-G	Raising hands to answer MCQ question	2.98	3.09	3.00
MCQ-H	Using app to answer MCQ question	4.09	3.73	4.03

Table 60 –Frequency of use Compared with Raising Hand Based on Language Background

Non-Parametric Tests were conducted using SPSS to test the significance of the differences in the responses based on the English Language background of the respondent. The results of these tests are shown in Table 123 in Appendix J. The results show that there is not a significant difference in responses to any of the statements indicating that there is not a significant different based on the English Language background of the respondents.

6.4 Responses from Small Group Discussions – INFO243 and MPAC607

This section presents the results of the questions relating to the use of the application for students providing open ended responses in the form of feedback from small group discussions (INFO243 and MPAC607).

Where the application had been used so that students could have small group discussions and submit their responses to open ended questions (INFO243 and MPAC607) the students were asked to rate their level of agreement with seven statements on a five step Likert Scale from strongly agree through to strongly disagree. The statements are shown in Table 114 in Appendix I. The students were also asked to rate how frequently they would use the application for an activity or complete a corresponding activity non-anonymously with these questions being shown in Table 115 in Appendix I. The students were also asked an open-ended question of "How did you feel about using <name of application> in this way?" The analysis of the responses to this question provided deeper insight into the benefits and issues from a student perspective in the use of the application for sharing responses from small group discussions with the rest of the class.

As indicated in Table 41 on page 183 the results on the Cronbach-Alpha test (Cortina, 1993; Tavakol & Dennick, 2011) conducted on the responses from INFO243 and MPAC607 was 0.847 indicating a high level of internal consistency when it came to the responses to the questions relating to the students level of agreement with the statements relating to the impact of the use of the APOD as shown in Table 114 in Appendix I.

6.4.1 Results for All Students Submitting Responses from Small Group Discussion

The summary of responses to the questions asking the students to rate their level of agreement with the statements regarding the use of the application across the two courses is shown in Table 61 with the statements being sorted into descending order based on the average rating for the statement (with 5 being strongly agree through to 1 being strongly disagree). The percentage of respondents strongly agreeing or at least agreeing with each statement is also shown.

Statement	Average Rating	Percentage Strongly Agreeing	Percentage Agreeing or Strongly Agreeing
SGD-B	4.41	54.0%	90.5%
SGD-A	4.38	50.8%	93.7%
SGD-F	4.30	38.1%	96.8%
SGD-D	4.17	41.3%	82.5%
SGD-G	4.11	47.6%	71.4%
SGD-E	4.10	41.3%	76.2%
SGD-C	3.71	17.5%	66.7%

Table 61 – Levels of Agreement with Statements from All Students

The summary of responses to the question asking the students to rate how frequently they would use the application for submitting their group's response compared with telling the rest of the class shown in Table 62 with the statements being sorted into descending order based on the average rating for the statement (with 5 being often through to 1 being never). The percentage of students indicating they would do each activity often and at least sometimes is also shown.

	Activity	Average Rating	Percentage Indicating Often	Percentage Indicating Often or Sometimes
SGD-H	Verbally telling the class what the small group discussion covered	3.11	12.7%	41.3%
SGD-I	Using the app to share what the small group discussion covered	4.02	44.4%	71.4%

Table 62 – Frequency of use for Sharing Responses Compared with Telling Class

6.4.2 Results by Course

The average ratings for each statement by course are shown in Table 63 along with the difference between the ratings. The statements are sorted into descending order by the difference in rating between the courses.

Statement	INFO243	MPAC607	Overall	Difference
SGD-C	3.57	4.00	3.71	0.43
SGD-G	4.21	3.90	4.11	0.31
SGD-E	4.00	4.29	4.10	0.29
SGD-F	4.21	4.48	4.30	0.27
SGD-D	4.12	4.29	4.17	0.17
SGD-B	4.43	4.38	4.41	0.05
SGD-A	4.38	4.38	4.38	0.00

Table 63 – Average Rating of Statements by Course

The average ratings for the question asking the students to rate how frequently they would use the application for submitting their groups' response compared with telling the rest of the class by course is shown in Table 54.

	Activity	INFO243	MPAC607	Overall	Difference
SGD-H	Verbally telling the class what the small group discussion covered	2.81	3.71	3.11	0.90
SGD-I	Using the app to share what the small group discussion covered	3.86	4.33	4.02	0.47

Table 64 –Frequency of use for Sharing Responses Compared with Telling Class by Course

Non-Parametric Tests were conducted using SPSS to test the significance of the differences in the responses based on the course the student was enrolled in. The results of these tests are shown in Table 124 in Appendix J. The results of the tests show that the only statement where there was a significant difference was statement MCQ-F (Answering questions anonymously using <name of application> is a reason why I would choose to use it to answer questions) with students in MPAC607 having a significantly higher level of agreement with the statement.

The data in Table 65 reproduces the data from Table 62 (page 193) by course and shows the students' willingness to participate verbally or with the application often, or at least sometimes. This shows an increase from 12.7% to 44.4% of students' willingness to participate often when being able to use the application, with the increase amongst INFO243 students being from 4.8% to 40.5%, and amongst MPAC607 students being from 28.6% to 52.4%.

When it comes to students' willingness to participate at least sometimes (i.e., often or sometimes), this shows an increase from 41.3% to 71.4% of students willingness, with the increase amongst the INFO243 students being from 31.0% to 64.3%, and amongst MPAC607 students being from 61.9% to 85.7%.

Course	Often Sharing Verbally	Often Using App	Often or Sometimes Sharing Verbally	Often or Sometimes Using App
INFO243	4.8%	40.5%	31.0%	64.3%
MPAC607	28.6%	52.4%	61.9%	85.7%
Total	12.7%	44.4%	41.3%	71.4%

Table 65 – Willingness of Students to Participate Often or Sometimes Verbally or With App

6.4.3 Results by Gender

The average ratings for each statement by gender are shown in Table 66 along with the difference between the ratings. The statements are sorted into descending order by the difference in rating between the courses.

Statement	Female	Male	Overall	Difference
SGD-F	4.50	4.12	4.30	0.38
SGD-G	4.23	4.00	4.11	0.23
SGD-B	4.53	4.30	4.41	0.23
SGD-A	4.50	4.27	4.38	0.23
SGD-C	3.77	3.67	3.71	0.10
SGD-D	4.13	4.21	4.17	0.08
SGD-E	4.13	4.06	4.10	0.07

Table 66 – Average Rating of Statements by Gender

The average ratings for the question asking the students to rate how frequently they would use the application for submitting their groups' response compared with telling the rest of the class by gender is shown in Table 67.

	Activity	Female	Male	Overall	Difference
SGD-H	Verbally telling the class what the small group discussion covered	3.27	2.97	3.11	0.30
SGD-I	Using the app to share what the small group discussion covered	4.10	3.94	4.02	0.16

Table 67 –Frequency of use for Sharing Responses Compared with Telling Class by Gender

Non-Parametric Tests were conducted using SPSS to test the significance of the differences in the responses based on the gender of the respondent. The results of these tests are shown in Table 125 in Appendix J. The results of the tests show that the only statement where there was a significant difference was statement SGD-F (Thinking about how I would answer the questions encouraged me to think more about the lecture content) demonstrating the female students have a significantly higher level of agreement with this than male students.

6.4.4 Results by Age

For the purposes of the analysis by age the respondents were grouped into those under the age of 21 and those 21 and over. The average ratings for each statement by course are shown in Table 68 along with the difference between the ratings. The statements are sorted into descending order by the difference in rating between the courses.

Statement	Under 21	21 & Over	Overall	Difference
SGD-C	3.31	4.00	3.71	0.69
SGD-E	3.85	4.27	4.10	0.42
SGD-F	4.08	4.46	4.30	0.38
SGD-B	4.19	4.57	4.41	0.38
SGD-A	4.23	4.49	4.38	0.26
SGD-D	4.08	4.24	4.17	0.16
SGD-G	4.12	4.11	4.11	0.01

Table 68 – Average Rating of Statements by Age

The average ratings for the question asking the students to rate how frequently they would use the application for submitting their groups' response compared with telling the rest of the class by age is shown in Table 69.

	Activity	**Under 21**	**21 & Over**	**Overall**	**Difference**
SGD-H	Verbally telling the class what the small group discussion covered	2.69	3.41	3.11	0.72
SGD-I	Using the app to share what the small group discussion covered	3.88	4.11	4.02	0.23

Table 69 –Frequency of use for Sharing Responses Compared with Telling Class by Age

Non-Parametric Tests were conducted using SPSS to test the significance of the differences in the responses based on the age of the respondent. The results of these tests are shown in Table 126 in Appendix J. Due to the distribution of this data, SPSS was not able to perform that Mann-Whitney tests. However, SPSS was able to perform the difference in medians test (Siegel & Castellan, 1988) which are also shown in Table 126. These tests showed that there was a significant difference was statement SGD-H (If the lecturer wanted someone to tell the rest of the class about the answer my group had decided on I would volunteer to do this) with students 21 years and older having a significantly higher level of agreement than students under the age of 21.

6.4.5 Results by English as a First Language

The average ratings for each statement based on the English language background of the students are shown in Table 70 (page 198) along with the difference between the ratings. The statements are sorted into descending order by the difference in rating between students based on their English language background.

Statement	English as First Language	English Not First Language	Overall	Difference
SGD-F	4.19	4.67	4.30	0.48
SGD-B	4.33	4.67	4.41	0.33
SGD-E	4.02	4.33	4.10	0.31
SGD-A	4.31	4.60	4.38	0.29
SGD-D	4.13	4.33	4.17	0.21
SGD-G	4.08	4.20	4.11	0.12
SGD-C	3.71	3.73	3.71	0.02

Table 70 – Average Rating of Statements by English Language Background

The average ratings for the question asking the students to rate how frequently they would use the application for submitting their groups' response compared with telling the rest of the class based on English language background is shown in Table 71.

	Activity	English as First Language	English Not First Language	Overall	Difference
SGD-H	Verbally telling the class what the small group discussion covered	3.25	2.67	3.11	0.58
SGD-I	Using the app to share what the small group discussion covered	4.15	3.60	4.02	0.55

Table 71 –Frequency of use for Sharing or Using Application by Language Background

Non-Parametric Tests were conducted using SPSS to test the significance of the differences in the responses based on the English Language background of the respondent. The results of these tests are shown in Table 127 in Appendix J. The results show that there is a significant difference for statement SGD-F (Thinking about how I would answer the questions encouraged me think more about the lecture content) with students who do not have English as their first language reporting a significantly higher level of agreement than those who do have English as their first language.

6.4.6 Responses to Open Ended Questions Where Application Used for Submitting Responses from Small Group Discussion

The responses to the open-ended question of "How did you feel about using <name of application> in this way?" are shown in Table 136 in Appendix L.

6.5 Responses from Small Group Discussions – INFO243 Only

Due to the difference in nature of INFO243 (second year undergraduate course) and MPAC607 (professional masters course) it was decided to separately analyse the responses from the students enrolled in INFO243 relating to using the application of responses from small group discussions.

As indicated in Table 41 on page 183 the results on the Cronbach-Alpha (Cortina, 1993; Tavakol & Dennick, 2011) test conducted on the responses from INFO243 was 0.871 indicating a high level of internal consistency when it came to the responses to the questions relating to the students level of agreement with the statements relating to the impact of the use of the APOD as shown in Table 114 in Appendix I.

6.5.1 Results from Where Application Used for Submitting Responses from Small Group Discussion by Gender for INFO243 Only

The average ratings for each statement by gender are shown in Table 72 (page 199) along with the difference between the ratings. The statements are sorted into descending order by the difference in rating between the courses.

Statement	Female	Male	Overall	Difference
SGD-A	4.56	4.27	4.38	0.29
SGD-D	3.94	4.23	4.12	0.29
SGD-G	4.38	4.12	4.21	0.26
SGD-F	4.44	4.20	4.29	0.24
SGD-C	3.44	3.65	3.57	0.22
SGD-B	4.56	4.35	4.43	0.22
SGD-E	3.94	4.04	4.00	0.10

Table 72 – Average Rating of Statements by Gender for INFO243 Only

The average ratings for the question asking the students to rate how frequently they would use the application for submitting their groups' response compared with telling the rest of the class by gender is shown in Table 73.

	Activity	Female	Male	Overall	Difference
SGD-H	Verbally telling the class what the small group discussion covered	2.63	2.91	2.81	0.30
SGD-I	Using the app to share what the small group discussion covered	3.75	3.92	3.86	0.17

Table 73 –Frequency of use for Sharing or Using Application by Gender (INFO243 only)

Non-Parametric Tests were conducted using SPSS to test the significance of the differences in the responses based on the gender of the respondent. The results of these tests are shown in Table 128 in Appendix J. The results show that there is a significant difference in the level of agreement with statement SGD-D (Using <name of application> in this way made the lecture more enjoyable) with male students having a significantly higher level of agreement than female students.

6.5.2 Results from Where Application Used for Submitting Responses from Small Group Discussion by Age

For the purposes of the analysis by age the respondents were grouped into those under the age of 21 and those 21 and over. The average ratings for each statement, based on age, are shown in Table 74 along with the difference between the ratings. The statements are sorted into descending order by the difference in rating between the courses.

Statement	Under 21	21 & Over	Overall	Difference
SGD-C	3.31	4.00	3.57	0.69
SGD-B	4.19	4.81	4.43	0.62
SGD-E	3.85	4.25	4.00	0.40
SGD-A	4.23	4.63	4.38	0.39
SGD-F	4.08	4.44	4.21	0.36
SGD-G	4.12	4.38	4.21	0.26
SGD-D	4.08	4.19	4.12	0.11

Table 74 – Average Rating of Statements by Age for INFO243 Only

The average ratings for the question asking the students to rate how frequently they would use the application for submitting their groups' response compared with telling the rest of the class by age is shown in Table 75.

	Activity	Under 21	21 & Over	Overall	Difference
SGD-H	Verbally telling the class what the small group discussion covered	3.88	3.81	3.86	0.07
SGD-I	Using the app to share what the small group discussion covered	2.69	3.00	2.81	0.31

Table 75 –Frequency of use for Sharing or Using Application by Age (INFO243)

Non-Parametric Tests were conducted using SPSS to test the significance of the differences in the responses based on the age of the respondent. The results of these tests are shown in Table 129 in Appendix J. The results show that there was a significant difference in the levels of agreement with statement SGD-B (The lecturer giving feedback on the answers helped my learning) and statement SGD-C (Discussing the questions with the person sitting next to me helped my learning) with the students 21 years and older having a significantly higher level of agreement with both statements than the students under the age of 21.

6.5.3 Results from Where Application Used for Submitting Responses from Small Group Discussion by English as a First Language

The average ratings for each statement by English as a First Language are shown in Table 76 along with the difference between the ratings. The statements are sorted into descending order by the difference in rating between the courses.

Statement	English as 1st Language	English not as 1st Language	Overall	Difference
SGD-C	3.66	3.14	3.57	0.51
SGD-F	4.14	4.57	4.21	0.43
SGD-B	4.37	4.71	4.43	0.34
SGD-G	4.17	4.43	4.21	0.26
SGD-A	4.37	4.43	4.38	0.06
SGD-D	4.11	4.14	4.12	0.03
SGD-E	4.00	4.00	4.00	0.00

Table 76 – Rating of Statements by English Language Background (INFO243)

The average ratings for the question asking the students to rate how frequently they would use the application for submitting their groups' response compared with telling the rest of the class by English as a First Language is shown in Table 77.

	Activity	English as 1st Language	English not as 1st Language	Overall	Difference
SGD-H	Verbally telling the class what the small group discussion covered	4.06	2.86	3.86	1.20
SGD-I	Using the app to share what the small group discussion covered	3.03	1.71	2.81	1.31

Table 77 – Frequency of use for Sharing or Using Application by Language (INFO243)

Non-Parametric Tests were conducted using SPSS to test the significance of the differences in the responses based on the English Language background of the respondent. The results of these tests a re shown in Table 130 in Appendix J. The results show that there is a significant difference in the level of agreement with statement SGD-H (If the lecturer wanted someone to tell the rest of the class about the answer my group had decided on I would volunteer to do this) and statement SGD-I (If the lecturer wanted someone to use <name of application> to share the answer my group had decided on I would volunteer to do this) with the students having English as their first language having a significantly higher level of agreement with both statements than those students who do not have English as their first language.

6.6 Reporting back on Most Important Content at end of Lecture

This section presents the results of the questions relating to the use of the application for students reporting back on the most important content in a lecture (INFO243).

Where the application had been used so that students could report back at the end of a lecture on what they thought the most important content in the lecture was (INFO243) the students were asked to rate their level of agreement with seven statements on a five step Likert Scale from strongly agree through to strongly disagree, with the statements being shown in Table 116 in Appendix I.

The students were also asked to rate how frequently they would use the application for indicating the most important content covered in the lecture or complete a corresponding activity non-anonymously with these questions being shown in Table 117 in Appendix I. The students were also asked an open-ended question of "How did you feel about using <name of application> in this way?" The analysis of the responses to this question provided deeper insight into the benefits and issues from a student perspective in the use of the application for reporting back on what the most important content covered in the lecture was.

Note that of the 42 respondents from INFO243, only 35 responded to these questions. Of these 35 respondents 30 had English as their first language while 5 did not which meant that it was not possible to compare the responses based on whether English was the first language or not with any significance.

As indicated in Table 41 on page 183 the results on the Cronbach-Alpha test (Cortina, 1993; Tavakol & Dennick, 2011) conducted on the responses from INFO243 was 0.839 indicating a high level of internal consistency when it came to the responses to the questions relating to the students level of agreement with the statements relating to the impact of the use of the APOD as shown in Table 116 in Appendix I.

6.6.1 Results for All Students

The summary of responses to the questions asking the students to rate their level of agreement with the statements regarding the use of the application for reporting back on the most important content in a lecture is shown in Table 78 (page 204) with the statements being sorted into descending order based on the average rating for the statement (with 5 being strongly agree through to 1 being strongly disagree). The percentage of respondents strongly agreeing or at least agreeing with each statement is also shown.

Statement	Average Rating	Percentage Strongly Agreeing	Percentage Agreeing or Strongly Agreeing
MIC-B	4.43	48.6%	94.3%
MIC-E	4.31	48.6%	85.7%
MIC-D	4.29	48.6%	82.9%
MIC-A	4.17	31.4%	91.4%
MIC-G	4.17	45.7%	77.1%
MIC-F	3.97	20.0%	80.0%
MIC-C	3.89	31.4%	65.7%

Table 78 – Levels of Agreement with Statements from All Students

The summary of responses to the question asking the students to rate how frequently they would use the application for reporting on the most important content from the lecture compared with telling the rest of the class shown in Table 79 with the statements being sorted into descending order based on the average rating for the statement (with 5 being often through to 1 being never). The percentage of students indicating they would do each activity often and at least sometimes is also shown.

	Activity	Average Rating	Percentage Indicating Often	Percentage Indicating Often or Sometimes
MIC-H	Verbally telling the class what the most important content was	2.69	2.9%	20.0%
MIC-I	Using the app to share what the most important content was	3.66	25.7%	60.0%

Table 79 – Frequency of use for Reporting Back on MIC Compared with Telling Class

The responses to the open-ended question of "How did you feel about using <name of application> in this way?" are shown in Table 137 in Appendix J.

6.6.2 Results from Where Application Used for Reporting Back on Most Important Lecture Content by Gender

The average ratings for each statement by gender are shown in Table 80 (page 205) along with the difference between the ratings. The statements are sorted into descending order by the difference in rating between the courses.

Statement	Female	Male	Overall	Difference
MIC-E	4.13	4.45	4.31	0.32
MIC-C	3.73	4.00	3.89	0.27
MIC-D	4.13	4.40	4.29	0.27
MIC-A	4.27	4.10	4.17	0.17
MIC-F	3.93	4.00	3.97	0.07
MIC-B	4.40	4.45	4.43	0.05
MIC-G	4.20	4.15	4.17	0.05

Table 80 – Average Rating of Statements by Gender

The average ratings for the question asking the students to rate how frequently they would use the application for submitting their groups' response compared with telling the rest of the class by gender is shown in Table 81.

	Activity	Female	Male	Overall	Difference
MIC-H	Verbally telling the class what the most important content was	2.53	2.80	2.69	0.27
MIC-I	Using the app to share what the most important content was	3.53	3.75	3.66	0.22

Table 81 – Frequency of use for Reporting Back on MIC v Telling Class by Gender

Non-Parametric Tests were conducted using SPSS to test the significance of the differences in the responses based on the gender of the respondent. The results of these tests are shown in Table 131 in Appendix J. The results show that there was not a significant difference in the responses to any of the statements based on the gender of the respondent.

6.6.3 Results from Where Application Used for Reporting Back on Most Important Lecture Content by Age

The average ratings for each statement by age are shown in Table 82 along with the difference between the ratings. The statements are sorted into descending order by the difference in rating between the courses.

Statement	Under 21	21 & Over	Overall	Difference
MIC-C	3.62	4.29	3.89	0.67
MIC-A	4.00	4.43	4.17	0.43
MIC-E	4.19	4.50	4.31	0.31
MIC-G	4.05	4.36	4.17	0.31
MIC-F	3.86	4.14	3.97	0.29
MIC-D	4.19	4.43	4.29	0.24
MIC-B	4.33	4.57	4.43	0.24

Table 82 – Average Rating of Statements by Age

The average ratings for the question asking the students to rate how frequently they would use the application for submitting their groups' response compared with telling the rest of the class by age is shown in Table 83.

	Activity	Under 21	21 & Over	Overall	Difference
MIC-H	Verbally telling the class what the most important content was	2.38	3.14	2.69	0.76
MIC-I	Using the app to share what the most important content was	3.43	4.00	0.57	0.57

Table 83 – Frequency of use for Reporting Back on MIC Compared with Telling Class by Age

Non-Parametric Tests were conducted using SPSS to test the significance of the differences in the responses based on the age of the respondent. The results of these tests are shown in Table 132 in Appendix J. The results show that there was not a significant difference in the responses to any of the statements based on the age of the respondent.

6.6.4 Results from Where Application Used for Reporting Back on Most Important Lecture Content by English as a First Language

As indicated earlier, of the 29 respondents to these questions 24 had English as their first language and only 5 did not which meant that it was not possible to compare the responses based on whether English was the first language, or not, with any significance.

6.7 *Students Asking Questions at end of Lecture*

This section presents the results of the questions relating to the use of the application for students asking questions at the end of a lecture (INFO243).

Where the application had been used so that students ask questions at the end of a lecture about the content (INFO243) the students were asked to rate their level of agreement with six statements on a five step Likert Scale from strongly agree through to strongly disagree, with the statements being shown in Table 118 in Appendix I. The students were also asked to rate how frequently they would use the application for asking questions at the end of a lecture or complete a corresponding activity non-anonymously with these questions being shown in Table 119 in Appendix I. The students were also asked an open-ended question of "How did you feel about using <name of application> in this way?" The analysis of the responses to this question provided deeper insight into the benefits and issues from a student perspective in the use of the application for asking questions at the end of a lecture.

As indicated in Table 41 on page 183 the results of the Cronbach-Alpha test (Cortina, 1993; Tavakol & Dennick, 2011) conducted on the responses from INFO243 was 0.777 indicating a high level of internal consistency when it came to the responses to the questions relating to the students level of agreement with the statements relating to the impact of the use of the APOD as shown in Table 118 in Appendix I.

Note that of the 42 respondents from INFO243, 29 responded to these questions. Of these 29 respondents 24 had English as their first language while only 5 did not which meant that it was not possible to compare the responses based on whether English was the first language or not with any significance.

6.7.1 Results for All Students

The summary of responses to the questions asking the students to rate their level of agreement with the statements regarding the use of the application for asking questions at the end of a lecture is shown in Table 84 (page 208) with the statements being sorted into descending order based on the average rating for the statement (with 5 being strongly agree through to 1 being strongly disagree).

The percentage of respondents strongly agreeing or at least agreeing with each statement is also shown.

Statement	Average Rating	Percentage Strongly Agreeing	Percentage Agreeing or Strongly Agreeing
QEL-A	4.45	48.3%	96.6%
QEL-F	4.41	44.8%	96.6%
QEL-E	4.31	37.9%	93.1%
QEL-B	4.17	31.0%	86.2%
QEL-C	3.86	17.2%	72.4%
QEL-D	3.79	20.7%	62.1%

Table 84 – Levels of Agreement with Statements from All Students

The summary of responses to the question asking the students to rate how frequently they would use the application for asking questions at the end of a lecture compared with asking the question in from of the rest of the class shown in Table 85. The percentage of students indicating they would do each activity often and at least sometimes is also shown.

	Activity	Average Rating	Percentage Indicating Often	Percentage Indicating Often or Sometimes
QEL-G	I would ask questions out loud at the end of a lecturer	2.48	0.0%	17.2%
QEL-H	I would use the app to ask questions at the end of a lecture	3.83	34.5%	62.1%

Table 85 – Frequency of use for Asking Questions Orally or Using Application

The responses to the open-ended question of “How did you feel about using <name of application> in this way?” are shown in Table 138 in Appendix N.

6.7.2 *Results from Where Application Used for Students Asking Questions at the end of Lectures by Gender*

The average ratings for each statement by gender are shown in Table 86 (page 209) along with the difference between the ratings. The statements are sorted into descending order by the difference in rating between the courses.

Statement	Female	Male	Overall	Difference
QEL-D	3.23	4.25	3.79	1.02
QEL-C	3.54	4.13	3.86	0.59
QEL-F	4.15	4.63	4.41	0.47
QEL-B	4.00	4.31	4.17	0.31
QEL-E	4.15	4.44	4.31	0.28
QEL-A	4.31	4.56	4.45	0.25

Table 86 – Average Rating of Statements by Gender

The average ratings for the question asking the students to rate how frequently they would use the application for asking questions at the end of lecture compared with asking questions out loud by gender is shown in Table 87.

	Activity	Female	Male	Overall	Difference
QEL-G	I would ask questions out loud at the end of a lecturer	2.15	2.75	2.48	0.60
QEL-H	I would use the app to ask questions at the end of a lecture	3.54	4.06	3.83	0.52

Table 87 – Frequency of use for Asking Questions Orally or Using Application by Gender

Non-Parametric Tests were conducted using SPSS to test the significance of the differences in the responses based on the gender of the respondent. The results of these tests are shown in Table 133 in Appendix J. The results show that there is a significant difference across the genders in the level of agreement with statement QEL-C (Thinking what questions I would ask with the person sitting next to me made me think more about the lecture content) and statement QEL-D (Discussing what questions I would ask with the person sitting next to me made me think more about the lecture content) with the male students reporting a significantly higher level of agreement with both statements than the female students.

6.7.3 Results from where Application Used for Students Asking Questions at the end of a Lecture by Age

The average ratings for each statement by age are shown in Table 88 along with the difference between the ratings. The statements are sorted into descending order by the difference in rating between the courses.

Statement	Under 21	21 & Over	Overall	Difference
QEL-D	3.41	4.33	3.79	0.92
QEL-C	3.59	4.25	3.86	0.66
QEL-B	3.94	4.50	4.17	0.56
QEL-A	4.24	4.75	4.45	0.51
QEL-F	4.24	4.67	4.41	0.43
QEL-E	4.18	4.50	4.17	0.32

Table 88 – Average Rating of Statements by Age

The average ratings for the question asking the students to rate how frequently they would use the application for submitting questions compared with asking questions out loud grouped by age is shown in Table 89.

	Activity	Under 21	21 & Over	Overall	Difference
QEL-G	I would ask questions out loud at the end of a lecturer	2.29	2.75	2.48	0.46
QEL-H	I would use the app to ask questions at the end of a lecture	3.59	4.17	3.83	0.58

Table 89 – Frequency of use for Asking Questions Orally or Using Application by Age

Non-Parametric Tests were conducted using SPSS to test the significance of the differences in the responses based on the gender of the respondent. The results of these tests are shown in Table 134 in Appendix J. The results show that there is a significant difference across the age groups in their level of agreement with the following four statements with students 21 years and older having a significantly higher level of agreement with each statement than those under 21 years:

- QEL-A (The lecturer answering the questions that were asked helped my learning)
- QEL-B (Using <name of application> in this way made the lecture more enjoyable)

- QEL-C (Thinking what questions I would ask with the person sitting next to me made me think more about the lecture content)
- QEL-D (Discussing what questions I would ask with the person sitting next to me made me think more about the lecture content)

6.7.4 Results from Where Application Used for Reporting Back on Most Important Lecture Content by English Language Background

As indicated earlier, of the 29 respondents to these questions 24 had English as their first language while only 5 did not which meant that it was not possible to compare the responses based on whether English was the first language or not with any statistical significance.

6.8 Responses to Open Ended Questions

This section analyses the responses to the open-ended questions in the survey and for each question identifies recurring themes and highlights specific quotes that provide additional insight.

6.8.1 Open Ended Responses Relating to Using Application for MCQ Questions

When looking at the responses to the question about how the students felt about using the application for multiple choice questions (see Table 135 in Appendix K) there were a number of themes to emerge with these being shown in Table 90.

Theme	**COSC368**	**ECON105**	**AMAP500**	**Total**
Specific mention of engagement	4	-	-	**4**
Specific mention of anonymity	3	5	-	**8**
Specific mention of enjoyment	1	4	-	**5**
Enhancing learning, understanding	2	7	3	**12**
Involvement, participation, interaction	-	6	1	**7**
Feedback	-	1	-	**1**
Total number of responses (some mention more than one theme and others mentioned none).	9	15	4	28

Table 90 – Themes from Open Ended Question About Using Apps for MCQ Questions

Particular statements to emerge of interest from some students were:

> "<name of application> allows for you to say your answer without the fear of getting it wrong infront of the class" (COSC368 student #9).

> "Very high level of student engagement compared to any other course I've done at <name of institution>" (COSC368 student #3).

> "Effective way to engage my thought process" (AMAP500 student #4).

> "Good, makes it a lot easier than speaking up in a lecture, more involved" (ECON105 student #4).

> "I really enjoyed using the app and would recommend it. It really helps with keeping interested and actually applying the content to real problems - very quickly shows you whether you understand it or not and then it is easy to ask questions after the class" (ECON105 student #9).

6.8.2 Open Ended Responses Relating to Using Application for Reporting Back from Small Group Discussions

When looking at the responses to the question about how the students felt about using the application for reporting back from small group discussions (see Table 136 in Appendix L) there were a number of themes to emerge with these being shown in Table 91.

Theme	**INFO243**	**MPAC607**	**Total**
Specific mention of engagement	1	2	**3**
Specific mention of anonymity	4	5	**9**
Specific mention of enjoyment	-	-	**-**
Enhancing learning, understanding	1	1	**2**
Involvement, participation, interaction		1	**1**
Feedback	2	-	**2**
Innovative	-	1	**1**
Total number of responses (some mentioned more than one theme and others mentioned none).	8	11	**19**

Table 91 – Themes from Open Ended Question about Using Apps for Responses from SGD

Responses of particular note were ones that related to the difficulty of people who learn better with audio aids and who mentioned the importance of not losing time for covering content.

> ".. however it is purely visual aid, it could be less efficient for people who learn better with audio aid…" (MPAC607 student #10).

> "I think provided you have sufficient time to cover the content for the lectures and have mini '<name of application> segments' its definitely a positive experience…" (INFO243 student #4).

One response vividly highlighted the issue of anonymity and shyness:

> "I think its a great way as I'm someone who would never ask a question or answer a question in class and it's also very intimidating when the teacher points you out in class to make you

answer a question. Its almost enough to make you not want to attend that class. So <name of application> is so much better" (INFO243 student #1).

6.8.3 Open Ended Responses Relating to Using Application for Reporting Back on Most Important Content from Lecture

When looking at the responses to the question about how the students felt about using the application for reporting back on the most important content in the lecture (see Table 137 in Appendix M) there were a number of themes to emerge with these being shown in Table 92.

Theme	**INFO243**
Specific mention of engagement	2
Specific mention of anonymity	1
Enhancing learning, understanding	3
Total number of responses (some mention more than one theme and others mentioned none).	11

Table 92 – Themes from Open Ended Question about Using Apps for Reporting MIC

Three students commented that the use of the application was not something they took part in with one stating it was "mostly a waste of time" (INFO243 student #9), and another stating "I didn't usually bother with this at the end of the class" (INFO243 student #4) and a third stating "I thought it was good but I preferred the questions that were about specific content" (INFO243 student #8).

The issue of anonymity and shyness was highlighted well by one respondent:

> "it was a good program to use in class, it allowed people to share opinions without anyone knowing who's opinion it was" (INFO243 student #3).

6.8.4 Open Ended Responses Relating to Using Application for Asking Questions at the end of a Lecture

When looking at the responses to the question about how the students felt about using the application for asking questions at the end of a lecture (see Table 138 in Appendix N) the main theme to emerge was related to learning from the responses to questions that they students had not thought of asking themselves with three (3) of the six (6) responses mentioning this specifically.

One particular response illustrated some of the value in this approach to the use of the application:

"When other students asked questions it tested my knowledge as I wanted to see if I could answer their questions. It also helped clarify points I was a little confused on" (INFO243 student #4).

6.9 Summary and Analysis of Survey Findings

This section is a summary of the findings from the results of the survey. The statements which students were asked to rate their level of agreement can be separated into three groups. The first group related to student perception of impact on their learning, with this including the statements relating to lecturer feedback and responses, seeing the answers and responses from other students and groups, and discussing responses with other students. The second group related to student perception of their engagement and enjoyment with this including the encouragement to think about content more which is related to the concept of cognitive engagement (Fredricks et al., 2004). The third group includes the questions relating to the importance of anonymity.

The analysis that follows is based on the different modes in which the applications were used in and looks at the statements in the three groups outlined above, followed by the statements relating to students' willingness to participate verbally or through the use of applications.

6.9.1 Student Perception of Impact on Learning (MCQ)

The questions relating to student perception of the impact on their learning were "Seeing the correct answers to questions that I got wrong helped my learning" (MCQ-B) and "Discussing the questions with the person sitting next to me helped my learning" (MCQ-A) as per Table 112 , page 382.

Seeing the Correct Answers Helping Learning (MCQ-B)

When examining the responses from all of the students about the statements relating to aspects that the students saw as helping their learning the highest average rating across the three courses was seeing the correct answers for questions they had gotten wrong, which is related to the lecturer giving feedback (4.53 as per Table 50, page 187) with the average rating for each of the three courses being similar (4.50 for AMAP500, 4.38 for COSC368 and 4.70 for ECON105 (see Table 53, page 188). Of the statements relating to helping their learning this statement had the highest percentage of students strongly agreeing with it (57.6%) and the highest percentage of students agreeing or strongly agreeing with it (97.0%), with this indicating a very high level of agreement overall (See Table 50, page 187).

Examining the responses to this statement based on whether the students were enrolled in ECON105 or COSC368 shows that there may be a higher level of agreement amongst the students in ECON105. This is supported by the results of the Mann-Whitney test that produced a p-value of 0.036 (see Table 120 in Appendix J). This indicates that there is a significantly higher level of agreement with this statement amongst the ECON105 students compared with the COSC368 students.

When examining this statement based on the gender of the respondents there is little difference in the average rating (4.59 for female students and 4.49 for male students as per Table 55, page 189) with this being supported by the results of the Mann-Whitney test that produced a p-value of 0.255 (see Table 121 in Appendix J). This indicates that there is not a significant difference between the genders when it comes to the importance of feedback.

Examining the level of agreement with this statement based on the age of the respondents shows that there is little difference based on the age (4.61 for under 21 and 4.43 for 21 and over as per Table 57, page 190). This is supported by the results of the Mann-Whitney test that produced a p-value of 0.290 (see Table 122, page 387) indicating that there is not a significant difference when it comes to the age of the students.

When examining this statement based on whether the students have English as a first language or not there is little difference in the average rating (4.56 for students who have English as a first language and 4.36 for students who do not as per Table 59, page 191). This is supported by the results of the Mann-Whitney test that produced a p-value of 0.683 (see Table 123, page 387) indicating that there is not a significant difference when it comes to whether the students have English as a first language or not.

Discussing the Questions Helped Learning (MCQ-A)

The statement asking whether discussing the questions helped their learning had a reasonably high average rating across all of the students (4.11 as per Table 50, page 187) with the average rating for each of the three courses being similar (4.30 for AMAP500, 4.10 for COSC368 and 4.04 for ECON105 (see Table 53, page 188). This statement had a reasonably high percentage of students strongly agreeing with it (34.8%) and a high percentage of students agreeing or strongly agreeing with it (84.8%), with this indicating a high level of agreement overall (See Table 50, page 187).

Examining the responses to this statement based on whether the students were enrolled in ECON105 or COSC368 shows that there is little difference between the students in the two courses. This is supported by the results of the Mann-Whitney test that produced a p-value of 0.838 (see Table 120 in Appendix J). This indicates that there is not a significant difference in the level of agreement with this statement across the students in ECON105 and COSC368.

When examining this statement based on the gender of the respondents there is little difference in the average rating (4.59 for female students and 4.49 for male students as per Table 55, page 189) with this being supported by the results of the Mann-Whitney test that produced a p-value of 0.255

(see Table 121 in Appendix J). This indicates that there is not a significant difference between the genders when it comes to the importance of feedback.

Examining the level of agreement with this statement based on the age of the respondents shows that there is little difference based on the age (4.61 for under 21 and 4.43 for 21 and over as per Table 57, page 190). This is supported by the results of the Mann-Whitney test that produced a p-value of 0.290 (see Table 122, page 387) indicating that there is not a significant difference when it comes to the age of the students.

When examining this statement based on whether the students have English as a first language or not there is little difference in the average rating (4.56 for students who have English as a first language and 4.36 for students who do not as per Table 59, page 191). This is supported by the results of the Mann-Whitney test that produced a p-value of 0.683 (see Table 123, page 387) indicating that there is not a significant difference when it comes to whether the students have English as a first language or not.

Summary Regarding Impact on Learning (MCQ)

There was a high level of agreement with the statements regarding seeing the correct answers helping learning, and discussing the questions helping learning with the overall ratings and percentages of students strongly agreeing and agreeing being higher for seeing the correct answers as compared to discussing the questions. Across the groupings of students, the only aspect where there was a significant difference was in the level of agreement with the statement regarding the importance of seeing the correct answers with the students in ECON105 attaching more importance to this than the students in COSC368.

6.9.2 Student Perception of Engagement and Enjoyment (MCQ)

The questions relating to student perception of the impact on their learning were "Using <name of application> in this way made the lecture more enjoyable" (MCQ-C), "Using <name of application>

in this way helped me to feel more engaged during lectures" (MCQ-D) and "Thinking about how I would answer the questions encouraged me think more about the lecture content" (MCQ-E) as per Table 112 in Appendix I.

Impact on Enjoyment (MCQ-C)

Of the three statements relating to engagement and enjoyment this statement had the second highest percentage of students strongly agreeing with it (47.0%) and with all three statements having the highest equal percentage of students agreeing or strongly agreeing with it (89.4%), with this indicating a very high level of agreement overall (See Table 50, page 187).

The average rating across the two courses relating to whether the use of the application made the lectures more enjoyable was relatively high (4.33) with the ratings across the three courses being relatively similar (4.40 for AMAP500, 4.24 for COSC368 and 4.41 for ECON105 as per Table 53, page 188). This is supported by the results of the Mann-Whitney test that produced a p-value of 0.335 when comparing COSC368 and ECON105 (See Table 120 in Appendix J) indicating that there is little difference between the responses from the students in the two courses. These tests did not include AMAP500 due to the low sample size.

When the responses are analysed based on gender there appears to be some difference (4.48 for female students and 4.23 for male students as per Table 55, page 189). This is not supported by the Mann-Whitney test which resulted in a p-value of 0.108 (see Table 121 in Appendix J) indicating that there is not a significant difference between the genders when it comes to use of the application making lectures more enjoyable.

Examining the level of agreement with this statement based on the age of the respondents shows that there is little difference based on the age (4.37 for under 21 and 4.29 for 21 and over as per Table 57, page 190). This is supported by the Mann-Whitney test that produced a p-value of 0.616

(See Table 122, page 387) indicating that there is not a significant difference between the two age groups when it comes to agreement on this statement.

When examining this statement based on whether the students have English as a first language or not there is some difference in the average rating (4.38 for students who have English as a first language and 4.09 for students who do not as per Table 59, page 191). However, the results of the Mann-Whitney test produced a p-value of 0.476 (See Table 123, page 387) indicating that there is not a significant difference when it comes to the increased enjoyment based on whether students have English as a first language or not.

Impact on Engagement (MCQ-D)

Of the three statements relating to engagement and enjoyment this statement had the highest percentage of students strongly agreeing with it (62.1%) and with all three statements have the same percentage of students agreeing or strongly agreeing with it (89.4%), with this indicating a very high level of agreement overall (See Table 50, page 187).

Across all of the students the statement relating to engagement and enjoyment that had the highest average rating was that the use of the application helped with feeling engaged during lectures (4.47 as per Table 50, page 187), with the students in the three courses having slightly different average ratings (4.80 for AMAP500, 4.52 for COSC368 and 4.30 for ECON105 as per Table 53, page 188). The non-parametric tests that were conducted to determine the level of significance of the difference between COSC368 and ECON105 produced a p-value resulting from the Mann-Whitney test of 0.450 (See Table 120, in Appendix J) indicating that the difference between the ECON105 and COSC368 is not significant. These tests were not conducted with the students from AMAP500 due to the low sample size.

When the responses are analysed based on gender there appears to be some difference (4.63 for female students and 4.36 for male students as per Table 55, page 189). However, the level of difference is not significant as evidenced at a 0.05 level by the Mann-Whitney test which resulted in a p-value of 0.110 (see Table 121 in Appendix J) indicating that there is not a significant difference between the genders.

Examining the level of agreement with this statement based on the age of the respondents shows that there is little difference based on the age (4.42 for under 21 and 4.54 for 21 and over as per Table 57, page 190). This is supported by the results of the Mann-Whitney test that produced a p-value of 0.656 (See Table 122, page 387) indicating that this is not a significant difference between the two age groups when it comes to agreement on this statement.

When examining this statement based on whether the students have English as a first language or not there appears to be some difference in the average rating (4.53 for students who have English as a first language and 4.18 for students who do not as per Table 59, page 191). However, this is not supported by the results of the Mann-Whitney test that produced a p-value of 0.682 (See Table 123, page 387). This indicates that there is not a significant difference based on the English language background of the students when it comes to their level of agreement with this statement.

Thinking about Questions Encouraging Thought about Lecture Content (MCQ-E)

Of the three statements relating to engagement and enjoyment this statement had the lowest percentage of students strongly agreeing with it (28.8%) and with all three statements having the same percentage students agreeing or strongly agreeing (89.4%) this indicates a high level of agreement overall (See Table 50, page 187).

The average rating across the three courses relating to whether the use of the application resulted in the students feeling more engaged was also relatively high (4.14) with the ratings across the three courses being relatively similar (4.00 for AMAP500, 4.14 for COSC368 and 4.19 for ECON105 as per Table 53. page 188). This is supported by the results of the Mann-Whitney test which compared COSC368 and ECON105 and produced a p-value of 0.486 (See Table 120 in Appendix J) indicating that there is not a significant difference between the responses from the students in COSC368 and ECON105. These tests were not conducted with AMAP500 due to the low sample size.

When the responses are analysed based on gender there appears to be little difference (4.11 for female students and 4.15 for male students as per Table 55, page 189). This is supported by the Mann-Whitney test which resulted in a p-value of 0.589 (see Table 121 in Appendix J) indicating that there is not a significant difference between the genders when it comes to agreeing with this statement.

Examining the level of agreement with this statement based on the age of the respondents shows that there is very little difference based on the age (4.13 for under 21 and 4.14 for 21 and over as per Table 57, page 190). This is supported by the Mann-Whitney test that produced a p-value of 0.970 (See Table 122, page 387) indicating that there is little difference between the two age groups when it comes to agreement on this statement.

When examining this statement based on whether the students have English as a first language or not there is some difference in the average rating (4.18 for students who have English as a first language and 3.91 for students who do not as per Table 59, page 191). However, this is not supported by the results of the Mann-Whitney test that produced a p-value of 0.276 (See Table 123, page 387) indicating that there is not a significant difference when it comes to the level of agreement with this statement.

Summary Regarding Impact on Engagement and Enjoyment (MCQ)

There was a high level of agreement with the statements regarding the impact on enjoyment and engagement with the question asking students about their engagement (MCQ-D) having the highest overall rating and percentages of students strongly agreeing and agreeing compared with the other two statements. The question asking students about their enjoyment (MCQ-C) was next highest based on overall average ratings and percentage of students agreeing and strongly agreeing, with the statement regarding encouragement to think about the lecture content (MCQ-E) being just below this.

Across the groupings of students there were not any groups were there was a significant difference in their levels of agreement with any of the statements relating to engagement and enjoyment.

6.9.3 Student Perception of Importance of Anonymity (MCQ)

The question regarding anonymity has a relatively high percentage of students strongly agreeing with it (42.4%) and a relatively high percentage of students either agreeing or strongly agreeing with it (69.7%) indicating a reasonably high level of agreement overall (see Table 50, page 187). This level of agreement appears to be lower than the level of agreement regarding the impact on learning, engagement and enjoyment based on the data in Table 50, page 187).

The average rating across the three courses relating to the importance of anonymity was also relatively high (4.03) with the ratings across the three courses being reasonably similar (4.10 for AMAP500, 3.86 for COSC368 and 4.19 for ECON105 as per Table 53, page 188). This is supported by the results of the Mann-Whitney test that compared COSC368 and ECON105 and produced a p-value of 0.108 (See Table 120 in Appendix J) indicating that there is not a significant difference between the responses from the students in the two courses when it comes to anonymity. The tests did not include AMAP500 due to the small sample size.

When the responses are analysed based on gender there appears to be some difference (4.56 for female students and 3.67 for male students as per Table 55, page 189). This is supported by the Mann-Whitney test which resulted in a p-value of 0.000 (see Table 121 in Appendix J) indicating that there is not a significant difference between the genders when it comes to the importance of anonymity.

Examining the level of agreement with this statement based on the age of the respondents shows that there may be some difference based on the age (4.21 for under 21 and 3.79 for 21 and over as per Table 57, page 190). This is supported by the difference in medians tests which produced a p-value of 0.027 (see Table 122 in Appendix J) suggesting there is a significant difference in the importance of anonymity between the age groups with more importance being attached to it for students under the age of 21 than those 21 or over.

Examining the level of agreement with this statement based on whether the students have English as a first language or not, shows that there may be some difference based on the English language background of the student (4.09 for students with English as a first language and 3.73 for students not having English as a first language as per Table 59, page 191). However, this is not supported by the results of the Mann-Whitney test that produced a p-value of 0.344 (see Table 123 in Appendix J). This suggests that there is not a significant difference when it comes to the importance of anonymity based on whether students have English as their first language or not.

Summary Regarding Importance of Anonymity (MCQ)

Anonymity has a high level of importance across all of the students. There is not a significant difference across the students in the courses that were surveyed, or based on whether the students have English as their first language or not. There is however a significant difference when analysed by age and by gender with students under the age of 21 attaching more by importance to anonymity than those 21 years and older and with female students attaching more importance to anonymity than male students.

Of interest is that the level of agreement with the importance of anonymity is not as high as the level of agreement with some of the other statements.

6.9.4 Student Willingness to Raise Hands or Use Application (MCQ)

The two questions relating to student willingness to participate by raising hands or through use if applications were "If the lecturer asks a multiple choice question I would raise my hand to indicate my answer" (MCQ-G) and "If the lecturer asks a multiple choice question I would use <name of application> to indicate my answer" (MCQ-H) as per Table 113, page 382.

Results of Questions Relating to Student Willingness to Participate (MCQ)

There is a clear difference between student willingness to use an application to indicate answers to multiple choice questions (MCQ-H) in comparison with raising hands (MCQ-G). The average rating increases from 3.00 to 4.67 when moving from raising hands to using an application (see Table 51, page 187) with 12.1% of students indicating that they would raise their hand often, with this increasing to 77.3% when asked how willingly they would use an application.

When looking at this increased willingness across the three courses it appears to be greater in COSC368 (increased by 1.90 from 2.69 to 4.59) compared with AMAP500 and ECON105 where the increases are 1.40 and 1.52 respectively (see Table 54, page 189).

Looking at the increased willingness by gender the difference is not as great with the average rating for female students increasing by 1.81 (from 2.89 to 4.70) compared with male students increasing by 1.56 (from 3.08 to 4.64) as per Table 56, page 190. Of note is that male students were marginally more willing to participate with raising of hands and that female students were marginally more willing to participate using the application.

When looking at the increased willingness by age, the increase for students under 21 years was 1.59 (from 3.13 to 4.74) and the increase for students 21 years and older was 1.75 (from 2.82 to 4.57) as per Table 58, page 191) with the younger students being slightly more willing to participate either way.

When looking at the increased willingness based on whether English is the student's first language the increase for students who have English as their first language is 1.11 (from 2.98 to 4.09) compared with those that do not have English as the first language with 0.64 (from 3.09 to 3.73) as per Table 60, page 191). Of interest was that students without English as their first language were slightly more willing to raise their hands than those with English as their first language.

The statistical tests that compared the level of agreement with statement MCQ-G (If the lecturer asks a multiple choice question I would raise my hand to indicate my answer) across groupings of students by course (ECON105 or COSC368), gender, age or English language background did not reveal any significant differences (see Table 120, Table 121, Table 122, and Table 123 in Appendix J).

The statistical tests that compared the level of agreement with statement MCQ-H (If the lecturer asks a multiple choice question I would use <name of application> to indicate my answer) across groupings of students by course (ECON105 or COSC368), gender, age or English language background did not reveal any significant differences (see Table 120, Table 121, Table 122, and Table 123 in Appendix J).

Summary of Student Willingness to Participate (MCQ)

The results show that there is a clear increase in students' willingness to participate in the answering of multiple choice questions through the use of applications as opposed to raising their hands. When this is looked at based on the course the student is enrolled in, or by gender, age or English language background no statistically significant differences were revealed.

6.9.5 Student Perception of Impact on Learning (SGD)

The analysis of the responses relating to the reporting back on small group discussion includes an analysis of all responses across INFO243 and MPAC607 as well as an analysis of the responses from students in INFO243 only. This was done due to the difference in nature of INFO243 and MPAC607 due to class size, level of study and experience of students across the two courses.

Student Perception of Impact on Their Learning (SGD)

The statements relating to students perceptions of impact on their learning when using an application were "Seeing the answers from some of the other groups helped my learning" (SGD-A), "The lecturer giving feedback on the answers helped my learning" (SGD-B) and "Discussing the questions with the person sitting next to me helped my learning" (SGD-C) as per Table 114, page 383.

Importance of Lecturer Feedback for Learning (SQD-B)

The statement relating to the importance lecturer giving feedback has the highest overall rating of the three statements relating to impact on learning (4.41) with the average rating for the two courses being similar (4.43 for INFO243 and 4.38 for MPAC607 as per Table 63, page 194). Of the statements relating to helping their learning this statement had the highest percentage of students strongly agreeing with it (54.0%) and the second highest percentage of students agreeing or strongly agreeing with it (90.5%), with this indicating a very high level of agreement overall (See Table 61, page 194).

When examining this statement based on the gender of the respondents across both INFO243 and MPAC607 there is some difference in the average rating (4.53 for female students and 4.30 for male students as per Table 66, page 195). However, this is not supported by the results of the Mann-Whitney test that produced a p-value of 0.308 (see Table 125 in Appendix J) indicating that there is not a significant difference between the genders when it comes to the importance of feedback.

The data for the students in INFO243 only was looked at to determine if there was a significant difference between the genders. The Mann-Whitney test produced a p-value of 0.681 (as per Table 128 in Appendix J) which indicates that there is not a significant difference in the importance of feedback across the genders for the students in INFO243.

Examining the level of agreement with this statement based on the age of the respondents across both INFO243 and MPAC607 shows that there may be some difference based on the age (4.19 for under 21 and 4.57 for 21 and over as per Table 68, page 196). The Mann-Whitney test was not able to be used for this test (See Table 126 in Appendix J), but as the data was approximately normal, a Z-score of 1.5357 was able to be used that had an associated p-value of 0.062 which indicates that the difference is not significant at a 0.05 level.

The data for the students in INFO243 only was looked at to determine if there was a significant difference between the age groups. The Mann-Whitney test produced a p-value of 0.011 (as per Table 129 in Appendix J) which indicates that there is a significant difference in the importance of feedback across the age groups for the students in INFO243 with the feedback being more important for the older students.

When examining this statement based on the English language background of the students across INFO243 and MPAC607 there is some difference in the average rating (4.33 for students who have English as a first language and 4.67 for students who do not as per Table 70, page 198). However, this is not supported by the results of the Mann-Whitney test that produced a p-value of 0.174 (See Table 127 in Appendix J) indicating that there is not a significant difference when it comes to the importance of feedback based on the English language background of the students.

The data for the students in INFO243 only was looked at to determine if there was a significant difference between the students who have English as their first language and those who do not. The Mann-Whitney test produced a p-value of 0.407 (as per Table 130 in Appendix J) which indicates that there is not a significant difference in the importance of feedback based on English language background for the students in INFO243.

Importance of Seeing Answers from Other Groups for Learning (SGD-A)

The statement relating to seeing the answers from some of the other groups had a reasonably high average rating (4.38 as per Table 61, page 194) which was the same (within 2 decimal places) in each course separately (as per Table 63, page 194). Of the statements relating to helping their learning this statement had the second highest percentage of students strongly agreeing with it (50.8%) and the highest percentage of students agreeing or strongly agreeing with it (93.7%), with this indicating a very high level of agreement overall (See Table 61, page 194).

When the responses are analysed based on gender for students across INFO243 and MPAC607 there appears to be some difference (4.50 for female students and 4.27 for male students as per Table 66, page 195). However, this is not supported by the Mann-Whitney test which resulted in a p-value of 0.307 (see Table 125 in Appendix J) indicating that there is not a significant difference between the genders when it comes to the usefulness of seeing the answers from other groups.

The data for the students in INFO243 only was looked at to determine if there was a significant difference across the genders in their level of agreement with seeing the answers from other groups helping their learning. The Mann-Whitney test produced a p-value of 0.539 (as per Table 128 in Appendix J) which indicates that there is not a significant difference in the importance of seeing the answers from other groups across the genders for the students in INFO243.

Examining the level of agreement with this statement based on the age of the respondents across both INFO243 and MPAC607 shows that there may be some difference based on the age (4.23 for under 21 and 4.49 for 21 and over as per Table 68, page 196). The Mann-Whitney test was not able to be used for this test (See Table 126 in Appendix J), but as the data was approximately normal, a Z-score of 0.9982 was able to be used that had an associated p-value of 0.159 which indicates that the difference is not significant at a 0.05 level.

The data for the students in INFO243 only was looked at to determine if there was a significant difference across the age groups in their level of agreement with seeing the answers from other groups helping their learning. The Mann-Whitney test produced a p-value of 0.791 (as per Table 129 in Appendix J) which indicates that there is not a significant difference in the importance of seeing the answers from other groups across the age groups for the students in INFO243.

When examining this statement based on the English language background of the student there is some difference in the average rating (4.31 for students who have English as a first language and 4.60 for students across INFO243 and MPAC607 who do not as per Table 70, page 198). However, this is not supported by the results of the Mann-Whitney test that produced a p-value of 0.314 (See Table 127 in Appendix J) indicating that there is not a significant difference when it comes to the importance of feedback based on the English language background of the students.

The data for the students in INFO243 only was looked at to determine if there was a significant difference between students who have English as their first language and those that do not in their level of agreement with seeing the answers from other groups helping their learning. The Mann-Whitney test produced a p-value of 0.843 (as per Table 130 in Appendix J) which indicates that there is not a significant difference in the importance of seeing the answers from other groups based on the English language background for the students in INFO243.

Importance of Discussing Questions with Other Students for Learning (SGD-C)

The third statement directly relating to students' perception of their learning was whether discussing the question with other students helped their learning with this having a lower average rating (3.71) but with the average rating in each course being reasonably different (3.57 for INFO243 and 4.00 for MPAC607) with the gap between the average ratings for the two courses being higher than for the other statements. Of the three statements relating to helping their learning this statement had the lowest percentage of students strongly agreeing with it (17.5%) and the highest percentage of students agreeing or strongly agreeing with it (66.7%), with this indicating a reasonable level of agreement overall (See Table 61, page 194).

The non-parametric tests that were conducted the difference between the two courses was not significant at a 0.05 level, but with the Mann-Whitney test it would have been significant at a 0.10 level with a p-value of 0.084 (See Table 124 in Appendix J). This suggests that the discussion between students may have been more useful for the students in MPAC607 than those in INFO243. This difference is likely to be due to the difference in nature of the two courses with MPAC607 students being enrolled in a professional post graduate qualification as opposed to being undergraduate students which results in the students in the post graduate qualification being slightly older; having had more experience as students; and studying at a higher academic level.

When this statement is looked at based on the gender of the respondents in both INFO243 and MPAC607 the average ratings across the genders are quite close together (3.77 for female student and 3.67 for male students). This is supported by the Mann-Whitney test of 0.756 (see Table 125 in Appendix J). This indicates that there is very little difference regarding the level of agreement with this statement across the genders.

The data for the students in INFO243 only was looked at to determine if there was a significant difference across the genders in their level of agreement with this statement. The Mann-Whitney test produced a p-value of 0.923 (as per Table 128 in Appendix J) which indicates that there is not a significant difference in the level of agreement with this statement based on gender for the students in INFO243.

Examining the level of agreement with this statement based on the age of the respondents in both INFO243 and MPAC607 shows that there may be some difference based on the age (3.31 for under 21 and 4.00 for 21 and over). However, this was not completely supported by the difference in medians test that produced a p-value of 0.128 (See Table 126 in Appendix J).

The data for the students in INFO243 only was looked at to determine if there was a significant difference across the age groups in their level of agreement with this statement. The Mann-Whitney test produced a p-value of 0.027 (as per Table 129 in Appendix J) which indicates that there is a significant difference in the level of agreement with this statement based on age group for the students in INFO243 with the older students having a higher level of agreement with the statement.

When examining this statement for respondents in both INFO243 and MPAC607 based on whether the students have English as a first language or not there is almost no difference in the average rating (3.71 for students who have English as a first language and 3.73 for students who do not). This is supported by the results of the Mann-Whitney test that produced a p-value of 0.903 (See Table 127 in Appendix J). This indicates that there is very little difference when it comes to the importance of feedback based on whether students have English as a first language or not.

The data for the students in INFO243 only was looked at to determine if there was a significant difference based on the English language background of the students in their level of agreement with this statement. The Mann-Whitney test produced a p-value of 0.140 (as per Table 130 in Appendix J) which indicates that there is a significant difference in the level of agreement with this statement based on age group for the students in INFO243 with the older students having a higher level of agreement with the statement.

Summary Regarding Student Perception of Impact on Learning (SGD)

Feedback from the lecturer and seeing the answers from other groups appear to have a high level of importance attached to them across students in the two courses and to students in INFO243 on its own, with the importance of discussing the questions with other students not being seen as being important but still has a relatively high level of importance attached to it.

When looking at the students across both courses and how they perceive the impact of the use of the application on their learning, there is no significant difference based on the gender, age or English language background of the students. However, when the responses from the INFO243 students are looked at in isolation, significant differences are revealed across the age groups with the older students (those 21 years and older) placing significantly more importance than the younger students on the importance of the lecturer giving feedback on the answers and on discussing the questions with the person sitting next to them.

There were no other groupings across both courses or within INFO243 on its own where there were significant differences revealed when it comes to the perception of impact on learning.

6.9.6 Student Perception of Engagement and Enjoyment (SGD)

The statements relating to students perceptions of impact on enjoyment and engagement when using an application were "Using <name of application> in this way made the lecture more enjoyable" (SGD-D), "Using <name of application> in this way helped me to feel more engaged during lectures" (SGD-E) and "Thinking about how I would answer the questions encouraged me think more about the lecture content" (SGD-F) as per Table 114, page 383).

Impact on Enjoyment (SGD-D)

Of the three statements relating to engagement and enjoyment this statement had the highest equal percentage of students strongly agreeing with it (41.3%) and the second highest percentage of students agreeing or strongly agreeing with it (82.5%), with this indicating a very high level of agreement overall (See Table 61, page 194).

The average rating across the two courses relating to whether the use of ,the application made the lectures more enjoyable was relatively high (4.17) with the ratings across the two courses being relatively similar (4.12 for INFO243 and 4.29 for MPAC607 as per Table 63, page 194). This is supported by the results of the Mann-Whitney test that produced a p-value of 0.455 (See Table 124 in Appendix J) indicating that there is little difference between the responses from the students in the two courses.

When the responses are analysed based on gender across both INFO243 and MPAC607 there appears to be little difference (4.13 for female students and 4.21 for male students as per Table 66, page 195). This is supported by the Mann-Whitney test which resulted in a p-value of 0.518 (see Table 125 in Appendix J). This indicates that there is very little difference between the genders when it comes to use of the application making lectures more enjoyable.

The data for the students in INFO243 only was looked at to determine if there was a significant difference based on the gender of the students in their level of agreement with this statement. The Mann-Whitney test produced a p-value of 0.048 (as per Table 128 in Appendix J) which indicates that there is a significant difference in the level of agreement with this statement based on the gender of the students in INFO243 with the male students being in stronger agreement with the statement.

Examining the level of agreement with this statement based on the age of the respondents in INFO243 and MPAC607 shows that there is little difference based on the age (4.08 for under 21 and 4.24 for 21 and over as per Table 68). This is supported by the difference in medians test that produced a p-value of 0.850 (See Table 126 in Appendix J) indicating that this is little difference between the two age groups when it comes to agreement on this statement.

The data for the students in INFO243 only was looked at to determine if there was a significant difference based on the age group of the students in their level of agreement with this statement. The Mann-Whitney test produced a p-value of 0.759 (as per Table 129 in Appendix J) which indicates that there is not a significant difference in the level of agreement with this statement based on the age group of the students in INFO243.

When examining this statement based on whether the students have English as a first language or not there is little difference in the average rating (4.13 for students who have English as a first language and 4.33 for students who do not) across students in INFO243 and MPAC607 (see Table 70). This is supported by the results of the Mann-Whitney test that produced a p-value of 0.177 (See

Table 127 in Appendix J). This indicates that there is not a significant difference when it comes to the increased enjoyment based on whether students have English as a first language or not.

The data for the students in INFO243 only was looked at to determine if there was a significant difference based on the English language background of the students in their level of agreement with this statement. The Mann-Whitney test produced a p-value of 0.817 (as per Table 129 in Appendix J) which indicates that there is not a significant difference in the level of agreement with this statement based on the English language background of the students in INFO243.

Impact on Engagement (SGD-E)

Of the three statements relating to engagement and enjoyment this statement had the highest equal percentage of students strongly agreeing with it (41.3%) and the second highest percentage of students agreeing or strongly agreeing with it (76.2%), with this indicating a high level of agreement overall (See Table 61, page 194).

The average rating across the two courses relating to whether the use of the application resulted in the students feeling more engaged was also relatively high (4.10) with the ratings across the two courses being relatively similar (4.00 for INFO243 and 4.29 for MPAC607 as per Table 63, page 194). This is supported by the results of the Mann-Whitney test that produced a p-value of 0.232 (See Table 124 in Appendix J). This indicates that there is not a significant difference between the responses from the students in the two courses.

When the responses for both INFO243 and MPAC607 are analysed based on gender there appears to be little difference (4.13 for female students and 4.06 for male students as per Table 66, page 195). This is supported by the Mann-Whitney test which resulted in a p-value of 0.770 (see Table 125 in Appendix J). This indicates that there is very little difference between the genders when it comes to use of the application resulting in students feeling more engaged.

The data for the students in INFO243 only was looked at to determine if there was a significant difference based on the gender of the students in their level of agreement with this statement. The Mann-Whitney test produced a p-value of 0.732 (as per Table 128 in Appendix J). This indicates that there is not a significant difference in the level of agreement with this statement based on the gender of the students in INFO243.

Examining the level of agreement with this statement based on the age of the respondents for both INFO243 and MPAC607 shows that there may be some difference based on the age (3.85 for under 21 and 4.27 for 21 and over as per Table 68, page 196). However, this was not supported by the difference in medians test that produced a p-value of 0.529 (See Table 126 in Appendix J). This indicates that there is little difference between the two age groups when it comes to agreement on this statement.

The data for the students in INFO243 only was looked at to determine if there was a significant difference based on the age group of the students in their level of agreement with this statement. The Mann-Whitney test produced a p-value of 0.189 (as per Table 129 in Appendix J). This indicates that there is not a significant difference in the level of agreement with this statement based on the age group of the students in INFO243.

When examining this statement based on the English language background of the students there is some difference in the average rating (4.02 for students who have English as a first language and 4.33 for students who do not) for students across INFO343 and MPAC607 (see Table 70). However, this is not supported by the results of the Mann-Whitney test that produced a p-value of 0.229 (See Table 127 in Appendix J) This indicates that there is not a significant difference when it comes to the increasing engagement based on whether students have English as a first language or not.

The data for the students in INFO243 only was looked at to determine if there was a significant difference based on the English language background of the students in their level of agreement with this statement. The Mann-Whitney test produced a p-value of 0.895 (as per Table 129 in Appendix J). This indicates that there is not a significant difference in the level of agreement with this statement based on the English language background of the students in INFO243.

Thinking about Questions Encouraging Thought about Lecture Content (SGD-F)

Of the three statements relating to engagement and enjoyment this statement had the lowest percentage of students strongly agreeing with it (38.1%) and the highest percentage of students agreeing or strongly agreeing with it (96.8%), with this indicating a very high level of agreement overall (See Table 61, page 194).

This statement has the highest average rating of the statement relating to engagement and enjoyment of 4.30, with the students in the two courses having slightly different average ratings (4.21 for INFO243 and 4.48 for MPAC607 as per Table 63). However, when the non-parametric tests were conducted the p-value resulting from the Mann-Whitney test was 0.210 (See Table 124 in Appendix J) indicating that the difference between the two courses is not significant.

When the responses are analysed based on gender across both INFO243 and MPAC607 there appears to be some difference (4.50 for female students and 4.12 for male students as per Table 66, page 195). This is supported by the Mann-Whitney test which resulted in a p-value of 0.042 (see Table 125 in Appendix J) indicating that there is a significant difference between the genders when it comes to thinking about questions encouraging thought about lecture content, and therefore encouraging cognitive engagement.

The data for the students in INFO243 only was looked at to determine if there was a significant difference based on the gender of the students in their level of agreement with this statement. The Mann-Whitney test produced a p-value of 0.287 (as per Table 128 in Appendix J). This indicates that there is not a significant difference in the level of agreement with this statement based on the gender of the students in INFO243.

Examining the level of agreement with this statement based on the age of the respondents in both INFO243 and MPAC607 shows that there may be some difference based on the age (4.08 for under 21 and 4.46 for 21 and over). However, this was not supported by the difference in medians test that produced a p-value of 0.178 (see Table 126 in Appendix J) indicating that there is little difference between the two age groups when it comes to agreement on this statement.

The data for the students in INFO243 only was looked at to determine if there was a significant difference based on age group of the students in their level of agreement with this statement. The Mann-Whitney test produced a p-value of 0.181 (as per Table 129 in Appendix J) which indicates that there is not a significant difference in the level of agreement with this statement based on the age group of the students in INFO243.

When examining this statement based on the English language background of the students across INFO243 and MPAC607 there appears to be some difference in the average rating (4.19 for students who have English as a first language and 4.67 for students who do not). This is supported by the results of the Mann-Whitney test that produced a p-value of 0.009 (see Table 127 in Appendix J). This indicates that there is a significant difference based on the English language background of the students when it comes to the thinking about the questions encouraging more thought about the lecture content, and as a consequence, increased cognitive engagement.

The data for the students in INFO243 only was looked at to determine if there was a significant difference based on the English language background of the students in their level of agreement with this statement. The Mann-Whitney test produced a p-value of 0.205 (as per Table 130 in Appendix J) which indicates that there is not a significant difference in the level of agreement with this statement based on the English language background of the students in INFO243.

Summary Regarding Impact on Engagement and Enjoyment (SGD)

There is a high level of agreement across the statements relating to enjoyment, engagement and the encouragement of thinking across the students in both courses collectively and in INFO243 on its own.

When looking at the level of agreement based on groupings of students a significant difference is revealed in the importance of thinking about how to answer the questions being more encouraging of thought about the lecture content across the genders and based on English language background. Female students attached more importance to this than male students. Students who do not have English as a first language attach more importance to this than those who do have English as a first language.

When looking at the students from INFO243 only, there was a significant difference across the genders when it came to the use of the application making the lecture more enjoyable with male students agreeing more strongly with this than female students.

6.9.7 Student Perception of Importance of Anonymity (SGD)

The statement regarding the importance of anonymity was "Answering questions anonymously using <name of application> is a reason why I would choose it to answer questions" (SGD-G) as per Table 114, page 383.

Analysis of Responses Regarding Importance of Anonymity (SGD-G)

The question regarding anonymity has a relatively high percentage of students strongly agreeing with it (47.6%) and a relatively high percentage of students either agreeing or strongly agreeing with it (71.4%) indicating a reasonably high level of agreement overall (see Table 61, page 194).

The average rating across the two courses relating to the importance of anonymity was also relatively high (4.11) with the ratings across the two courses being potentially different (4.21 for INFO243 and

3.90 for MPAC607 as per Table 63, page 194). However, this is not supported by the results of the Mann-Whitney test that produced a p-value of 0.328 (See Table 124 in Appendix J) indicating that there is not a significant difference between the responses from the students in the two courses when it comes to anonymity.

When the responses across INFO243 and MPAC607 are analysed based on gender there appears to be little difference (4.23 for female students and 4.00 for male students as per Table 66, page 195). This is supported by the Mann-Whitney test which resulted in a p-value of 0.384 (see Table 125 in Appendix J). This indicates that there is not a significant difference between the genders when it comes to the importance of anonymity.

The data for the students in INFO243 only was looked at to determine if there was a significant difference based on gender in their level of agreement with this statement. The Mann-Whitney test produced a p-value of 0.684 (as per Table 128 in Appendix J) which indicates that there is not a significant difference in the level of agreement with this statement based on the gender of the students in INFO243.

Examining the level of agreement with this statement based on the age of the respondents across INFO243 and MPAC607 shows that there is almost no difference based on the age (4.12 for under 21 and 4.11 for 21 and over as per Table 68, page 196).

The data for the students in INFO243 only was looked at to determine if there was a significant difference based on the age group of the students in their level of agreement with this statement. The Mann-Whitney test produced a p-value of 0.340 (as per Table 129 in Appendix J) which indicates that there is not a significant difference in the level of agreement with this statement based on the age group of the students in INFO243.

Examining the level of agreement with this statement based on the English language background of the students shows that there is almost no difference based on the English language background of the students (4.08 for those with English as a first language and 4.20 for those without English as a first language as per Table 70, page 198) for the students across INFO243 and MPAC607. This is supported by the Mann-Whitney test that produced a p-value of 0.665 (see Table 127 in Appendix J) that indicates there is not a significant difference based on English language background.

The data for the students in INFO243 only was looked at to determine if there was a significant difference based on the English language background of the students in their level of agreement with this statement. The Mann-Whitney test produced a p-value of 0.597 (as per Table 130 in Appendix J) which indicates that there is not a significant difference in the level of agreement with this statement based on the age group of the students in INFO243.

Summary Regarding Importance of Anonymity (SGD-G)

Anonymity has a high level of importance across the students in both courses and for the students in INFO243 on its own. The only statement regarding impact on learning, enjoyment or engagement where the importance of anonymity appeared to have a higher rating was the statement relating to discussing the questions helping student learning. When this is looked at by course, this statement had the lowest level of agreement amongst the students in MPAC607, with the INFO243 students seeing this statement as being more important than discussing the responses helping student learning and the impact on engagement.

When looking at the anonymity issue based on the groupings of students there were no significant differences revealed. Of interest is that the level of agreement with the importance of anonymity is not as high as the level of agreement with some of the other statements.

6.9.8 Student Willingness to Participate Verbally or through use of Applications (SGD)

The two questions relating to student willingness to participate by raising hands or through use of applications were "If the lecturer wanted someone to tell the rest of the class about the answer my group had decided on I would volunteer to do this" (SGD-H) and "If the lecturer wanted someone to use <name of application> to share the answer my group had decided on I would volunteer to do this" (SQD-I) as per Table 115, page 383).

Results of Questions Relating to Student Willingness to Participate (SGD)

There is a clear difference between student willingness to use an application to share what their small group had talked about compared with sharing the response verbally. The average rating increases from 3.11 to 4.02 when moving from sharing verbally to using an application (see Table 62, page 193) with 12.7% of students indicating that they would share their response verbally, with this increasing to 44.4% when asked how willingly they would use an application.

When looking at this increased willingness across the two courses it appears to be greater in INFO243 (increased by 1.05 from 2.81 to 3.86) compared with MPAC607 where the increase is 0.62 (see Table 64, page 194). The data in Table 65 (page 195) presents the percentages of students willing to share often or at least sometimes verbally in comparison with using an application. This shows MPAC607 students being more willing to share verbally (28.6% often compared with 4.8% and 61.9% sometimes compared with 31.0%) and also shows a significant increase in willingness to participate often or at least sometimes when moving from verbal participation to using an application.

Looking at the increased willingness by gender the difference is not as great with the average rating for female students increasing by 0.83 (from 3.27 to 4.10) compared with male students increasing by 0.97 (from 2.97 to 3.94) as per Table 67, page 196).

When looking at the increased willingness by age, the increase for students under 21 years was 1.19 (from 2.69 to 3.88) and the increase for students 21 years and older was 0.70 (from 3.41 to 4.11) as per Table 69 (page 197) with the younger students being slightly more willing to participate either way. This suggests the use of the application has a bigger impact on the willingness of the younger students to participate in this manner.

When looking at the increased willingness based on the English language background of the student, the increase for students who have English as their first language is 0.95 (from 3.25 to 4.15) compared with those that do not have English as the first language with 0.93 (from 2.67 to 3.60) as per Table 71, page 198. This indicates that there is little difference in the increased willingness to participate when it comes to the English language background of the students.

Summary of Student Willingness to Participate (SQD)

The results show that there is a clear increase in students' willingness to participate in sharing of responses from small group discussion through the use of applications as opposed to responding verbally. When this is looked at by age, there is a significant difference in the willingness of students across the two courses to share small group responses verbally, with the older students (21 years and older) being significantly more willing to share verbally than the younger students.

There is also a significant difference in the willingness to share verbally across the two courses with the students in MPAC607 being significantly more willing than those in INFO243. When the responses from only the INFO243 students are looked at, there is (a) a significant difference in the willingness of students based on English language background to share their responses verbally and (b) to use the application to share responses using the application, with students who have English as their first language being significantly more willing on both counts.

6.9.9 Student Perception of Impact on Learning (MIC)

The analysis of the responses relating to the reporting back on the most important content covered in a lecture includes an analysis of the responses from the students in INFO243 only as this was the only course where the application was used in this mode.

Student Perception of Impact on Their Learning (MIC)

The statements relating to students perceptions of impact on their learning when using an application were "Seeing what other groups thought the most important thing was helped my learning" (MIC-A), "The lecturer giving feedback on what the class thought the most important thing was helped my learning" (MIC-B) and "Discussing what the most important thing was with the person sitting next to me helped my learning" (MIC-C) as per Table 116, page 384).

Importance of Feedback from Lecturer for Learning (MIC)

When examining the responses from all of the students about the statements relating to aspects that the students see as helping their learning the highest average rating across the two courses was for the lecturer giving feedback (4.43, see Table 78 on page 204). Of the statements relating to helping their learning this statement had the highest percentage of students strongly agreeing with it (48.6%) and the highest percentage of students agreeing or strongly agreeing with it (94.3%), with this indicating a very high level of agreement overall (See Table 78, page 204).

When examining this statement based on the gender of the respondents there is little difference in the average rating (4.40 for female students and 4.45 for male students as per Table 80, page 205). This is supported by the results of the Mann-Whitney test that produced a p-value of 0.746 (see Table 131 in Appendix J) indicating that there is not a significant difference between the genders when it comes to the importance of feedback.

Examining the level of agreement with this statement based on the age of the respondents shows that there may be some difference based on the age (4.33 for under 21 and 4.57 for 21 and over as per Table 82, page 206). However, this is not supported by the Mann-Whitney test that produced a p-value of 0.592 (see Table 132 in Appendix J) indicating that there is not a significant difference between the age groups when it comes to the importance of feedback.

Due to the small number of students responding to these questions it was not possible to conduct an analysis based on whether the students had English as a first language or not.

Importance of Seeing Responses from Other Groups for Learning (MIC)

The statement relating to seeing the responses from some of the other groups had a high average rating (4.17, see Table 78 on page 204) and was the second highest of the three statements relating to impact on learning. Of the statements relating to helping their learning this statement had the second highest equal percentage of students strongly agreeing with it (31.4%) and the second highest percentage of students agreeing or strongly agreeing with it (91.4%), with this indicating a very high level of agreement overall (See Table 78, page 204).

When the responses are analysed based on gender there appears to be little difference (4.27 for female students and 4.10 for male students as per Table 80, page 195). This is supported by the Mann-Whitney test which resulted in a p-value of 0.713 (see Table 131 in Appendix J) indicating that there is not a significant difference between the genders when it comes to the usefulness of seeing the answers from other groups.

Examining the level of agreement with this statement based on the age of the respondents shows that there may be some difference based on the age (4.00 for under 21 and 4.43 for 21 and over as per Table 82, page 206). However, this was not supported by the results of the Mann-Whitney test that produced a p-value of 0.385 (see Table 132 in Appendix J) indicating that the difference is not significant at a 0.05 level.

Due to the small number of students responding to these questions it was not possible to conduct an analysis based on whether the students had English as a first language or not.

Importance of Discussing Responses with Other Students for Learning (MIC)

The third statement directly relating to students' perception of their learning was whether discussing the responses with other students helped their learning with this having a lower average rating (3.89 as per Table 78, page 204). Of the three statements relating to helping their learning this statement had the second highest equal percentage of students strongly agreeing with it (31.4%) and the third highest percentage of students agreeing or strongly agreeing with it (65.7%), with this indicating a reasonably high level of agreement overall (See Table 78, page 204).

When this statement is looked at based on the gender of the respondents the average ratings across the genders are reasonably close together (3.73 for female student and 4.00 for male students as per Table 80, page 195). This is supported by the Mann-Whitney test that produced a p-value of 0.812 (see Table 131 in Appendix J) indicating that there is very little difference regarding the level of agreement with this statement across the genders.

Examining the level of agreement with this statement based on the age of the respondents shows that there may be some difference based on the age (3.62 for under 21 and 4.29 for 21 and over as per Table 82, page 206). However, this was not supported by the results of the Mann-Whitney test that produced a p-value of 0.592 (See Table 132 in Appendix J).

Due to the small number of students responding to these questions it was not possible to conduct an analysis based on whether the students had English as a first language or not.

Summary Regarding Student Perception of Impact on Learning (MIC)

Feedback from the lecturer and seeing the answers from other groups appear to both have a high level of importance attached to them with the importance of discussing the questions with other students not being seen as being important but still has a relatively high level of importance attached to it. When looking at the responses broken down by gender and by age there were no significant differences revealed.

6.9.10 Student Perception of Engagement and Enjoyment (MIC)

The statements relating to students perceptions of impact on enjoyment and engagement when using an application were "Using <name of application> in this way made the lecture more enjoyable" (MIC-D), "Using <name of application> in this way helped me to feel more engaged during lectures" (MIC-E) and "Thinking about what the most important thing was encouraged me think more about the lecture content" (MIC-F) as per Table 116, page 384).

Impact on Enjoyment (MIC-D)

This statement had a high percentage of students strongly agreeing with it (48.6%) and a high percentage of students agreeing or strongly agreeing with it (82.9%). The average rating across the students in the course was also relatively high (4.29 see Table 78, page 204), with these indicating a very high level of agreement overall (See Table 78, page 204).

When the responses are analysed based on gender there may be some difference (4.13 for female students and 4.40 for male students as per Table 80, page 195), with this not being supported by the Mann-Whitney test which resulted in a p-value of 0.286 (see Table 131 in Appendix J) indicating that there is not a significant difference between the genders when it comes to use of the application making lectures more enjoyable.

Examining the level of agreement with this statement based on the age of the respondents shows that there may be some difference based on the age (4.19 for under 21 and 4.43 for 21 and over as per Table 82, page 206). This is not being supported by Mann-Whitney test that produced a p-value of 1.000 (see Table 132 in Appendix J) indicating that this is almost no difference between the two age groups when it comes to agreement on this statement.

Due to the small number of students responding to these questions it was not possible to conduct an analysis based on whether the students had English as a first language or not.

Impact on Engagement (MIC)

This statement had a high percentage of students strongly agreeing with it (48.6%) and a high percentage of students agreeing or strongly agreeing with it (85.7%). The average rating across the students enrolled in the course was also high (4.31 see Table 78, page 204), with these indicating a very high level of agreement overall (See Table 78, page 204).

When the responses are analysed based on gender there appears to be some difference (4.13 for female students and 4.45 for male students as per Table 80, page 205. This is not supported by the Mann-Whitney test which resulted in a p-value of 0.350 (see Table 131 in Appendix J) indicating that there is not a significant difference between the genders when it comes to use of the application resulting in students feeling more engaged.

Examining the level of agreement with this statement based on the age of the respondents shows that there may be some difference based on the age (4.19 for under 21 and 4.50 for 21 and over as per Table 82, page 206). However, this was not supported by the difference in medians test that produced a p-value of 0.408 (See Table 132 in Appendix J) indicating that there is not a significant difference between the two age groups when it comes to agreement on this statement.

Due to the small number of students responding to these questions it was not possible to conduct an analysis based on whether the students had English as a first language or not.

Thinking about Questions Encouraging Thought about Lecture Content (MIC)

This statement had a lower percentage of students strongly agreeing with it (20.0%) and had a reasonably high percentage of students agreeing or strongly agreeing with it (80.0%). Across all of the students the statement relating to thinking about the questions encouraging more thinking about the lecture content had a reasonably high average rating of 3.97 (See Table 78, page 204), with these indicating a reasonably high level of agreement overall (See Table 78, page 204), but not as high as the statements relating to enjoyment and engagement.

When the responses are analysed based on gender there appears to be little difference (3.93 for female students and 4.00 for male students as per Table 80, page 195). This is supported by the Mann-Whitney test which resulted in a p-value of 0.183 (see Table 131 in Appendix J) indicating that there is not a significant difference between the genders when it comes to thinking about questions encouraging thought about lecture content.

Examining the level of agreement with this statement based on the age of the respondents shows that there is little difference based on the age (3.86 for under 21 and 4.14 for 21 and over as per Table 82, page 206). This is supported by the difference in medians test that produced a p-value of 0.065 (See Table 132 in Appendix J) indicating that this is not a significant difference between the two age groups when it comes to agreement on this statement.

Due to the small number of students responding to these questions it was not possible to conduct an analysis based on whether the students had English as a first language or not.

Summary Regarding Impact on Engagement and Enjoyment (MIC)

High levels of agreement exist with the statements regarding the use of the application helping enjoyment and engagement were evident, with the level of agreement about the use of the application encouraging more thinking about the content not being as high, but still at a reasonably high level. When looking at the responses broken down by gender and by age there were no significant differences revealed.

6.9.11 Student Perception of Importance of Anonymity (MIC)

The statement regarding the importance of anonymity was "Submitting what we thought was the most important thing anonymously using <name of application> is a reason why I would choose to use it to do this" (MIC-G) as per Table 116, page 384.

Analysis of Responses Regarding Importance of Anonymity (MIC-G)

The question regarding anonymity has a relatively high percentage of students strongly agreeing with it (45.7%) and a relatively high percentage of students either agreeing or strongly agreeing with it (77.1%) indicating a reasonably high level of agreement overall. The average rating across the students in the course was also reasonably high (4.17 see Table 78, page 204).

When the responses are analysed based on gender there appears to be little difference (4.20 for female students and 4.15 for male students). This is supported by the Mann-Whitney test which resulted in a p-value of 0.812 (see Table 131 in Appendix J) indicating that there is not a significant difference between the genders when it comes to the importance of anonymity.

Examining the level of agreement with this statement based on the age of the respondents shows that there may be some difference based on the age (4.05 for under 21 and 4.36 for 21 and over as per Table 82, page 206). However, this is not supported by the results of the Mann-Whitney test that produced a p-value of 0.113 indicating that there is not a significant difference between the age groups when it comes to the importance of anonymity.

Due to the small number of students responding to these questions it was not possible to conduct an analysis based on whether the students had English as a first language or not. Of interest is that the level of agreement with the importance of anonymity is not as high as the level of agreement with some of the other statements.

Summary Regarding Importance of Anonymity (MIC)

Anonymity has a high level of importance across all of the students, and the statistical tests reveal no significant difference in its importance based on gender, age or English language background.

6.9.12 Student Willingness to Participate Verbally or through use of Application (MIC)

The two questions relating to student willingness were "If the lecturer wanted someone to tell the rest of the class about the most important thing my group had decided on I would volunteer to do this" (MIC-H) and "If the lecturer wanted someone to use <name of application> to share the most important thing my group had decided on I would volunteer to do this" (MIC-I) as per Table 117, page 384.

Results of Questions Relating to Student Willingness to Participate (MIC)

There is a clear difference between student willingness to use an application to share what the most important content in the lecture was compared with sharing the response verbally. The average rating increases from 2.69 to 3.66 when moving from sharing verbally to using an application (see Table 79, page 204) with 2.9% of students indicating that they would share their response verbally, with this increasing to 25.7% when asked how willingly they would use an application.

Looking at the increased willingness by gender there is little difference in the impact of using the application with the average rating for female students increasing by 1.00 (from 2.53 to 3.53) compared with male students increasing by 0.95 (from 2.80 to 3.75) as per Table 81, page 205.

When looking at the increased willingness by age, the increase for students under 21 years was 1.05 (from 2.38 to 3.43) and the increase for students 21 years and older was 0.86 (from 3.14 to 4.00) as per Table 83 (page 206) with the younger students being slightly more willing to participate either way. This suggests the use of the application has a bigger impact on the willingness of the younger students to participate in this manner.

Due to the low sample size of students who do not have English as their first language who answered these questions it was not appropriate to analyses these responses based on English language background.

Summary of Student Willingness to Participate (MIC)

The results show that there is a clear increase in students' willingness to participate in sharing what their group thought was the most important content in the lecture as opposed to responding verbally.

When this is looked at by gender and age, there is not a significant difference in the willingness to participate using the application or verbally.

6.9.13 Student Perception of Impact on Learning (QEL)

The analysis of the responses relating to the use of the application for asking questions at the end of lectures includes an analysis of the responses from the students in INFO243 only as this was the only course where the application was used in this mode. The analysis is separated into three sections, with the first covering the statement regarding student perception of the impact on their learning, the second covering five statements regarding the impact on student engagement and enjoyment, and the third covering student willingness to participate verbally or through the use of the application.

Student Perception of Impact on Their Learning (QEL)

Of the statements that the students were asked to indicate their level of agreement with, one related to the impact on student learning which was "The lecturer answering the questions that were asked helped my learning" (QEL-A) as per Table 118, page 384.

Importance of Feedback from Lecturer for Learning in the Form of Answering Questions (QEL)

When examining the responses from all of the students regarding the lecturer answering questions helping learning the average rating across the students was quite high (4.45). This statement had a high percentage of students strongly agreeing with it (48.3%) and a high percentage of students agreeing or strongly agreeing with it (96.6%), with this indicating a very high level of agreement overall (See Table 84, page 208).

When examining this statement based on the gender of the respondents there is little difference in the average rating (4.31 for female students and 4.56 for male students as per Table 86, page 209). This is supported by the results of the Mann-Whitney test that produced a p-value of 0.215 (see Table 133 in Appendix J) indicating that there is not a significant difference between the genders when it comes to the importance of the lecturer answering the questions.

Examining the level of agreement with this statement based on the age of the respondents shows that there may be some difference based on the age (4.24 for under 21 and 4.75 for 21 and over as per Table 88, page 210). This is supported by the Mann-Whitney test that produced a p-value of 0.034 (see Table 134 in Appendix J) indicating that there is a significant difference between the age groups when it comes to the importance of the lecturer answering the questions with this being more important for the male students.

Due to the small number of students responding to these questions it was not possible to conduct an analysis based on whether the students had English as a first language or not.

Summary Regarding Student Perception of Impact on Learning (QEL)

There was a very high level of agreement that a lecturer answering the questions at the end of a lecture would help student learning and that there was a significant difference in the level of agreement with the statement with the male students having a significantly higher level of agreement with the statement.

6.9.14 Student Perception of Engagement and Enjoyment (QEL)

The statements relating to students perceptions of impact on enjoyment and engagement when using an application were "Using <name of application> in this way made the lecture more enjoyable" (QEL-B), "Thinking what questions I would ask made me think more about the lecture content" (QEL-C), "Discussing what questions I would ask with the person sitting next to me made me think more about the lecture content" (QEL-D), "Seeing the questions asked by other groups helped me think more about the lecture content" (QEL-E) and "Using <name of application> in this way helped me to feel more engaged during lectures" (QEL-F) as per Table 118, page 384.

Using the Application Helped with Engagement (QEL-F)

Of the five statements, this one had the highest average rating across the students (4.45) and had the highest percentage of students strongly agreeing with it (44.8%) and the highest percentage of students agreeing or strongly agreeing with it (96.6%) as per Table 84 (page 208) with this indicating a very high level of agreement.

When this statement is looked at by gender there may be some difference between the genders (4.31 for female students and 4.56 for male students as per Table 86, page 209). However, this is not supported by the Mann-Whitney test that produced a p-value of 0.215 (see Table 133 in Appendix J) indicating that there is not a significant difference between the genders when it comes to the importance of the lecturer answering the questions.

When this statement is looked at by age there appears to be some difference between the age groups (4.24 for under 21 years and 4.75 for 21 years and older as per Table 88, page 210). However, this is not supported by the results of the Mann-Whitney test that produced a p-value of 0.080 (see Table 134 in Appendix J) indicating that there is not a significant difference between the age groups when it comes to feeling more engaged.

Due to the small number of students responding to these questions it was not possible to conduct an analysis based on whether the students had English as a first language or not.

Seeing the Questions Asked by Others Helped With Thinking about Content (QEL-E)

Of the five statements, this one had the second highest average rating across the students (4.31) and had the second highest percentage of students strongly agreeing with it (37.9%) and the second highest percentage of students agreeing or strongly agreeing with it (93.1%) as per Table 84 (page 208) with this indicating a very high level of agreement.

When this statement is looked at by gender there may be some difference between the genders (4.15 for female students and 4.44 for male students as per Table 86, page 209). However, this is not supported by the Mann-Whitney test that produced a p-value of 0.249 (see Table 133 in Appendix J) indicating that there is not a significant difference between the genders when it comes to the importance of seeing the questions asked by others based on gender.

When this statement is looked at by age there may be some difference between the age groups (4.18 for under 21 years and 4.50 for 21 years and older as per Table 88, page 210). However, this is not supported by the results of the Mann-Whitney test that produced a p-value of 0.245 (see Table 134 in Appendix J) indicating that there is not a significant difference between the age groups when it comes to the importance of seeing the questions asked by others based on age group.

Due to the small number of students responding to these questions it was not possible to conduct an analysis based on whether the students had English as a first language or not.

Using the Application Made the Lecture More Enjoyable (QEL-B)

Of the five statements, this one had the third highest average rating across the students (4.17) and had the third highest percentage of students strongly agreeing with it (31.0%) and the third highest percentage of students agreeing or strongly agreeing with it (86.2%) as per Table 84 (page 208) with this indicating a high level of agreement.

When this statement is looked at by gender there may be some difference between the genders (4.00 for female students and 4.31 for male students as per Table 86, page 209). However, this is not supported by the Mann-Whitney test that produced a p-value of 0.288 (see Table 133 in Appendix J) indicating that there is not a significant difference between the genders when it comes to the use of the application increasing enjoyment based on gender.

When this statement is looked at by age there may be some difference between the age groups (3.94 for under 21 years and 4.50 for 21 years and older as per Table 88, page 210), This is supported by the results of the Mann-Whitney test that produced a p-value of 0.048 (see Table 134 in Appendix J) indicating that there is a significant difference between the age groups when it comes to the use of the application increasing enjoyment based on age group with the older students more strongly agreeing with this.

Due to the small number of students responding to these questions it was not possible to conduct an analysis based on whether the students had English as a first language or not.

Thinking About What Questions to Ask Encouraged Thinking about Lecture Content (QEL-C)

Of the five statements, this one had the fourth highest average rating across the students (3.86) and had the lowest percentage of students strongly agreeing with it (17.2%) and the fourth highest percentage of students agreeing or strongly agreeing with it (72.4%) as per Table 84 (page 208) with this indicating a reasonably high level of agreement.

When this statement is looked at by gender there may be some difference between the genders (3.54 for female students and 4.13 for male students as per Table 86, page 209). However, this is not supported by the Mann-Whitney test that produced a p-value of 0.068 but being supported by the results of the difference in medians test that produced a p-value of 0.048 (see Table 133 in Appendix J). This would indicate that there is a significant difference between the genders when it comes to thinking about the questions to ask encouraging more thinking about the lecture content and therefore increasing cognitive engagement based on gender with male students being more strongly in agreement.

When this statement is looked at by age there may be some difference between the age groups (3.59 for under 21 years and 4.25 for 21 years and older as per Table 88, page 210). This is supported by the results of the Mann-Whitney test that produced a p-value of 0.030 (see Table 134 in Appendix J) indicating that there is a significant difference between the age groups when it comes to thinking about the questions to ask encouraging more thinking about the lecture content and therefore increasing cognitive engagement based on age group with older students being more strongly in agreement.

Due to the small number of students responding to these questions it was not possible to conduct an analysis based on whether the students had English as a first language or not.

Discussing What Questions to Ask Encouraged Thinking about Lecture Content (QEL-D)

Of the five statements, this one had the lowest average rating across the students (3.79) and had the second lowest percentage of students strongly agreeing with it (20.7%) and the lowest percentage of students agreeing or strongly agreeing with it (62.1%) as per Table 84 (page 208) with this indicating a reasonably high level of agreement.

When this statement is looked at by gender there may be some difference between the genders (3.23 for female students and 4.25 for male students as per Table 86, page 209). This is supported by the Mann-Whitney test that produced a p-value of 0.001 (see Table 133 in Appendix J). This would indicate that there is a significant difference between the genders when it comes to discussing the questions to ask encouraging more thinking about the lecture content and therefore increasing cognitive engagement based on gender with male students being more strongly in agreement.

When this statement is looked at by age there may be some difference between the age groups (3.41 for under 21 years and 4.33 for 21 years and older as per Table 88, page 210). This is supported by the results of the Mann-Whitney test that produced a p-value of 0.004 (see Table 134 in Appendix J) indicating that there is a significant difference between the age groups when it comes to discussing the questions to ask encouraging more thinking about the lecture content and therefore increasing cognitive engagement based on age group with older students being more strongly in agreement.

Due to the small number of students responding to these questions it was not possible to conduct an analysis based on whether the students had English as a first language or not.

Summary Regarding Impact on Engagement and Enjoyment (QEL)

There was a high level of agreement across all of these statements regarding enjoyment and engagement with the highest levels of agreement relating to the students' perception of their own engagement and the benefit of seeing other students' questions.

Statement QEL-C (Thinking what questions I would ask made me think more about the lecture content) and QEL-D (Discussing what questions I would ask with the person sitting next to me made me think more about the lecture content) related to increased cognitive engagement. Statistical tests revealed that there was a significantly higher level of agreement with both of these statements amongst the older students (21 years and older) than the younger students and amongst the male students compared with the female students. This suggests that the approach of using the application for the students asking questions at the end of lecturers is more encouraging of cognitive engagement amongst older students and male students.

The other statement that revealed a significant difference was QEL-B (Using <name of application> in this way made the lecture more enjoyable) with the older students (21 years and over) reporting a higher level of agreement than the younger students.

6.9.15 Student Willingness to Participate Verbally or through use of Application (QEL)

The two questions relating to student willingness to participate by raising hands or through use if applications were "If at the end of the lecture the lecturer asks "are there any questions" and there is something I was wondering about, I would ask about it in front of the class" (QEL-G) and "If at the end of the lecture the lecturer asked for any questions to be submitted using <name of application> I would consider doing so" (QEL-H) as per Table 119, page 385.

Results of Questions Relating to Student Willingness to Participate (QEL)

There is a clear difference between student willingness to use an application to ask questions at the end of a lecture compared with asking questions verbally. The average rating increases from 2.48 to 3.83 when comparing asking verbally and using the application to ask questions (see Table 85, page 208) with none of the students indicating that they would ask questions at the end of a lecture often, with this increasing to 34.5% when asked how willingly they would use an application.

Looking at the increased willingness by gender there is little difference in the impact of using the application with the average rating for female students increasing by 1.39 (from 2.15 to 3.54) compared with male students increasing by 1.31 (from 2.75 to 4.06) as per Table 87, page 209. When looking at the increased willingness by age, the increase for students under 21 years was 1.30 (from 2.29 to 3.59) and the increase for students 21 years and older was 1.42 (from 2.75 to 4.17) as per Table 89 (page 210) with the older students being more willing to participate either way.

Due to the low sample size of students who do not have English as their first language who answered these questions it was not appropriate to analyses these responses based on English language background.

Summary of Student Willingness to Participate (QEL)

The results show that there is a clear increase in students' willingness to participate in sharing what their group thought was the most important content in the lecture as opposed to responding verbally. When this is looked at by gender and age, there is not a significant difference in the willingness to participate using the application or verbally.

6.10 Summary of Main Points from Student Surveys

A summary of the main points to emerge from the student surveys is shown in Table 93 (page 262), Table 94 (page 263), and Table 95 (page 264). The summary in these tables is organised by the mode of use and for each mode of use by issues relating to (a) impact on learning, (b) impact on engagement and enjoyment, (c) the importance of anonymity and (d) the impact on student willingness to participate.

Mode	Impact on Learning	Engagement and Enjoyment	Importance of Anonymity	Student Willingness to Participate
MCQ	High level of agreement that the use of the APOD helped student learning. Higher agreement with seeing the correct answers helping than discussing the questions helping. Importance of seeing the correct answers was significantly higher in the larger first year course (where use was optional and formative) than the smaller third year course (where the use was for summative assessment). There were no other significant differences across groupings.	High level of agreement that students felt more engaged, and almost as high when it came to increased enjoyment, followed by being encouraged to think more about lecture content (cognitive engagement). No significant differences across groupings.	High levels of agreement with the importance of anonymity but not quite as high as for other statements. Female students attach significantly more importance to anonymity than male students. Students under 21 attach more importance to anonymity than students 21 and older. There were no other significant differences across groupings.	A clear increase in students' willingness to participate in the answering of multiple choice questions through the use of APODs as opposed to raising their hands. No significant differences across groupings.

Table 93 – Summary of Main Points from Student Surveys – Part 1

Mode	Impact on Learning	Engagement and Enjoyment	Importance of Anonymity	Student Willingness to Participate
SGD	High level of agreement with the importance of feedback from the lecturer and slightly less importance of seeing the answers from other groups. Lesser importance placed on discussing the questions. When looking at the larger undergraduate course in isolation, students 21 and older were placing significantly more importance on lecturer feedback. There were no other significant differences across groupings.	High level of agreement that students felt more engaged; felt that learning was more enjoyable; and that thinking about content was encouraged. Female students and students not from an English language speaking background attached more importance to the value of thinking about lecture content (cognitive engagement). With the larger undergraduate course male students agreed more strongly with the use of APODs making lectures more enjoyable. There were no other significant differences across groupings.	The importance of anonymity had a high level of agreement, although the level of agreement was lower than it was for some of the statements regarding impact on learning. The students in the smaller post graduate course had the lowest levels of agreement with the importance of anonymity. There were no other significant differences across groupings.	A clear increase in student willingness to participate when using an APOD than verbally. Students 21 years and older significantly more willing to share verbally than those under 21. Students in the smaller post graduate course significantly more willing to share verbally than those in the larger undergraduate course. Within the larger undergraduate course students from an English language background were significantly more likely to share responses verbally or through using an APOD than those not from an English language background. There were no other significant differences across groupings.
MIC	High level of agreement with the importance of feedback from the lecturer and seeing the responses from other groups, with a slightly lower level of agreement with the importance of discussions with other students before responding. There were no significant differences across groupings.	High level of agreement that students felt more engaged and that learning was more enjoyable with a lower, but still reasonably high, level of agreement about the use of APODs encouraging more thinking about the content (cognitive engagement). There were no significant differences across groupings.	The importance of anonymity had a high level of importance. There were no significant differences across groupings.	A clear increase in student willingness to participate when using an APOD than verbally. There were no significant differences across groupings.

Table 94 – Summary of Main Points from Student Surveys – Part 2

Mode	Impact on Learning	Engagement and Enjoyment	Importance of Anonymity	Student Willingness to Participate
QEL	High level of agreement with the importance of the lecturer answering the questions. Male students attach significantly more importance to the lecturer answering the questions compared to the importance attached to this by female students. There were no other significant differences across groupings.	High level of agreement that students felt more engaged and that learning was more enjoyable with the agreement being stronger relating to the increased engagement and being able to see the questions from other students. There significantly higher cognitive engagement reports by the students 21 years and older and the male students, when compared to the students under 21 and the female students respectively. Students 21 years and older reported significantly more enjoyment than the students under 21. There were no other significant differences across groupings.		A clear increase in student willingness to participate when using an APOD than verbally. There were no significant differences across groupings.

Table 95 – Summary of Main Points from Student Surveys – Part 3

6.11 Implications of Survey Findings for Later Phases of the Research

The implications for later phases of the research (which only included the student focus groups) were first, a need to investigate what appeared to be an inconsistency in how the literature and interviews of lecturers and student advisers saw the importance of anonymity in comparison with what appeared to emerge from the surveys. The findings from the survey, while indicating that anonymity is important, do not appear to be suggesting that it as important as the earlier phases suggested.

A second implication was the need to investigate from a student perspective the use of APODs for summative assessment and the issue of whether the use of APODs should be mandatory for all students.

6.12 Student Focus Groups

One of the motivations for conducting the focus group was to triangulate some of the findings of the earlier phases of the study with a model that had been developed from the literature with the aim of further validating some of the findings, particularly as they relate to the importance of anonymity, issues surrounding the ownership of devices like smart phones, the time needed to cover course content and the importance of feedback from the lecturer.

6.12.1 Structure and Organisation of Focus Groups

Seven students responded to an email invitation to participate in the focus group. The students were from two classes that had been taught by the researcher in the previous semester, with the invitation not being sent to students that were being taught by the researcher in the semester the study was completed in.

The focus group was led by the researcher. Prior to the start of the focus group the participants were sent information sheets and consent forms the be signed. The signed consent forms were collected prior to the commencement of the focus group. Notes were taken by the researcher throughout the focus group. At the end of the focus group, the notes were read back to the participants to ensure that what had been recorded was an accurate reflection of what had been discussed.

In the first part of the focus group the students were given a list of 15 statements (see Table 96, page 267) and were asked to rank the statements into order based on how strongly they agreed with them. These statements were developed from themes that emerged from earlier findings in the research, particularly relating to anonymity, student willingness to participate, ease of use, the importance of effective questions, taking up time in lectures, and issues relating to the use of APODs being mandatory and using APODs for recording student attendance.

A more general discussion surrounding the use of the application followed this. The content of this discussion was analysed using thematic analysis based on the themes that emerged from the literature review.

6.12.2 Results from Ranking Exercise in Focus Groups

This section presents an analysis of the results of the ranking exercise that was conducted in the focus group, and on the series of discussions that took place during the focus group, with this being broken down by the themes emerging from the literature review. The statements and the results of the rankings are shown in Table 96. The statements are sorted by the average ranking of how strongly students (listed as A-G) agreed with them. The numbers in the first column indicate the numbers that the statements were originally labelled with. The standard deviation of the ranking for each statement is also shown. A summary of the comments made by participants in the focus group (grouped into categories relating to the themes emerging from the literature review) is also presented.

	Statement	A	B	C	D	E	F	G	Mean	SD
11	I would be happy with using an application like <name of application> to do multi choice quizzes to check on learning during lectures	2	2	8	2	3	4	10	4.4	3.4
7	The lecturer giving feedback on responses to open ended questions helps my learning	5	9	4	6	1	3	4	4.6	2.7
12	<name of application> is easy to use	1	1	7	5	6	10	3	4.7	3.1
5	I would be happy to ask the lecturer a question using an application like <name of application>	10	14	5	3	2	1	1	5.1	5.0
6	I am happy to work on my own answering questions using an application like <name of application>	3	8	10	8	5	5	2	5.9	2.9
15	Questions where there isn't an obvious correct answer are better for my learning	8	7	3	9	10	2	5	6.3	3.2
4	Answering questions out loud and getting them wrong makes me feel bad	13	10	1	7	7	9	9	8.0	3.3
3	I would be happy if we were all required to use an application like <name of application> during lectures	7	4	9	14	12	12	7	9.3	3.7
9	If doing questions using an application like <name of application> shows I am understanding the content then I am less likely to study it	9	5	6	4	13	13	15	9.3	4.8
1	Being able to respond anonymously using an application like <name of application> is important for me	14	13	2	1	11	11	14	9.4	5.7
8	I am happy to work in small groups answering questions using an application like <name of application>	4	12	13	11	9	6	11	9.4	2.5
2	It is possible to overdo it using an application like <name of application>	11	15	14	13	4	8	8	10.4	4.3
10	I would be happy if an application like <name of application> was used to take attendance in lectures	6	6	11	10	14	14	12	10.4	3.0
13	I would be happy if we were all required to get a device to run an application like <name of application> on if we didn't have one	15	3	12	12	15	15	6	11.1	4.9
14	The time taken to use an application like <name of application> can result in losing time for valuable content	12	11	15	15	8	7	13	11.6	3.4

Table 96 – Statements to Rank Level of Agreement with by Mean Ranking

6.12.3 Results from Discussion in Focus Groups

A summary of the comments made by the students in the focus group is presented in the following sections and is organised by the four sub-questions of the overall research question, with the analysis in each section conducted in a manner that is consisten with thematic analysis based on the themes identified in the literature review.

6.12.4 Benefit of Using APODs

Anonymity

Discussion relating to anonymity highlighted that the use of applications for the person would be "good for less extroverted people or those that are shy", and that students feel better about asking a lecturer to slow down if they are anonymous. This was further highlighted by the general feeling that they (the students) would not want to interrupt a lecturer with a question, but would feel OK with asking questions using an application.

Engagement

There were comments indicating that the students felt that there was clearly more engagement, particularly from students who would not normally engage. There were also comments that the use of the applications "makes me think more". There were some comments about how some students did not bother to participate, but there was a general feeling that this was balanced by more students participating than normal. It was also commented that the use of applications in this way encouraged attention.

Making Learning More Enjoyable

It was agreed that the comic relief that the use of applications can provide could result in lectures being more enjoyable and could be good for the classroom environment. This related to the lecturer for one of the courses wearing a purple shirt to their first lecture of the year in a different course and that comments via the application relating to the purple shirt (whether it was being worn or not) continued through that course and into a later course that included some of the students who were in the focus groups. The general feeling was that this added to the enjoyment and atmosphere of learning.

Quality of Learning

There were comments from the students in the focus group that included "it makes things clearer", and "seeing different words that others used was helpful". There was also a general feeling that the activity surrounding the use of the application created a break that was good for their learning.

Comparing Responses

It was commented that if the application was being used for students to ask questions that it is good for other students to be able to see what the student had asked as it is not always possible to hear what the student asked. This was seen as being particularly useful when the lecturer had a long answer to the question as it enabled other students to recall what the question was asking. There was agreement from some of the students that being tested to check their learning during class could result in less studying as students know what it is they know.

Participation

The concept of using the application where lectures are being live streamed to enable students not physically present to participate was discussed. It was agreed that this would be an interesting concept. There was also some discussion about whether the use of an application could increase student confidence, and as a result reduce the amount of studying that a student does.

Feedback

There was a general agreement with the concept that it was good to get feedback and correct and incorrect answers to questions.

Contingent Teaching (CT) and Question Driven Instruction

The concepts of CT and QDI were discussed with the students in the focus groups with the general agreement that both approaches were of value and that they would also work with multiple choice questions.

6.12.5 Challenges of Using APODs

Students not Having or Bringing Device

The concept of making participation using the application a course requirement was discussed with the members of the focus group not being sure if that was a good idea overall, but there was a general feeling that if participation was a requirement for a course, then perhaps the course or institution should provide the technology. There was also a general sense of agreement that students not having a device could be a problem, however it was also agreed that this could be solved by getting students to work in small groups.

Coverage of Course Content

The issue of having time to cover lecture content was also raised during discussion time in the focus group, with some students suggesting that multiple choice questions might be better than questions with open ended answers as a way of not losing as much time for covering content. The risk of overusing the applications (although the statement relating to this was ranked 12th out of the 15 statements) was raised as this could potentially reduce the engagement and interest of students with this also being the subject of some discussion and some agreement in the discussions in the focus groups.

Summative Assessment/Identifying Students

The concept of making participation using the application a course requirement was discussed with the members of the focus group and the students were not sure if this was a good idea overall, but there was a general feeling that if participation was a requirement for a course, then perhaps the course should provide the technology. As indicated earlier, there was also a general sense of agreement that students not having a device could be a problem, however it was also agreed that this could be solved by getting students to work in small groups. A consequence of this is that the use of applications for summative assessment would probably not be a good idea, but that it would be good for formative assessment.

The students were asked for their views on whether applications could or should be used for checking attendance and on whether marks should be allocated for participation. On the subject of checking for attendance it was not generally seen as being a good idea and when it came to the concept of allocating marks for participation there were mixed views. There was a view that there would be some implementation issues, particularly where not all students might have a device. As a consequence of this part of the discussion it was generally felt that it would be better if marks were not allocated for participation so that the use of the applications would remain optional.

The issue of whether or not students could be identified, while not explicitly addressed in the focus groups, appeared to be connected to the concept of anonymity.

6.12.6 Pedagogical Issues Associated with Using APODs

When it came to the use of applications in classes of a range of sizes it was agreed that there was more added value in large classes as there tends to be less interaction as classes get larger. As indicated in the student based challenges, it was generally agreed in the focus groups that it would be better if the use of the applications was optional. The wider range of question types that were possible with using applications as opposed to being restricted to multiple choice questions was seen as being an advantage of the use of clickers.

6.12.7 Cost and Simplicity of Devices

During the discussion in the focus groups the issue of not all students having a device was raised, and how that, in part, could relate to the cost of devices. The use of applications on devices was generally seen as being an improvement over clickers because of familiarity due to many students owning and being regular users of the devices.

6.12.8 Other Concepts Raised in Focus Groups

Other concepts to emerge from the focus groups included:

- The idea of using the applications to profile a room of students for their views on an issue, particularly if it was a controversial issue.
- The concept of using the application where lectures are being live streamed to enable students not physically present to participate as this would help to increase their engagement.

6.12.9 Overall Summary of Focus Groups

While the results of the student surveys did not demonstrate the importance of anonymity as quite as important as it appeared to be in the literature and in the interviews of lecturers and learning advisers, the results from the student focus groups suggest that for some students this is an extremely important factor, and that it is less so for other students. This may be related to where the students sit on the introversion-extroversion spectrum.

The findings from the focus groups also confirm the increase in student engagement; increased enjoyment of learning; and the importance of feedback; from earlier phases of the study. The concept of using small group work to overcome the issue of not all students having a device was agreed with.

The concept that the use of APODs should be optional and for formative assessment, as opposed to being mandatory, for summative assessment, and recording attendance was also agreed with. Issues relating to not overusing APODs and not being able to cover required course content were also touched on and are areas that need further exploration.

7 Analysis, Discussion and Conclusions

In this chapter, the findings from chapter four (pilot study), chapter five (interviews of lecturers and interviews of learning advisers) and chapter six (student surveys and student focus groups) are analysed and discussed with conclusions being drawn that address the overarching research question and associated sub-questions. As indicated at the end of chapter two, there were significant aspects to bring forward from the literature review which were first the benefits and challenges arising from the use of APODs in large lectures as depicted in Table 4 (page 62). Second how these benefits can be attained and the challenges addressed through pedagogically sound use of APODs. Third a special emphasis on the importance of developing effective activities for use with APODs. Fourth a special emphasis on issues relating to the cost and simplicity of devices.

From section 7.3 (commencing on page 324) models are presented that are the main contribution of this research. These models relate to the pedagogical issues surrounding the use of APODs; issues surrounding how to design effective activities for use with APODs; using APODs to cater for different groups of students; the benefits of using APODs in lectures; and the challenges to be addressed when using APODs in lectures. For each of these models a scenario is presented that demonstrates how the model can be used to address the context present in that scenario.

Implications for further research are also identified. The overarching research question and associated sub-questions are represented here as a point of reference.

Overarching Research Question: When and how should applications on personally owned devices be adopted for use in large lectures to enhance student engagement so that the benefits of their use can be achieved while addressing the challenges relating to their use?

Sub Question 1: What are the benefits of using applications on personally owned devices to engage with students in lectures (from a range of different perspectives and across a range of different contexts)?

Sub Question 2: What are the challenges involved in using applications on personally owned devices to engage with students in lectures (from a range of different perspectives and across a range of different contexts) and how can these challenges be addressed?

Sub Question 3: What are the pedagogical implications involved in using applications on personally owned devices to engage with students in lectures?

Sub Question 4: How do issues relating to the cost and simplicity of devices impact on the use of applications on personally owned devices to engage with students in lectures and how can these issues be addressed?

7.1 Analysis by Sub-Question

In this section, the findings from the preceding chapter are analysed based on the themes emerged from the thematic analysis of the literature review and interviews (see Table 40 on page 179). This is followed by a section that highlights the new findings that have emerged as a result of the analysis.

7.1.1 Benefits of Using APODs in Lectures

7.1.1.1 Anonymity for Students

The results of the pilot study highlighted the importance of anonymity with this being suggested by the students who sent in text messages during Phase A of the pilot study asking the lecturer to speak louder and not to talk so fast, with this sort of request very rarely being made verbally in large lectures. Other feedback from students in the pilot study indicated that anonymity was important.

The interviews of lecturers and learning advisers highlighted that anonymity was one of the keys to the success of using APODs to increase student interaction and engagement, particularly in large classes and for students who would not engage otherwise. It was also noted that full anonymity was not going to be possible if the applications were being used for summative assessment.

In the surveys of students (across all modes of use of APODs) there were clear increases in students' willingness to participate anonymously rather than non-anonymously, thereby providing further confirmation that anonymity is a major driving factor. The surveys of students where applications were used for multiple choice questions or for students submitting open ended responses all had a high level of agreement that anonymity was an important factor in students using the application. When it came to the comments made by students, close to one third of the comments across the three different modes in which the applications were used in related to the importance of anonymity with most of these relating to being easier to participate when anonymous and the level of fear and apprehension that some students have when asked to share verbally.

The importance of anonymity was significantly higher for female students than male students for answering multiple choice questions. There is some indication that when used for feedback from small group discussions that undergraduate students saw anonymity as being more important when discussing the questions with other students rather than having an impact on their engagement.

The discussion in the focus groups provided some confirmation that anonymity was an important factor, particularly for those students who are shy, and included that students were more likely to interrupt a lecture with a question or to ask the lecturer to slow down if it could be done anonymously. While the surveys of students did not indicate the importance of anonymity to the same extent as the literature and the interviews of lecturers and learning advisers, it was of interest that of the statements ranked by the members of the focus group, the standard deviation of the ranking relating to the importance of anonymity was the highest of all statements. This suggests that for some students, particularly those who are shy and/or introverted, the concept of anonymity may be very important and potentially enough to make a big difference for them in participating, attending lectures and in some cases enrolling in courses.

The findings from the interviews of lecturers and advisers, the surveys and focus groups all confirm the importance of anonymity relating to large classes in the literature (Binder, 2013; Bristol, 2011; Dunn et al., 2013; Kay & LeSage, 2009a) and particularly relating to students who are shy or introverted (Latham & Hill, 2014). This indicates that anonymity is significantly important for some students, particularly those who may choose to not participate verbally, with these including female students and undergraduate students (with the importance for the undergraduate students being related to one or more of age, class size and student confidence). This high variation of the importance of anonymity is also consistent with the finding that extroversion is negatively correlated to the preference for anonymity (Latham & Hill, 2014). This suggests that to cater for students who are at different ends of the introversion/extroversion spectrum could involve having a range of activities where students can choose to participate with anonymity and without anonymity.

7.1.1.2 Student Engagement

The impact on student engagement was noted in Stage A, Stage B and Stage D of the pilot study. The interviews of lecturers highlight that the desire to increase student engagement during lectures was one of the main motivations for adopting this approach in their lectures, with many of the lecturers indicating that increased engagement was one of the desired outcomes for them. The interviews of learning advisers also highlighted that increasing student engagement was a motivating factor for many of the lecturers they had been involved with, and had also been a common outcome.

With the survey responses also demonstrating that students are on average much more willing to engage and participate anonymously than non-anonymously, this is confirmation that engagement increased in large classes using this type of approach. The questions relating to student perception of their own engagement across all modes of use indicated a very high level of agreement that the use of APODs increased their engagement, with many of the comments, particularly in the classes where APODs were used for multiple choice questions also indicating this. One particular student commented it was the highest level of engagement they had come across in their courses.

Where students were questioned about whether different modes of use of the application encouraged them to think more deeply about the content (as a measure of their cognitive engagement) there was a high level of agreement across all modes, although this was not quite as high as the students' level of agreement about their engagement generally. One student commented that it was "a very good way to engage their thought process" with this being a good indicator of increased cognitive engagement (Fredricks et al., 2004).

When it came to differences across groupings of students, the significant differences that emerged were to do with the questions regarding the use of the application encouraging more thought about the lecture content which is consistent with the idea of cognitive engagement (Fredricks et al., 2004). These were confined to where the application was used for students to make open ended responses, and were varied across the modes in which the application was used.

Interestingly, when the application was used for feedback from small group discussions during lectures, female students indicated significantly higher levels of cognitive engagement than male students, whereas when the application was used for students to ask questions at the end of a lecture, the male students reported significantly higher levels of cognitive engagement than the female students. Also, when the application was used for students asking questions at the end of a lecture, the older students (21 years and older) reported more cognitive engagement than the younger students (under the age of 21).

It was noted in the focus groups that there was clearly more engagement, particularly from students who would not normally be engaging. The comments that the use of the application "makes me think more" were also an indication of increased cognitive engagement (Fredricks et al., 2004). The goal of increasing engagement as one of the driving factors present in the interviews of lecturers and learning advisers was consistent with the literature (Kay & LeSage, 2009a) particularly associated with large classes (Freeman et al., 2006; Kay & LeSage, 2009b; Scornavacca et al. 2007). The findings from the surveys demonstrating that students felt more engaged when using applications on their devices was consistent with the literature regarding the use of ARS increasing student engagement (Blasco-Arcas et al., 2013; Carnaghan et al., 2011; Chen & Lan, 2013; Dunn et al., 2013; Fortner-Wood et al., 2013; Han & Finklestein, 2013; Sternberger, 2012). The benefits highlighted in the findings are also consistent with the literature regarding the benefits of using ARS including the enhancement of student engagement (Calma et al., 2014; Dunn et al., 2013; Habel & Stubbs, 2014; Shishah et al., 2013).

7.1.1.3 Student Interaction

Increased interaction was observed by the lecturers involved with Stage A of the pilot study and was included in the student responses in Stage B and Stage D of the pilot study. From the interviews of lecturers, it was apparent that increasing student interaction was one of the predominant goals in adopting the approaches that they took, and for many it was an outcome that was achieved. The increase in student interaction was also commented on during the interviews of learning advisers with this extending to the concept of breaking the mold of the traditional lecture.

It was noted in the focus groups that the larger the class sizes, the less interaction there tended to be. An extension of this was that the use of APODs would increase some of this interaction. There were also comments in the focus groups about the increased activity that took place when APODs were used.

The increased interaction that was found in the pilot study, the interviews of lecturers and learning advisers and in the focus groups was consistent with the literature (Blasco-Arcas et al., 2013; Kay & LeSage, 2009a; Shishah et al., 2013; Sternberger, 2012) regarding increased interaction from the use of ARS, and in particular as it relates to larger class sizes (DeCaparaiis, 1997; Tobias, 1990; Wolter et al., 2011). That the increased interaction was a motivating factor for many of the lecturers was also consistent with the literature (Kay & LeSage, 2009b; Sternberger, 2012). The increase in interactivity has also seen the development of a number of models that have been reported on in the literature

(Blasco-Arcas et al., 2013) including the CT model (Stewart & Stewart, 2013) and QDI (Beatty et al., 2006).

7.1.1.4 Contingent Teaching & Question Driven Instruction

The responses from students during Stage A of the pilot study proved useful for the lecturer in that some of the lecture time was able to be spent addressing some of the more common errors that students made in one of the questions. During the interviews of lecturers, one lecturer had explicitly set out to use a model of delivery that was consistent with CT and QDI. Other lecturers commented on the concept of using responses from students to create teaching points in a manner that is consistent with CT and QDI, with one lecturer commenting that they gave feedback based (or contingent) on the student responses.

The interviews of learning advisers also highlighted the concept of ideas submitted by the student being used as the basis for discussion in a manner that is also consistent with CT and QDI. There were no questions relating to CT and QDI specifically in the survey and no specific comments about them in the responses from students to the survey. In the focus groups, there was a general agreement that the concepts of CQ and QDI would add some value and that they would also work with multiple choice questions.

The models of question driven instruction (QDI) and contingent teaching (CT) were evident in Stage A of the pilot study where concepts were able to be re-explained. Concepts relating to QDI and CT were noted by a number of the lecturers in their interviews, along with noting that it is technology in the form of ARS generally that can enable these approaches, particularly in large classes. Concepts closely related to QDI and CT were referred to in the learning adviser interviews, particularly as they allow for knowledge gaps to be identified and addressed. This was consistent with the literature (Beatty et al., 2006; Kay & LeSage, 2009a; Wolter et al., 2011), and in particular that these approaches could be helpful in the teaching and learning process (Cline et al., 2012; Stewart & Stewart, 2013). Implicit in the approaches of CT and QDI is the importance of feedback, with this being consistent with the high levels of agreement with the importance of feedback that was present in the results of the surveys and the focus groups.

The concepts of QDI and CT were discussed briefly in the focus groups and were met with general agreement.

7.1.1.5 Student Discussion

The creation of discussion amongst the students was one of the driving forces for the pilot study, and enabling discussion (with feedback) was one of the major motivating factors for some of the lecturers who were interviewed. Related to student discussion was the importance of designing activities that would encourage discussion and the idea that students discussing in small groups with one member submitting a response would help to address the issue of not all students having a device. It was also highlighted from an interview of a learning adviser that the responses from students can create new areas and topics for discussion.

From the student surveys across the different modes where APODs were used, the students' comments as to whether discussing their responses had helped their learning showed a high level of agreement, with there being significantly high levels of importance placed on this when used for feedback from small discussion groups by older students (21 years and older) than younger students (under 21 years) at undergraduate level. The high level of agreement amongst the students surveyed with the statement regarding the discussion helping their learning was consistent with aspects of the literature (Blasco-Arcas et al., 2013) including the use of ARS to facilitate classroom discussion (Friedline et al., 2013) and to facilitate better performance for students (Mazur, 1998; Scornavacca et al., 2007).

7.1.1.6 Feedback

During Stage A of the pilot study it was observed that students were making comments like "I get it now" when the lecturer provided feedback. The interviews of lecturers highlighted that feedback from the lecturer based on the student responses was seen as being very important, particularly in the addressing of student misconceptions that may emerge and incorrect answers that the students may have given to questions. The interviews of learning advisers also highlighted the importance of the timeliness of the feedback so that the misconceptions could be corrected earlier.

The importance of the feedback received by students when applications were used was an aspect where there was a very high level of agreement that feedback helped student learning. This was irrespective of whether it was students seeing the correct answers for multiple choice questions; the lecturer giving feedback on the responses from small group discussions; the lecturer giving feedback on student responses to what was the most important content from the lecture; or the lecturer answering the questions that students asked at the end of the lecture.

There were some differences in how important some groupings of students saw the feedback from lecturers, with female students and younger students (under 21 years) attaching significantly more importance to seeing the correct answers for multiple choice questions than male students and older students (21 years and older) respectively. Older undergraduate students (21 years and older) attach more importance to the feedback from the lecturer on responses from small group discussions than younger students. Comments from students also supported the importance of the feedback with some students stating that knowing what they had gotten correct helped validate their understanding. Where APODs had been used for students asking questions at the end of a lecture, students commented on the usefulness of the questions being answered, particularly with questions they had not thought of asking themselves.

In the focus groups' ranking exercise, the statement relating to the importance of feedback had the second highest mean ranking further indicating the importance of feedback. In the discussions in the focus groups it was generally agreed that getting feedback from the lecturer was important, with this including seeing what the correct and incorrect answers were.

The importance of feedback for students from the surveys, focus groups and interviews of learning advisers was consistent with the literature (Azevedo & Bernard, 1995; Bangert-Downs et al., 1991; Blood &Gulchak, 2013; Calma et al. 2014; Camacho-Minano & del Campo, 2014; Dunn et al., 2013; Flies & Marshall, 2006; Heaslip et al., 2014; Kay & LeSage, 2009a; Kennedy & Robson, 2008; Keough, 2012; Kulik & Kulik, 1998; Nelson & Hauck, 2008). The importance of feedback for lecturers from the interviews of lecturers and learning advisers was consistent with the literature (Beatty et al., 2006; Chui et al., 2013, Kay & LeSage, 2009b) with the importance of the feedback being bi-directional also being consistent with aspects of the literature (Guthrie & Carlin, 2004; Wolter et al., 2011). The importance of the timeliness of feedback specifically identified by the learning advisers that was also implied in the responses of some of the lecturers was also evident in the literature (Azevedo & Bernard, 1995; Bangert-Downs et al., 1991; Blood & Gulchak, 2013; Chui et al., 2013; Dunn et al., 2013; Flies & Marshall, 2006; Kennedy & Robson, 2008; Kulik & Kulik, 1998; Wash, 2014).

7.1.1.7 Student Participation

It was noted in the pilot study that there was an increase in student participation through the observation of the lecturers involved and from student feedback in Stage A (the initial trial of the text messaging system) and from the increased willingness of students to participate in Stage B (extended use of the text messaging system) and Stage D (the use of an application based on mobile devices).

The interviews of lecturers also highlighted that there appears to be an increase in student participation, and in one case enabled students studying at a distance watching real time video streaming of a lecture to participate. In the case where marks were being awarded based on participation this also served as a motivation for students to increase participation. Student responses to questions about their willingness to use applications to share responses as opposed to the traditional raising of hands or sharing verbally indicated a very high willingness to do so in comparison. When it comes to sharing verbally there is a significant difference in the willingness based on age and level of study, with post graduate students and those 21 years and older being significantly more willing to share verbally than undergraduate students and those under the age of 21 respectively.

Amongst the undergraduate students there was a significant difference based on English Language background in the willingness to share responses from small group discussion using an application, with students having English as a first language being significantly more willing to share using the application. It is also noted that there is a marked increase in willingness of students to participate using APODs irrespective of their English Language background. It was mentioned in the focus groups that some students chose not to participate using an application, but that this should be balanced by a higher overall participation rate. This suggests that the use of APODs were removing one of the barriers to participation for many of the students.

The increased participation is consistent with the literature (Blood & Gluchak 2013; Dunn et al., 2013; Kay & LeSage, 2009a; Keough, 2012; Landrum, 2013) in that the use of ARS will increase participation, and is of particular relevance for younger students, students who do not have English as their first language and undergraduate students. The issue of undergraduate students is related to one or more of age, class size and student confidence/experience.

7.1.1.8 Learning Performance

When it comes to the improvement of learning performance the interviews of lecturers suggest that the approach of using APODs appears to help learning, and that encouraging students to work in pairs or small groups for discussion also appears to help the learning performance. The interviews of learning advisers highlighted a different concept in that the use of approaches like ARS can result in students seeing that the lecturers have a plan and care about how well the students are learning, and that students respond positively to this. A significant number of the students in the classes where the application was used for multiple choice questions who made comments (12 out of 28) indicated that the use of the application was good for their learning.

In the focus groups, the statement regarding questions without an obvious answer helping learning had the 6th highest overall mean ranking indicating that there are benefits to learning, with this tying in to the importance of the design of effective questions. In the discussions that took place during the focus groups there was agreement with the concept that the activity surrounding the use of APODs was good for learning. The concept that students realised they understood something during the lecture and not studying that material as much as a consequence also had some agreement in the focus groups. This latter point is connected to some of the findings of Chui et al. (2013) and Sutherlin, Sutherlin and Akpanudo (2013) that showed that students felt more confident about their learning and spent less time preparing out of class, but showed no increase in performance.

That the use of APODs could improve learning performance as identified in the interviews of lecturers and the surveys of students was consistent with the literature (Kay & LeSage, 2009a), with much of this relating to the increased discussion (Blasco-Arcas et al., 2013; Smith et al., 2009; Wolter et al., 2011) and the increased cognitive engagement that this sort of activity creates (Mayer & Wittrock, 2006; Wolter et al., 2011). The design of effective questions was highlighted in the focus groups as being key to the increased learning performance (Beatty et al., 2006; Carnaghan et al., 2011; Innes & Main, 2013; Kay & LeSage, 2009b). That increased participation and engagement can increase learning performance was also identified in the literature (Freeman & Blayney, 2005; Nelson & Hauck, 2008), with the extent of this depending on teaching strategies (Mayer & Wittrock, 2006) and that cognitively engaged students learn more (Wolter et al., 2011). Other important factors in the literature included the importance of lecturers taking an active role (Welch, 2013) and the value of peer instruction or small group discussion (Blasco-Arcas et al., 2013).

7.1.1.9 Quality of Learning

With one of the significant motivations for lecturers being to "see where the class is at" (Lecturer 4), the use of APODs to enable this is seen as being significant. This concept also emerges from the interviews of learning advisers where checking on student learning so that it can be addressed was commented on. This is consistent with the concept of using ARS to resolve misconceptions (Kay & LeSage, 2009a). The very high level of agreement with seeing the correct answers to multiple choice questions; lecturer feedback to responses from small group discussions; and lecturers answering questions asked by students at the end of lectures helping learning are key indicators that the use of APODs in these manners can improve the quality of learning. Irrespective of the mode that the APODs were being used in there was a high level of agreement that student's discussing the responses before submitting would help student learning. This clarification process was consistent with a number of aspects in the literature (Blood & Gluchak, 2013; Heaslip et al., 2014; Keough, 2012; Stewart & Stewart, 2013).

When it came to the use of APODs to submit responses from small group discussions, older students (21 year and over) at undergraduate level had a significantly higher level of agreement regarding the importance of lecturer feedback than younger students (under 21 years) at undergraduate level. When it came to the use of APODs for students asking questions at the end of lectures male students reported a significantly higher level of agreement with this helping their learning than female students. Comments made by students regarding the quality of learning confirmed much of the above and included comments such as *"… very quickly shows you whether you understand it or not…"* and in another case relating to using APODs for asking questions at the end of the lecture a student's comment included *"…. it tested my knowledge as I wanted to see if I could answer their questions…"*. Comments such as these are consistent with idea of identifying much earlier if students had a misunderstanding (Blasco-Arcas et al., 2013).

7.1.1.10 Formative Assessment

Comments like *"I get it now"* that were noticed during Stage A of the pilot study show the benefit of the use of ARS for formative assessment. The results of the lecturer interviews highlighted the use of APODs as a diagnostic tool to enable formative feedback to take place, with the learning adviser interviews highlighting the check on student learning and the use of APODs as a diagnostic tool that are consistent with the concepts of formative assessment.

The students in the third year computer science course (where APODS were used for attendance and summative assessment purposes) had a significantly lower level of agreement with the statement that seeing the correct answers helped their learning than the students in the first year economics class (where APODs were used for formative assessment only). This significant difference could be due to a number of factors including the size of the class and the level of study, but could also be due to the differences between formative and summative assessment, although this cannot be ascertained from the data.

In the discussions in the focus groups it was generally concluded that it would be better if marks were not associated with the use of APODs or for attendance to be recorded using APODs, with this being consistent with more value being added to the learning process through the use of the applications for formative assessment. The benefits of APODs being used for formative assessment that were present in aspects of the pilot study, the interviews of lecturers and the interviews of learning advisers was consistent with the findings of other researchers (Kay & LeSage, 2009a).

When it came to summative assessment the discussion in the focus groups pointed to this perhaps not being a good idea, with agreement levels regarding seeing the correct answers helping being less in the course where APODs were used for summative assessment purposes, while noting that there were some other differences between the courses that could explain some of this. The issues relating to potential issues in the use of APODs for summative assessment were consistent with aspects of the literature (Carnaghan et al., 2011; Han & Finkelstein, 2013; Kay & LeSage, 2009b) which suggest that the use of ARS for formative assessment has a bigger impact on student learning than the use of ARS for summative assessment.

7.1.1.11 Comparing Student Responses

The histogram that was displayed in Stage A of the pilot study was one way of allowing students to compare their responses with others as was displaying the answers to open ended questions. The interviews of lecturers also highlighted the usefulness of students being able to see where they are relative to the rest of the class, with this also being commented on during the learning adviser interviews.

Where APODs had been used for multiple choice questions and for responses from small group discussions there was a high level of agreement that seeing the answers from others in the class was helpful for learning, and in the case of the multiple choice questions the younger students (under 21 years) and female students attached significantly more importance to this than the older students (21 years and older) and male students respectively. Where APODs had been used for students to ask questions at the end of a lecture, students had commented that it was good to see what other questions had been asked because they were questions that they had not thought of themselves, or that it gave them a chance to see if they could answer the questions themselves as a test of their own learning.

The focus group discussions highlighted the value of students being able to compare their responses with those of other students. The findings emerging from the pilot study, the interviews of lecturers, the surveys of students and the focus group discussions regarding the usefulness of students being able to compare their responses was consistent with the literature (Chui et al., 2013; Kay & LeSage, 2009a).

7.1.1.12 Student Attention

Data was not explicitly collected from the students relating to the improving of student attention in lectures through the use of applications, however there were some observations relating to this from the lecturers and in some of the student comments in the surveys and focus groups.

The idea that the use of applications would result in increased student attention was commented on in the interviews of lecturers particularly with students being more involved, and more student attention was observed by the lecturers. One of the ECON105 students surveyed commented how the use of the application *"really helps with keeping interested"*. It was also commented on in the focus groups that the use of applications on the devices helped with encouraging student attention. The comment in the survey and the discussions in the focus groups regarding increased attention appears consistent with the literature that demonstrated that the use of ARS could result in increased student attention (Dunn et al., 2013; Graham et al., 2007; Kaleta & Joostenm 2007; Kay & LeSage, 2009a).

7.1.1.13 Making Learning More Enjoyable

The feedback from students in Phase A of the pilot study indicated that they had enjoyed the approach to learning, with this being commented on by a number of the lecturers who were interviewed. The survey responses to the question regarding whether the use of APODs made lectures more enjoyable had a very high level of agreement across all modes in which the application had been used with one student commenting that they had *"… really enjoyed using the app …"* as a further indication of this.

Where the APODs were used for responses from small group discussion, males in the undergraduate course indicated significantly higher levels of enjoyment than female students (which is interesting when put alongside the finding that this mode showed female students having significantly higher reported cognitive engagement than the male students). Where the APODs were used for students to ask questions at the end of a lecture, older students (21 years and older) reported significantly higher levels of enjoyment than younger students (under 21 years). The idea that the use of APODs could help make learning more enjoyable was also highlighted in one of the focus groups, particularly in relation to light hearted interchanges about a lecturer wearing a purple shirt. The findings from the surveys regarding student enjoyment was consistent with the literature (Blood & Gluchak, 2013; Camacho-Minano & del Campo, 2014; Chen & Lan, 2013; Innes & Main, 2013; Macarthur & Jones, 2008; Stewart & Stewart, 2013) and this extended to making the learning processes more effective (Beekes, 2006; Camacho-Minano & del Campo, 2014; Eastman et al. 2011).

7.1.1.14 Attendance

Data was not explicitly collected from the students relating to the improvement of attendance through the use of APODs in lectures. However, there were suggestions in the interviews of lecturers and learning advisers and in the responses of students that a reduction in attendance could be countered, thereby having the same effect as increasing attendance.

It was noted in some of the interviews of lecturers and learning advisers, with one learning adviser commenting that where some lecturers had required students to turn off their mobile devices in lectures that this had led to a reduction in attendance, so conversely, the concept of the use of APODs during lectures could have a positive impact on attendance. One of the comments made by a student in the survey of INFO243 students demonstrated how not using an anonymous approach, and requiring individual students to answer directly could result in some students not attending.

While it was suggested in the literature (Fortner-Wood et al., 2013; Habel & Stubbs, 2014; Kay & L Sage, 2009a; Nelson & Hauck, 2008) that the use of APODs could serve to increase attendance, there was little evidence of this from the findings of this research. However, from the interviews of advisers and the focus groups the concept of activities that require students to verbally participate, particularly in large classes, could result in reduced attendance. Based on the findings from the interviews of advisers and the focus groups, it was established that lecturers wanting to have students participate and interact more can maintain attendance through the use of APODs.

7.1.1.15 Students Seeing Lecturer Cares about their Learning

Emerging from the learning adviser interviews was the concept that where students can see that the lecturer cares about their learning, this can in itself result in students becoming more engaged.

7.1.2 Challenges Related to Use of APODs in Lectures

7.1.2.1 Students not Having or Bringing Device

The decision to use a text messaging based system in the early phases of the pilot study was to maximise the percentage of students that had a device they could participate with, and this along with having the students discuss their responses in small groups went a long way to addressing this challenge. Stage C of the pilot study demonstrated that the ownership of devices such as smart phones, tablets, and laptops had almost reached the level of mobile phones that were able to send text messages and as such applications running on them could be used in conjunction with small group work to address this challenge.

During the interviews of lecturers there were a number of comments relating to this issue, particularly as it relates to equity where students who are not able to afford a device that is needed may not be able to participate, and potentially benefit from their participation. The concept of institutions owning clickers and lending them to students emerged from one lecturer interview with this having the potential to extend to purchasing low end tablets that could be loaned to students who do not have a device. The use of clickers is seen by some lecturers as dealing with the issue, but does not yield the benefit of being able to ask questions that have open ended responses which were seen as being one of the motivating factors for some of the lecturers. In one case, a lecturer had used an application for checking attendance and for summative assessment purposes but due to the nature of the class being a third year computing and information technology related course, all of the students owned (at least) one suitable device.

The interviews of learning advisers also highlighted this challenge, although some saw this issue as declining in importance as more students have their own device as time goes on. A number of the learning advisers also identified the use of students working in small groups as being a good way to address the issue. The selection criteria developed by one of the learning advisers included whether SMS (text) messaging can be used to submit responses as this would enable students with older mobile phones to participate, and potentially allow for a lecturer or an institution to have a pool of older phones that could be used by students that do not have one.

The issue of not all of the students having a device that an application could run on was an issue that was raised in discussion during the focus groups with the concept of the institution providing the device for the application to run on. This resonates with the findings from one of the lecturer interviews where the institution had placed clicker devices in the library and issued them in a similar style to how they issue books. An extension of this concept could see institutions deciding to purchase entry level tablets at quite cheap prices and make them available for loan from the library for students in classes where the use of APODs was required.

Of interest to emerge from this issue is that the use of small group discussions to deal with the issue is also a very sound pedagogical approach, with the use of small group discussions being one of the motivating factors for some of the lecturers that were interviewed and for this entire study as a whole. The idea of using APODs in conjunction with small group discussions also emerged from the discussions in the focus groups as a way of dealing with the situation where not all students had a device that the application could run on.

Recognition of the issue of students not having or not bringing the required device was underlying many of the decisions made in the research and was also recognised in the interviews of lecturers, the interviews of learning advisers, and in the findings from the focus groups. These decisions included those to use the text messaging based system in the pilot study and the decision to survey students regarding mobile device ownership patterns later in the pilot study prior to adopting applications running on smart phones, tablets or laptops. These decisions were consistent with the importance of this issue that had been identified in the literature (Caldwell, 2007; Kay & LeSage, 2009a; Reay et al., 2005). Of significance in this research was the underlying motive being to facilitate feedback from small group discussion, and how this addresses the challenge of device ownership in a manner that is (a) pedagogically sound including social learning theory (Vygotsky, 1978) and constructivism (Bruner, 1973), and (b) in a manner that is consistent with the literature (Dunn et al., 2013; Scornavacca et al., 2007; Wash, 2014).

7.1.2.2 Development of Effective Questions

The development of effective questions was highlighted as a challenge in the lecturer interviews particularly as it relates to the time that is required to do so. When writing multiple choice questions for use with APODs it is important that the answers that are incorrect are reasonably close to being correct so that discussion and teaching points can be created around why the correct answers are the correct answers. The development of good open ended questions can also be time consuming (and can take up more time during lectures than multiple choice questions). One of the lecturers had commented that the use of APODs results in reduced time distributing clickers and collecting them in at the end of lectures so as to create more time for preparation. This increased preparation to create effective questions was also identified in the interviews of learning advisers as being a challenge and at the same time identified that doing this was one of the keys to success. In the focus groups, it was discussed how APODs could be overused with this being linked to the design of effective questions, and also the types of questions being used. The issues surrounding the development of effective questions for use with APODs was consistent with the literature (Kay & LeSage, 2009a), particularly as it relates to the extra time that would be involved for lecturers (Beatty et al., 2006; Carnaghan et al., 2011; Innes & Main, 2013; Kay & LeSage, 2009b).

7.1.2.3 Technology not Functioning Correctly

One of the contributing reasons for the text messaging based system that was developed in Stage A of the pilot study not being continued was some of the teething difficulties or "*clunkiness*" (from the perspective of the lecturers involved in the pilot study) in its operation and would not have been easy for lecturers who do not have a high degree of ability with information technology to use. In the interviews of lecturers there were cases of applications being used that were designed for the larger screens of tablets and laptops rather than for smart phones, and as a consequence the application did not function as desired.

Issues relating specifically to clickers included the battery life of the hand held devices when class or institution sets were being used and lecturers or learning advisers were required to spend time checking them, whereas when students had their own device the responsibility lay with the students for the battery to be charged. Set up issues, whether using applications on mobile devices or using clickers, were also seen as being a challenge, and highlighted the need for institutional support, which was specifically commented on in two lecturer interviews, with this being the role (institutional support) that the majority of learning advisers were in. The issue of the WiFi infrastructure was also identified by one of the learning advisers. With the application that was used in INFO243, a number of the students downloaded the application as opposed to using the mobile web based version of the application with one student commenting about some difficulties with one version during the focus groups.

These issues emerging from the pilot study, the interviews with lecturers, the interviews with learning advisers, the focus groups, and along with the comment in the survey highlight the significance of having technology that functions well that was highlighted in the literature (Graham et al., 2007; Kay & LeSage, 2009a; Keough, 2012) while noting that some of the issues raised are more to do with clickers than APODs. These issues also highlight the importance of considering the TPACK model (Harris et al., 2009; Koehler & Mishra, 2008) when implementing educational technologies, particularly when it comes to the seamless use of the technologies.

7.1.2.4 Potential for Overuse

This aspect was not specifically identified in the literature review but was added as a result of being identified in the lecturer interviews. This was also highlighted during one of the learning adviser interviews who commented that over use (whether clickers or applications on mobile devices) is a potential challenge. The statement relating to this in the focus group ranking exercise had a mean ranking of 12 out of the 15 questions that were ranked, suggesting that this was not seen as being important as some the other statements. This needs to be balanced with the self-selecting nature of the focus groups and that there were comments from the members of the focus groups that over use of the applications could be an issue. The challenge of not overusing APODs is also related to the design of effective questions (Beatty et al., 2006) and the characteristics of effective learning (Goodyear, 2002).

7.1.2.5 WiFi Issues

One of the consequences of lecturers and institutions adopting the use of APODs instead of clicker devices is that the provision of good WiFi coverage becomes critically important, with this being an important finding emerging from the learning adviser interviews.

7.1.2.6 Coverage of Course Content

One student in INFO243 commented about the coverage of course content in relation to the use of applications for responses from small group discussions; for responding about the most important content from the lecture; and for asking questions at the end of the lecture, indicating that they were all useful, but added the comment that it only be used if there is sufficient time for all of the required content to be covered. The issue of coverage of course content was discussed in the focus groups, with the suggestion being made to using APODs for multi-choice questions as opposed to open-ended questions as this would take less time. The statement in the ranking exercise relating to this had a mean ranking of 11.6 of the 15 statements, with this being the lowest mean ranking of the 15 statements and indicating that this may not be a large issue, however this also needs to be balanced with the self-selecting nature of the focus groups. The issues surrounding the coverage of course content being a potential issue was consistent with the literature (Dunn et al., 2013; Elliot, 2003; Kay & LeSage, 2009a) and is an issue that could be analysed in some depth in future studies.

7.1.2.7 Summative Assessment/Identifying Students

During the focus groups, it was discussed whether the use of the applications should be assessed (summative assessment) with there being general agreement that it would be better if this was not done, with some of this being related to whether or not all students had a device on which the application would run. This is consistent with the literature surrounding issues to do with summative assessment when using ARS (Kay & LeSage, 2009a; Caldwell, 2007). As noted earlier, within this study, the course where APODs were used for summative assessment was a third year computer science course where, because of the nature of the course, all of the students enrolled each had one or more device on which the APOD would run.

Similar to the issue regarding the use of APODs for summative assessment, there was general agreement in the focus groups that it would be better if the APODS were not used to measure attendance and to have some of the grading of a course attached to attendance. The statement in the ranking exercise of "I would be happy if an application like <name of application> was used to take attendance in lectures" had a mean ranking of 13th out of the 15 statements, with this supporting the concept that it is seen by students as not being a good thing to do. This is consistent with the issues identified in the literature (Caldwell, 2007; Kay & LeSage, 2009a) around using ARS for checking attendance and using attendance for grades.

In the pilot study, some of the student feedback in Stage A indicated that from a student perspective there was a real advantage in them not being identified when they responded. While this issue was not raised during the focus groups the discussion surrounding the importance of anonymity was related to the idea of many students wanting to be anonymous when using APODs. This importance of not being able to identify students from their responses was consistent with the literature (Caldwell, 2007; Kay & LeSage, 2009a), with this also relating to the issues to do with summative assessment and attendance for grades.

7.1.2.8 Responding to Student Feedback

While the issue of lecturers finding it challenging to respond to student feedback was evident in the literature review, this was not raised throughout the interviews of lecturers or learning advisers, student surveys or focus groups.

7.1.2.9 New Method of Teaching for Students

In the pilot study, the students appeared to adjust to the new method relatively easily with this also being evident in the ranking exercise that took place in the focus groups that showed that a high level of agreement with the application being easy to use. The literature (Beatty, 2004; Chen & Lan 2013; Kay & LeSage, 2009a) indicated the importance of adjusting to a new method of teaching, with the indications from the finding being that the students did adjust reasonably easily. This ease of adjustment is consistent with the students being digital natives (Prensky, 2001) and/or Net Generation Learners (Robinson & Ritzko, 2006).

7.1.2.10 Discussion of Topics Causing Confusion

This concept did not emerge from within the findings of the study, but remains important and has a strong connection to the design of effective questions (Kay & LeSage, 2009a) and to not overusing ARS.

7.1.2.11 Too Much Effort Required by Students

This concept did not emerge from within the findings of the study but is connected to the ease of use for students (Beeeks, 2006; Chen & Lan, 2013; Dunn et al., 2013; Elliot, 2003; Heaslip et al., 2014; MacArthur & Jones, 2008), which was consistent with the findings from the focus groups where the application was seen as being easy to use. This is also consistent with the earlier discussion relating to students adjusting to a new method of teaching reasonably easily.

7.1.2.12 Negative Feedback

The concept of lecturers negatively responding to students' responses did not emerge from within the findings of the research, however the motives behind many of the lecturers for using APODs or ARS was around giving constructive feedback to the responses.

7.1.2.13 Students with Disabilities

In the focus groups, the benefit of being able to see a question that had been asked by a student was identified as sometimes it was not possible to hear what the student had said, with this having a direct relevance to students with impaired hearing. In one of the lecturer interviews a scenario was recounted in which a visually impaired student had benefitted from hearing other students discuss their responses to a question in a way in which they would not have if the application had not been used in that way. Both of these findings were consistent with the idea of the use of ARS helping students with some disabilities (Blood & Gluchak, 2013). The issue of some students needing specialised equipment and installations was identified in the literature (Carnaghan et al., 2011), and while being significant, could partly be addressed through the use of small group discussions with one member of each group submitting, with this being similar in concept to the small group work addressing the issue of not all students having a device.

7.1.3 Pedagogical Implications Surrounding Use of APODs in Lectures

7.1.3.1 Large Class Issues

The feedback from the students in Stage A of the pilot study and the results of Stage B and Stage D of the pilot study all related to the context of large classes and the increased willingness of students to participate in large classes through the use of ARS were in the form of text messaging based systems or applications on devices. The issue of large classes and the lack of interaction and engagement during them was a motivator for many of the lecturers that were interviewed, with special note taken of the lecturer involved in teacher education who was motivated to find a way of introducing more interaction into a lecture covering the importance of interaction in the classroom. Issues relating to the large classes were also referred to in the interviews of learning advisers, particularly with what they saw as being the increased importance of anonymity as class sizes increase. The discussion in the focus groups also highlighted the usefulness of using the applications in large classes.

The decreased willingness of students to interact and engage in larger classes that was noted particularly in the interviews of lecturers was consistent with the literature (Cutler, 2007; Freeman & Blayney, 2005; Heaslip et al., 2014; Scornavacca et al., 2007; Wolter et al., 2011). That the use of APODs could increase interaction and engagement in large classes was an overriding concept present in the findings of the pilot study, interviews of lecturers, interviews of learning advisers and in the focus groups with this being consistent with much of the literature (Freeman et al., 2006; Heaslip et al., 2014; Landrum, 2013; Shishah et al., 2013; Sternberger, 2012).

7.1.3.2 Constructivism

The importance of Social Constructivism (Vygotsky, 1978) as a pedagogical approach and how it relates to the use of group discussion around topics is strongly connected to the motivation for conducting this research and was evident in Stage A, Stage B and Stage D of the pilot study. The importance of group discussion in this context was also noted by a number of the lecturers in their interviews with one specifically commenting on the use of applications helping to enable the construction of knowledge. The benefit of being able to see the correct and incorrect answers that was identified in the focus groups is related to the concepts of Social Constructivism (Vygotsky, 1978). The concept of social construction of knowledge from the use of ARS emerging from the findings of the pilot study, the interviews of lecturers and the focus groups was consistent with much of the literature surrounding the use of ARS (Brown et al., 1989; Camacho-Minano & del Campo, 2014; Driscoll, 2005; Habel & Stubbs, 2014; Mayer & Wittrock, 2006; Van de Pol et al., 2011; Wolter et al., 2011).

7.1.3.3 Good Teaching Strategies

Emerging from the pilot study was that the approach used in Stage A (the text messaging based system) was useful for increasing interaction and in Stage B and Stage D, where the text messaging system and an application were used it became clear that the approach was very useful in enabling small group discussion with feedback. The desire to increase interaction, engagement and feedback was evident in the motivations of a number of the lecturers who were interviewed, with two of the lecturers who were involved in education having the increased motivation to model good teaching strategies. These findings are consistent with the literature relating to the importance of using ARS along with good teaching strategies (Blood & Gluchak 2013; Brady et al., 2013; Mayer et al., 2009), and the literature relating to successful use of ARS being more about the teaching strategies involved (Christpherson, 2011; Landrum, 2013; Wolter et al., 2011). One of the less successful attempts at using APODs related to a scenario where the motives were more about the adoption of technology with this being consistent with the concept that the use of ARS systems is not a "magic bullet" for improving teaching (Banks, 2006; Stewart & Stewart, 2013).

7.1.3.4 Instructional Design

The importance of instructional design, particularly as it related to the construction of effective questions, was evident in the lecturer interviews with this importance being consistent with the importance of instructional design in this context in the literature (Chen & Lan, 2013) and that improvements to teaching with technology can only really take place alongside good instructional design (Eilks & Byers, 2010).

7.1.3.5 Learning Styles and Cultures

Emerging from one of the learning adviser interviews was the idea of adapting to the life of a new generation rather than fighting it in a manner that has some connection to the idea of digital natives

(Prensky, 2001). This also relates to the students with different learning styles and from different cultures. The issue of different cultures is consistent with some of the literature relating to willingness to ask questions in class being different across cultures (Holtbrugge & Mohr, 2010; Hwang & Francesco, 2010; Latham & Hill, 2014).

The discussion in one of the focus groups included one student relating a scenario where a visiting lecturer from a culture where it is common for students to interrupt to ask questions was under the impression that students had not enjoyed the lecture because they had not asked questions. The focus group discussed this within the context of the power-distance ratio demonstrating that this would impact on students' willingness to ask questions during lectures (Hwang & Francesco, 2010; Latham & Hill, 2014). That there are some significant differences across groups of students based on demographics (gender, language background, age) in the survey responses indicate that some attention should be placed on using APODs in different ways, with this being consistent with the need to consider different learning styles and cultures when using ARS that was present in the literature (Kay & LeSage, 2009a; Latham & Hill, 2014).

7.1.3.6 Specifically Identified Pedagogical Issues

The findings did not address or identify any additional pedagogical issues. The literature relating to the use of ARS along with good teaching practices is evident in much of the findings particularly from the interviews of lecturers and learning advisers (Brady et al., 2013; Flies & Marshall, 2006; Habel & Stubbs, 2014) and the importance of placing pedagogy before technology (Draper & Brown, 2004; Stewart & Stewart, 2013). An underlying theme in much of these findings was the importance of pedagogical development (Han & Finkelstein, 2013).

7.1.3.7 Optional or Mandatory Use

The issue of optional or mandatory participation was discussed in the focus groups with it being generally agreed that requiring participation may not be a good idea, with this partly being related to issues surrounding whether every student had an appropriate device for the application. The statement in the ranking exercise of "I would be happy if we were all required to get a device…." had a mean ranking of 11.1 of 15 which was 14th out of the 15 statements, with this low ranking supporting the concept that participation should be optional. While this decision about being optional or mandatory was identified as being a deployment strategy (Carnaghan et al., 2011), the discussions in the focus group reached a similar conclusion to those around the use of APODs for tracking attendance and summative assessment (Caldwell, 2007; Kay & LeSage, 2009a). This issue is also connected with the issues surrounding device ownership as identified in the literature (Caldwell, 2007; Kay & LeSage, 2009a; Reay et al., 2005).

7.1.4 Issues Relating to Cost and Simplicity of Devices

7.1.4.1 Cost for Students

The texting based system that was developed in Stage A of the pilot study and used in Stage B included two different phone numbers that students could send texts to as at that time students could send text messages for free to numbers only on their own network. During the lecturer interviews the cost to students was seen as a significant issue particularly as it relates to the ownership of devices (which was also seen as being an equity issue), with some lecturers noting that if the students already own a device that this reduces the cost of their participation. The use of freely available applications by a number of these lecturers addresses the cost to student issue, with one of the lecturers who used an application that was not free for students normally having their own funding that covered the student cost.

It was also noted by some lecturers that some institutions had previously required students to purchase clickers for use in class, and that by moving to freely available applications that would run on devices they already owned would serve to reduce this cost (provided that a sufficient number of students own the device), with this concept also emerging from one of the learning adviser interviews. This issue of cost to students was also identified in one of the learning adviser interviews as being an important ingredient in the selection criteria for an application to be adopted by an institution.

The cost of devices was also identified in the focus groups as being a major potential issue, with potential solutions being those of optional use, small group work and the institution providing devices for students who cannot afford them. The development of the system in the pilot study allowing all students to be able to send text messages for free, the lecturer interviews, the learning adviser interviews, and discussions in the focus groups were consistent with the importance of not having a cost barrier to students participating with this being consistent with much of the literature (Carnaghan et al., 2011; Flies & Marshall, 2006; Freeman & Blayney, 2005; Kay & LeSage, 2009a).

The adoption of devices that a high percentage of students own as per the text messaging application in the pilot study and the later adoption of applications on mobile devices was consistent with approaches in the literature (Dunn et al., 2013; Scornavacca et al., 2007; Shishah et al., 2013).

7.1.4.2 Ease of Use for Students

The ease of use for students was commented on in the student feedback to the trial of the text based system in Stage A of the pilot study. In the lecturer interviews, one had commented on the desire to make lectures more user friendly for the students, with others commenting on how many students are already quite familiar with using applications, and one lecturer making the comment that the ease of use was not a big issue as the devices had become like prosthetics for many of the students. The ease of use for students was also identified as an important part of the selection criteria by one of the learning advisers with others commenting that the ease of use was not a big issue for many due to the almost ubiquitous nature of smart phones. An issue that was identified when it comes to the ease of use by one of the advisers is the use of some applications where students can be required to login to use them, and that this can be time consuming.

In the focus groups, it was agreed that the ease of use for students was an important factor, and that the application they had been using was easy to use, with some of this being attributed to most students having familiarity with using applications on their phones, tablets or laptops, with this being especially the case when compared with the use of clickers. The ease of use for students is evident in the findings and was consistent with the literature (Beekes, 2006; Chen & Lan, 2013; Dunn et al., 2013; Elliot, 2003; Heaslip et al., 2014; Macarthur & Jones, 2008), with the familiarity of applications on mobile devices for many students also being identified (Dunn et al., 2013).

7.1.4.3 Ease of Use for Lecturers

The ease of use for lecturers was not commented on significantly by the lecturers, however in one case the importance of good institutional support for lecturers with less experience and confidence with technology was commented on. The issue of ease of use for lecturers was also one of the reasons that the texting based application developed in Stage A of the pilot study was not continued.

For the learning advisers, one of their roles was seen as being able to support lecturers to address the issue of ease of use for them, with some seeing the ease of use as being a factor resulting in some lecturers being resistant to change. The ease of use was also identified as being one of the important criteria for the selection of an application for an institution to adopt. That the ease of use for lecturers was one of the driving forces behind the text messaging system not being continued is consistent with the literature regarding the importance of ease of use for lecturers (Blood & Gluchak, 2013; Flies & Marshall, 2006), and findings from the interviews of lecturers and learning advisers regarding the time for lecturers to adapt, partly because of steep learning curves, was consistent with other aspects of the literature (Carnaghan et al., 2011; Chen & Lan, 2013; Hatch et al., 2005; Keough, 2012; Lincoln, 2009; Sprague & Dahl, 2010).

7.1.4.4 Cost for Lecturers and their Institutions

The texting based application developed in Stage A and used in Stage B of the pilot study involved some development time and the purchase of some software and mobile phones, and the application that was used in Stage D of the pilot study had been developed by students during an in-term project and as part of a summer school scholarship project. The issue of cost to lecturers and their institutions was present in the lecturer interviews with most using applications that were free to use, with a smaller number having funding on either a personal or institutional level to cover the cost. The cost to institutions was also identified as being an important part of the selection criteria by one of the learning advisers for an application to be adopted by an institution.

While the focus groups did not identify this as being an issue, the issue arises out of the potential solution of institutions providing devices to students who cannot afford to purchase the devices for themselves. The importance of considering the costs to institutions was consistent with, and appeared to be more significant than some of the literature (Scornavacca et al., 2007; Kennedy & Robson, 2008).

7.1.5 New Findings

This section summarises the new findings and is organised based on the sub-questions of the overarching research question

7.1.5.1 New Findings Regarding Benefits

New findings emerging from this study relating to the benefits of using APODs involve the themes of attendance, anonymity, participation, engagement and making learning more enjoyable.

With regards to attendance there is some evidence that forcing non-anonymous participation can reduce the attendance of some students. Requiring students to turn off mobile devices in lectures can also serve to reduce attendance by some students. While the second of these points may raise some other interesting questions, this suggests the use of APODs in lectures may address declining attendance in lectures.

When it comes to anonymity, the varied level of importance of anonymity for a range of students has emerged as being a significant finding. As indicated earlier in the analysis and discussion, it may be that students who are more at the extroverted end of the extroversion-introversion scale, anonymity could have a negative impact on the enjoyment of learning. Whereas, for students more at the introverted end of the scale are much more likely to participate and engage if anonymity is an option. This is a concept that would need to be explored in later studies. A consequence of this concept would be that a model for use of APODs that appeals to students at both ends of the extroversion-introversion scale would be to create activities that are based on anonymous use, but at the end of the activity allow for students to make comments or ask questions verbally.

It was also noted that where the APODs were used for multiple choice questions, that female students valued the anonymity significantly more than male students.

Regarding participation, the concept of the use of APODs when live video streaming lectures to enable participation of students who are not present is seen as being a positive enabler of participation. The concept of awarding marks to increase participation has been noted, but there is some suggestion that doing so may have a negative effect on learning and as a consequence the benefit of doing this is unclear.

When it came to engagement it became clear that early adopters of concepts such as the use of APODs had the motivation of increasing engagement, and that lecturers having this motivation was one of the keys to the increase in engagement. The findings show that there is an increased willingness for students to engage in lectures when APODs are used. The mode in which APODs are used can result in statistically significant more reported engagement for some groups of students than for others. An example of this was the use of APODs for responses from small group discussion where female students reported significantly more encouragement of cognitive engagement when this approach was used to answer questions during lectures, whereas male students reported significantly more encouragement of cognitive engagement when used for students asking questions at the end of lectures. While there may be some interesting reasons for this difference between the genders, it does suggest that varying the way in which APODs are used during lectures is likely to have a bigger impact on engagement for a wider range of students. Older students report statistically significantly more cognitive engagement than younger students when the APODs were used for students asking questions at the end of lectures.

When it came to increasing the enjoyment of learning, male students reported statistically significant more enjoyment than female students when using APODs for answering questions based on small group discussion, yet female student were reporting significantly more cognitive engagement that male students. This may be related to how students from the different genders perceive the use of technologies such as APODs and may suggest that males tend to derive enjoyment from the use of the technology as an end in itself, whereas it may be that females are more likely to want to use the technology for a particular purpose. Older students report statistically significant more enjoyment than younger students when using the APODs for students to ask questions at the end of a lecture. Also noted in making learning more enjoyable through the use of APODs is the "purple shirt effect" where an ongoing lighthearted dialog between students and the lecturer about something not specifically related to the content can enhance the learning environment.

APODs can be used in a variety of ways during lectures to maximize engagement, participation and enjoyment across different groups of students based on gender, age and levels of introversion/extroversion. This suggests that the best ways to use APODs in lectures to have a positive impact on classroom environment is to use them in a variety of ways including students answering multiple choice and open ended questions during lectures and students asking questions at the end of lectures.

Other findings emerging from this research relating to the benefits of using APODs involve the themes of interaction, discussion, learning performance, and quality of learning. First, relating to interaction, one of the main forces behind the adoption of APODs has been the desire of lecturers to increase interaction, and in some cases to break the mode of the traditional large class lecture of one-way dialog. What has emerged from this is that where lecturers perceive a need to increase interaction in lectures, the use of APODs is a successful way of achieving this.

Second, the use of the APODs to enable feedback from small group discussions in a manner consistent with social learning theory (Vygostky, 1978) and constructivism (Bruner, 1973) is successful and also addresses some of the issues surrounding the cost and access to devices on which APODs can be used. Older students appear to value the discussion based approach more than younger students, which relates to Adult Learning Theory (Cross, 1981) and Andragogy (Knowles, 1984).

Third, when it comes to learning performance, a finding that emerged was that where students can see that the lecturer has a plan to increase student engagement that this in itself can serve to increase student learning performance and engagement. It was found that students perceive that the use of APODs can benefit their learning. An interesting issue that will need further exploration is that students gain confidence from realising that they understand new material because of the use of APODs and that this can result in studying less, with this having some connection to the study conducted by Sutherlin et al. (2013). This latter point may be related to the findings of prior studies that students enjoyed the use of ARS but without there being a corresponding increase in grades. The impact on student learning performance is also connected to effective use of APODs, and in particular to the design of effective questions (Beatty et al., 2006; Carnaghan et al., 2011; Innes & Main, 2013; Kay & LeSage, 2009b).

Fourth, when it comes to the quality of learning, the importance of feedback was significantly higher for older students when it came to feedback from the lecturer after small group discussions with this being consistent with some of the concepts of Adult Learning Theory (Cross, 1981) and Andragogy (Knowles, 1984). Other new concepts to emerge include that students found value in seeing if they could answer the questions that other students asked using APODs and that the asking of questions at the end of the lecture had male students reporting statistically significantly more help for the learning than female students.

Other findings emerging from this research relating to the benefits of usig APODs involve themes of lecturer feedback, issues to do with formative assessment, and being able to compare responses. When it comes to lecturer feedback different groups of students place more value on the importance of lecturer feedback depending on the mode that the APODs are used. Younger and female students reported a statistically significant higher level of importance of lecturer feedback than older and male students respectively when the APODs are used for multiple choice questions. Older undergraduate students reported a statistically significant higher level of importance of lecturer feedback than younger undergraduate students when the APODs are used for answering small group discussion questions. These points both highlight the importance of using the APODs in a variety of ways so as to maximise the value of lecturer feedback for students.

Relating to formative assessment issues, the students in the course where the APODs were used for summative assessment reported a statistically significant lower level of value placed on seeing the correct answers than students in a course where the APODs were only being used for summative assessment. While this is a significant difference, there are other differences between the two courses including the level of the course and the subject material. This is an area that would warrant further investigation by comparing the responses from students in two courses at the same level and in the same subject where the only difference was the use of the APODs for summative or formative assessment. It was also noted that (a) students under the age of 21 reported a statistically significant higher level of value placed on seeing the correct answer for multiple choice questions than students 21 years old and older, and (b) that female students reported a statistically significant higher level of value placed on seeing the correct answer for multiple choice questions than male students.

7.1.5.2 New Findings Emerging Related to Challenges

The importance of considering pedagogical issues such as the design of effective questions (Beatty et al., 2006) and the characteristics of effective learning (Goodyear, 2002) and not overusing ARS or APODs are intertwined and should be of more importance to lecturers than technological issues when it comes to the use of ARS or APODs in lectures.

Students adjusting to the use of APODs or finding it to require too much effort does not appear to be a significant challenge or issue. Issues related to the use of APODs for summative assessment; using APODs to record attendance; and identifying students are intertwined, and the findings suggest that more benefits are to be gained if the use is optional and for formative assessment. The challenge of how students with disabilities will adapt, while not explored directly, is at least partly offset by the benefits that APODs can provide to students with some disabilities.

7.1.5.3 New Findings Emerging – Pedagogical Issues

The issue of whether it should be mandatory or optional for students to participate in APODs-based activities is strongly connected to the issues of whether APODs should be used for summative or formative assessment; for attendance checking and identifying students. A key to these differences may lie in the concept of mutual engagement in communities of learners (Nesbit, 2008) based on the concept of mutual engagement in communities of practice (Wenger, 1999).

7.1.5.4 New Findings Cost and Simplicity of Devices

Institutions adopting APODs need to consider the level of support required for lecturers who are not confident or experienced users of technology, which in addition to the licensing cost for some commercially available applications can result in significant costs to institutions.

7.2 Summary of Findings from Analysis and Discussion

Through the analysis and discussion of the findings based on the thematic analysis relating to the sub questions of the overarching research questions it becomes apparent that many of the themes are interrelated. This results in the need for a redefinition of the model made up of themes that have a direct mapping to one of the research questions (as per Table 97).

Themes	**Sub Questions**
Classroom Environment Benefits Learning Benefits Assessment Benefits	**Sub Question 1:** What are the benefits of using applications on personally owned devices to engage with students in lectures (from a range of different perspectives and across a range of different contexts)?
Technology Based Challenges Lecturer Based Challenges Student Based Challenges	**Sub Question 2:** What are the challenges involved in using applications on personally owned devices to engage with students in lectures (from a range of different perspectives and across a range of different contexts) and how can these challenges be addressed?
Pedagogical Issues	**Sub Question 3:** What are the pedagogical implications involved in using applications on personally owned devices to engage with students in lectures?
Cost and Simplicity of Devices	**Sub Question 4:** How do issues relating to the cost and simplicity of devices impact on the use of applications on personally owned devices to engage with students in lectures and how can these issues be addressed?

Table 97 – Mapping of Research Sub Questions to Themes

The analysis and discussion of findings and how these relate to the overarching research question is presented in Table 98, with the overarching research question being re-stated here for reference: "When and how should applications on personally owned devices be adopted for use in large lectures to enhance student engagement so that the benefits of their use can be achieved while addressing the challenges relating to their use?"

Five aspects of significance emerge in Table 98. First, there is the decision as to whether in a particular scenario a lecturer should consider the use of APODs in their lectures. Second is the need to address the challenges involved. Third, there is the importance of addressing the pedagogical issues involved. Fourth, there is the importance of designing effective activities that APODs are used for in lectures. Fifth and finally, there is the use of APODs in diverse ways to best cater for different groups of students. These aspects of significance are expanded on in the following sections.

Why should APODs be used in lectures?	• Where there is a desire to increase student interaction, participation and engagement during lectures • Where there is a desire to get feedback from the students so that there learning can be checked on • So that students can check on their understanding • To break the mold of the traditional lecture • To make learning more enjoyable • Can be an enabler of effective and authentic learning
Who should APODs be used with?	• Where the lectures are large enough for there to be a very low percentage of students willing to interact, participate and engage non-anonymously • Where students have less confidence to share their views • In undergraduate courses as opposed to post graduate courses
How should APODs be used in lectures?	• In ways that are pedagogically sound through the design of effective questions, coupled with…. • Closed questions - Multiple choice questions or true/false questions • Short answer questions • Individually • Small group • Students asking questions • Students identifying the most important content from a lecture • In a range of approaches to cater for a range of students (age, gender, language background) • In manners consistent with mutual engagement to address Optional v Mandatory; Summative v Formative; and Attendance checking
When should APODs be used in lectures?	• At the start of the lecture • During the lecture • At the end of the lecture
What needs to be addressed when APODs are going to be used in lectures?	• Cost of devices for students • Simplicity of APODs for students • Simplicity of APODs for lecturer • Cost for institutions • Support for staff willing to adopt but lacking in confidence • What is the best APOD to use • Not overusing APODs

Table 98 – Overall Summary of Analysis and Discussion

7.2.1 Addressing Challenges Involved in Adopting APODs in Lectures

There are a number of challenges involved in adopting APODs for use in lectures that have been identified throughout the course of this research with these challenges being shown in Table 99 (noting that these are challenges to address in the decision to adopt the use of APODs, and are not decisions regarding how to use APODs effectively).

Ease of use for students
Cost for students
Cost for institutions if being adopted across an institution
Cost for lecturers
Ease of use for lecturers
Provision of support for lectures if being adopted across an institution
Quality of WiFi

Table 99 – Challenges to be Addressed in the Adoption of APODs in Lectures

The issues of ease of use for students and cost for students are less of an issue as time goes on as the nature of APODs means that students who do own a device will be familiar with using the applications that run on them. As a high percentage of students already own them, there is no additional cost, provided there is not cost for using the application and that the institution has good WiFi coverage. It is noted that while not every student owns a device that this is best addressed through the APODs based activities being based on work in pairs or small groups. Where a particular APOD is being adopted across an institution, there may be a licensing issue for the institution that would also provide some ongoing support. There will also be the need to provide support to some lecturers in the use of the APOD should they need it, with this relating to the ease of use for lecturers if the APOD is being adopted across an institution. The cost to the institution could also include contemplating the upgrading of WiFi coverage.

The issue of cost to lecturers has some potential to be significant, however of the lecturers who were interviewed that were using APODs (as opposed to clicker technologies), only one was using an application where there was a cost to the lecturer, and this cost had been covered by an institutional research grant. The others were using APODs that were freely available to them. The ease of use for lecturers where they are not adopting an institutionally supported APOD does not appear to be significant from this study as those who were adopting individually did not find the ease of use to be an issue (aside from one lecturer who was directed to become part of a pilot study at their institution).

7.2.2 Deciding Whether to Use APODs in Lectures

The decision as to whether APODs should be used in lectures depends on whether the benefits of using APODs apply in a particular situation. Through the earlier analysis and discussion seven scenarios have been identified in which the use of APODs could be considered with these scenarios being shown in Table 100.

There is a desire to increase participation, interaction and engagement
There is a desire to get feedback from students so that learning can be checked on
There is a desire for students to check on their own learning during lectures
There is a desire to make learning more enjoyable
There is a desire to break the mold of the traditional lecture
The is a desire to have more effective and/or authentic learning
Lectures are being live streamed

Table 100 – Scenarios Where the Use of APODs Should Be Considered

The desire to increase participation, interaction and engagement particularly relates to the scenario of large undergraduate lectures where student desire for anonymity is a significant driving factor in low levels of participation, interaction and engagement. The desire to get feedback from students so that their learning can be checked on allows for misconceptions to be identified and highlighted and addressed within the same lecture, with this concept being similar to students being able to identify their own misconceptions so that they can address this themselves outside of the lecture.

The desire to make learning more enjoyable stems from the evidence that suggests when students are enjoying the learning environment more that they will learn more. This relates to the scenario of having a desire to have more effective and/or authentic learning and highlights the possibilities of using APODs to create a more effective and/or authentic learning environment. The desire to break away from what is seen as being the traditional one-way delivery of content during lectures is a scenario what APODs are able to be employed to enable two-way dialog between lecturers and students.

Where lectures are being live streamed, the use of APODs by the students who are geographically remote from the lecturer would enable them to participate, interact and engage in ways that would not be possible otherwise.

7.2.3 Addressing Pedagogical Issues in Adopting APODs in Lectures

There are a number of pedagogical issues involved in adopting APODs for use in lectures that have been identified throughout the course of the study. The ways in which these issues can be addressed are shown in Table 101.

The use of the APODs should be in such a manner that encourages mutual engagement
Students should be encouraged to work in pairs or small groups
Use APODS for multiple choice questions to check basic understanding and open ended question to check deeper understanding
Use APODs at the start of lectures to check prior knowledge
Use APODs during lectures to build understanding
Use APODs at the end of lectures to check overall understanding
Use APODs for different types of questions and at different stages during the lecture for variety
Ensure the APODs-based activities are designed effectively, including that they are not overused

Table 101 – Pedagogical Issues to Be Addressed in the Adoption of APODs in Lectures

While the use of the APODs in lectures should be optional as opposed to mandatory, the way in which they are used should be in a manner that encourages mutual engagement in that the students have a desire to deepen their understanding through sharing knowledge in a manner that is consistent with communities of practice for knowledge sharing (Wenger, 1999). This sharing of knowledge is partly related to encouraging students to work in pairs and small groups and is consistent with the concepts of social learning theory (Vygostky, 1978), constructivism (Bruner, 1973), Andragogy (Knowles, 1984) and Adult Learning Theory (Cross, 1981).

Decisions about whether to use APODs for multiple choice questions or open ended questions should be based on two factors with the main pedagogical factor being the depth of understanding that is being checked on with the multiple choice questions being better for checking on general concepts and the open ended questions being better for checking deeper understanding. However, with multiple choice questions taking up less time in a lecture than open ended questions, this needs to be taken into consideration too. This could be addressed through more careful design of multiple choice questions that assess students' understanding at a deeper level than traditional multiple choice questions, with this concept being strongly connected to the design of effective questions (Beatty et al., 2006).

Decisions as to when to use APODs during a lecture should be based on three factors relating to the nature of what knowledge is being assessed. First, if the aim is to ask questions relating to students' prior knowledge consistent with the ideas of Andragogy (Knowles, 1984) and Adult Learning Theory (Cross, 1981) then using APODs at the start of a lecture is appropriate. Second, if the aim is to build understanding then use of APODs during a lecture is appropriate and could be done in conjunction with models such as CT (Stewart & Stewart, 2013) and QDI (Beatty et al., 2006). Third, if the aim is to get a check on overall understanding, then the use of APODs at the end of the lecture is suggested, with some consideration being given to using APODs in a manner consistent with the idea of the "one-minute paper" (Hattie, 1997).

Three overarching and intertwining factors to be considered when deciding how and when to use APODs during lectures are the importance of a variety of approaches; and the importance of designing effective questions (Beatty et al., 2006); and not to over use APODs.

7.2.4 Design of Effective Activities Using APODs

The pedagogical issues to be addressed in the previous section pointed to the importance of the design of effective APODs-based activities as being significant. Key decisions to consider in the design of effective activities are shown in Table 102.

Deciding when during the lecture to use APODs-based activities based on what the aim of the activity is.
Deciding on what mode to use the APODs in during the activity based on the type of responses the lecturer wants to receive from the students.
Deciding on whether the student responses to the lecturer will impact on the direction of the lecture as it proceeds.

Table 102 – Key Steps to Consider in the Design of Effective APODs-Based Activities

With the decision as to when the APODs-based activities should take place depending on the aim of the activity, there are a number of possible scenarios that may exist:

First, there may be a desire to review past content from previous lectures or to present students with a problem that they may be able to work out some of the solution to in small groups in a manner consistent with Andragogy (Knowles, 1984); Adult Learning Theory (Cross, 1981); social learning theory (Vygostky, 1978); and constructivism (Bruner, 1973).

Second, if there is a desire to build understanding and check on that understanding as the lecture progresses then APODs should be used during the lecture. Deciding the extent to which student responses will direct the path of the lecture is a significant decision. The importance of students receiving feedback on their responses has been identified as being significant in the findings of the study. If this extends to the path that the lecture follows as result of the student responses, this would take the design of the lecture down the paths of CT (Stewart & Stewart, 2013) and QDI (Beatty et al., 2006).

Third, if there is a desire to check overall understanding of content covered or for activities similar to the "one-minute paper" (Hattie, 1997), then APODs should be used at the end of the lecture.

The decision as to what mode APODs should be used in depends on how deep an understanding of the content is being checked on and the amount of time available. If a basic level of understanding is being checked on, a short quiz made up of 4-5 multiple choice questions should be considered for use. If a deeper level of understanding is being checked on and there is sufficient time, then the use of a mini-case with one or two open ended questions should be considered.

7.2.5 Using APODs to Cater for Different Groups of Students

Through the analysis of survey responses based on demographic and other information there were a number of areas where there were statistically significant differences between different groups of students. These different groups were based on the age of students (under 21 or 21 and older); student gender; the English language background of students; the level of study of the course; and whether the APODs were used for summative assessment or not.

The significant differences between the ages are displayed in Table 103. Suggestions as to how to address the differences are also shown.

Students under the age of 21	• Place a significantly higher level of importance on the anonymity of responses when APODs are used for multiple choice questions • Have a significantly higher level of agreement with the statement regarding discussing questions helping learning when APODs are used for sharing responses from small group discussions

Students over the age of 21	• Are significantly more willing to share the responses from small group discussions verbally
	• Have a significantly higher level of agreement with the statement regarding the lecturer giving feedback on correct answers helping learning when APODs are used for sharing responses from small group discussions
	• Have a significantly higher level of agreement with the following when APODs are used for students to ask questions at the end of a lecture:
	  o That the lecturer answering the questions helped learning
	  o That this made the lectures more enjoyable
	  o That thinking about what questions to ask and discussing the questions to ask encouraged more thinking about the content (leading increased cognitive engagement)

Addressing the differences	The significant differences can be addressed by having a range of activities that to provide a significant difference for both age groups. These include having activities where students can: • be anonymous with their responses • choose to respond verbally (as well as anonymously) • choose to work in pairs or small groups • receive feedback on why the correct answers are correct • be given the opportunity to ask questions at the end of lectures

Table 103 – Catering for Different Age Groups of Students When Using APODs

These significant differences between age groups highlight the need to use APODs and any other teaching strategies in a variety of ways so that it is not one age group experiencing significantly higher benefits than the other on a continual basis. The significant differences between the genders are displayed in Table 104 (page 321). Suggestions as to how to address the differences are also shown.

Female Students	• Place a significantly higher level of importance on the anonymity of responses when APODs are used for multiple choice questions • Report significant higher levels of cognitive engagement when APODs are used for feedback from small group discussions during lectures
Male Students	• Report significantly higher levels of enjoyment when APODs are used for feedback from small group discussions during lectures in the larger undergraduate course • Have a significantly higher level of agreement with the following when APODs are used for students to ask questions at the end of a lecture: o That thinking about what questions to ask and discussing the questions to ask encouraged more thinking about the content (leading increased cognitive engagement)
Addressing the differences	The significant differences can be addressed by having a range of activities that to provide a significant difference for female and male students. These include having activities where students can: • be anonymous with their responses • discuss questions in pairs or small groups • be given the opportunity to ask questions at the end of lectures

Table 104 – Catering for Different Genders When Using APODs

These significant differences between genders highlight the need to use APODs and any other teaching strategies in a variety of ways so that it is not one gender experiencing significantly higher benefits than the other on a continual basis.

The significant differences between students with English as a first language and those were English is not their first language are shown in Table 105. Suggestions as to how to address the differences are also shown.

Students with English as First Language	• Had a significantly higher willingness to verbally share responses from small group discussions in the larger undergraduate course • Had a significantly higher willingness to share responses from small groups using APODs in the larger undergraduate course
Students with English Not as First Language	• Had a significantly higher level of agreement that the use of APODs for responses from small group discussion encouraged cognitive engagement
Addressing the differences	• See comment below regarding not needing to specifically address this issue

Table 105 – Catering for Different English Language Backgrounds When Using APODs

Even though students with English as a first language are significantly more like to share verbally and are significantly more likely to use APODS to share responses from small group discussions than their counterparts who do not have English as their first language, this does not need to be addressed. This is because of the significant increase in both of these groups willingness to share using APODs in comparison to sharing verbally.

The significant differences between students at (a) different levels; (b) in courses where APODs are used for summative assessment where they were not used for summative assessment; and (c) differences that have been identified by students at different ends of the introversion/extroversion spectrum are shown in Table 106 (page 323).

As to whether the reasons for students in the smaller postgraduate course had some significant differences from those in the larger undergraduate course relate to course size or course level is something that is not answered by this research and could be explored in further research by comparing a large undergraduate course with a smaller undergraduate course. The difference between the classes where APODs were used in a similar manner, but with one being used for summative assessment and one for formative assessment is consistent with some of the other findings where students appear to learn better when APODs and ARS are used for formative assessment instead of summative assessment. The possible relevance of the introversion / extroversion spectrum and the varying degrees of anonymity also highlight the need to use APODs and any other teaching strategies in a variety of ways so that students at one end of the spectrum are not experiencing significantly higher benefits than those at the other end of the spectrum on a continual basis.

Grouping	Differences Identified	Addressing the Differences
Undergraduate or Postgraduate	• Students in the smaller post indicated that they were significantly more willing to share responses from small group discussions verbally than those in the larger undergraduate course	• The significant difference may be due to the smaller sized class or that the course was at postgraduate level. Given that the focus of the study is on large classes, the significance of the difference has little relevance to the overall aims of the study
Using APODs for Summative Assessment	• Students in the first year course were APODs were not used for summative assessment indicated that seeing the correct answers to questions helped their learning more than students in the third year course where the APODs were used for summative assessment	• This difference suggests that the best use of APODs is for formative assessment as opposed to summative assessment when it comes to impact on learning • Formative use is consistent with the importance of anonymity, optional use and working in pairs or small groups
Introversion/ Extroversion	• The more extroverted a student is may be related to how strong the student's preference for anonymity • The more introverted a student is may be negatively related to the student's preference for anonymity • Note that these relationships are inferred from the literature and would need further testing	• This difference can be addressed by giving students the option of participating verbally • This could be done at the start or end of each APOD-based activity by asking if any student wishes verbally to add to what has been shared.

Table 106 – Catering for Different Levels, Assessment Modes and Personality Types.

7.2.6 Outline of Findings from Analysis and Discussion

An outline of where in the preceding sections of this chapter that the different aspects of the findings can be found is shown in Table 107.

Findings	Location
Analysis and discussion of findings as they relate to the research questions.	Table 98, page 313.
Challenges related to the use of APODs in lectures.	Table 99, page 314.
Scenarios in which the use of APODs should be considered.	Table 100, page 315.
Pedagogical issues relating to the use of APODs in lectures.	Table 101, page 316.
Key steps to consider in the design of APODs-based activities.	Table 102, page 318.
Catering for different groups of students based on age.	Table 103, page 320.
Catering for different groups of students based on gender.	Table 104, page 321.
Catering for different groups of students based on English language background.	Table 105, page 321.
Issues relating to the level of the course; whether APODs are used for formative and/or summative assessment; and where students are on the introversion-extroversion spectrum.	Table 106, page 323.

Table 107 – Guide to the Important Findings

7.3 Development of New Models

The section and the sections that follow set out the conclusions of this research, presents models that are the main contributions of this research, and addresses the overarching research question (restated below) and outlines the implications for further research.

The overarching research question for this study was "When and how should applications on personally owned devices be adopted for use in large lectures to enhance student engagement so that the benefits of their use can be achieved while addressing the challenges relating to their use?

The sections follow for the pedagogical issues surrounding the use of APODs (section 7.4), issues surrounding how to design effective activities when using APODs (section 7.5), using APODs to cater for different groups of students (section 7.6), the benefits of using APODs in lectures (section 7.7), and the challenges to be addressed when using APODs (section 7.8). In each of these sections a model is presented that includes an decription of the issues addressed in the model, a hypothetical scenario demonstrating the use of the model, and a diagram to depict the model.

7.4 Pedagogical Issues Surrounding the use of APODs

7.4.1 Isssues addressed in the model

There is clear evidence that the best use of APODS in lectures is a pedagogical issue and that significant importance should be placed on the design of effective activities. Factors of significant importance in this context are shown in Table 108. These are based on the outcomes of the literature review and the analysis of the findings of this research.

Students being able to choose to participate in the APODs-based activities with this being related to the concept of mutual engagement
The focus should be on formative assessment with the APODS as there is evidence that students will engage and learn more as opposed to using APODS for summative assessment
Encouraging students to work in pairs or groups as this is consistent with Social Learning Theory (Vygotsky, 1978), Constructivist Theory (Bruner, 1973), Andragogy (Knowles, 1984) and Adult Learning Theory (Cross, 1981).
Using of APODs at the start of lectures to check prior understanding and experiences with this being consistent with Andragogy (Knowles, 1984) and Adult Learning Theory (Cross, 1981).
Using APODs during lectures to check on understanding before moving on and/or part of the coverage of content using approaches such as question driven instruction (Beatty et al., 2006) and contingent teaching (Draper & Brown, 2004).
Using APODs at the end of lectures not just to have students answer questions, but to have students ask questions and identify the most important content covered in a manner consistent with the "one minute paper" (Hattie, 1997).
Using a mixture of closed ended questions for checking general understanding and saving time and open ended questions for deeper understanding to lead to more cognitive engagement (Fredricks et al., 2004).
Using APODs in a variety of manners including timing and the type of activity so as to cater for different groups of students who may be in the lecture

Table 108 – Pedagogical Issues of Significance relating to the use of APODS.

7.4.2 Hypothetical Scenario Demonstrating the Model

The Scenario

Sue is the lecturer for a first-year economics course where there are 250-300 students enrolled in most semesters when the course is offered. Sue is wanting to better understand the extent of background knowledge of some of the concepts that are covered at the start of some of the lectures. There are other lectures in which significant concepts are covered where Sue wants to check at the end of the lecture that the students have taken on board a basic understanding of the concepts. Sue also has some concern that not all of the students may have a device that an APOD could run on.

Use of the Model

Sue could use this model in a number of ways. To address the issue of students potentially not have a device for an APOD to run on, participation would not be required as what Sue is wanting to accomplish is formative in nature as opposed to summative, however it should be explained to students about the usefulness of the lecturer and the students receiving feedback about the level of understanding of concepts. Encouraging the students to discuss the questions in pairs or small groups would also go some way to addressing this issue.

As the level of understanding that Sue would be wanting to check at the start of lecturers and/or at the end of lectures is at a basic conceptual level the APOD should be used to ask multiple-choice questions. The questions should be asked at the start of the lecture when is a desire to check on background understanding, and at the end of the lecture when Sue is wanting to check on whether students have grasped concepts covered during the lecture.

This variety of usage in terms of timingis identified in the model as being advantageous, and by limiting the use of the APODs to when there are important background concepts to be checked on and to when there are significant new concepts to be checked on at the end of the lecture, the potential for overuse of the APODs is reduced.

7.4.3 Diagram Depicting the Model

A diagram depicting the pedagogical issues of significance relating to the use of APODs in lectures is shown in Figure 12 (page 327). This diagram covers issues relating to students being able to choose whether to participate, encouraging students to work in pairs or small groups, the depth of understanding that is being checked on, and the importance of designing effective activities for use with APODs.

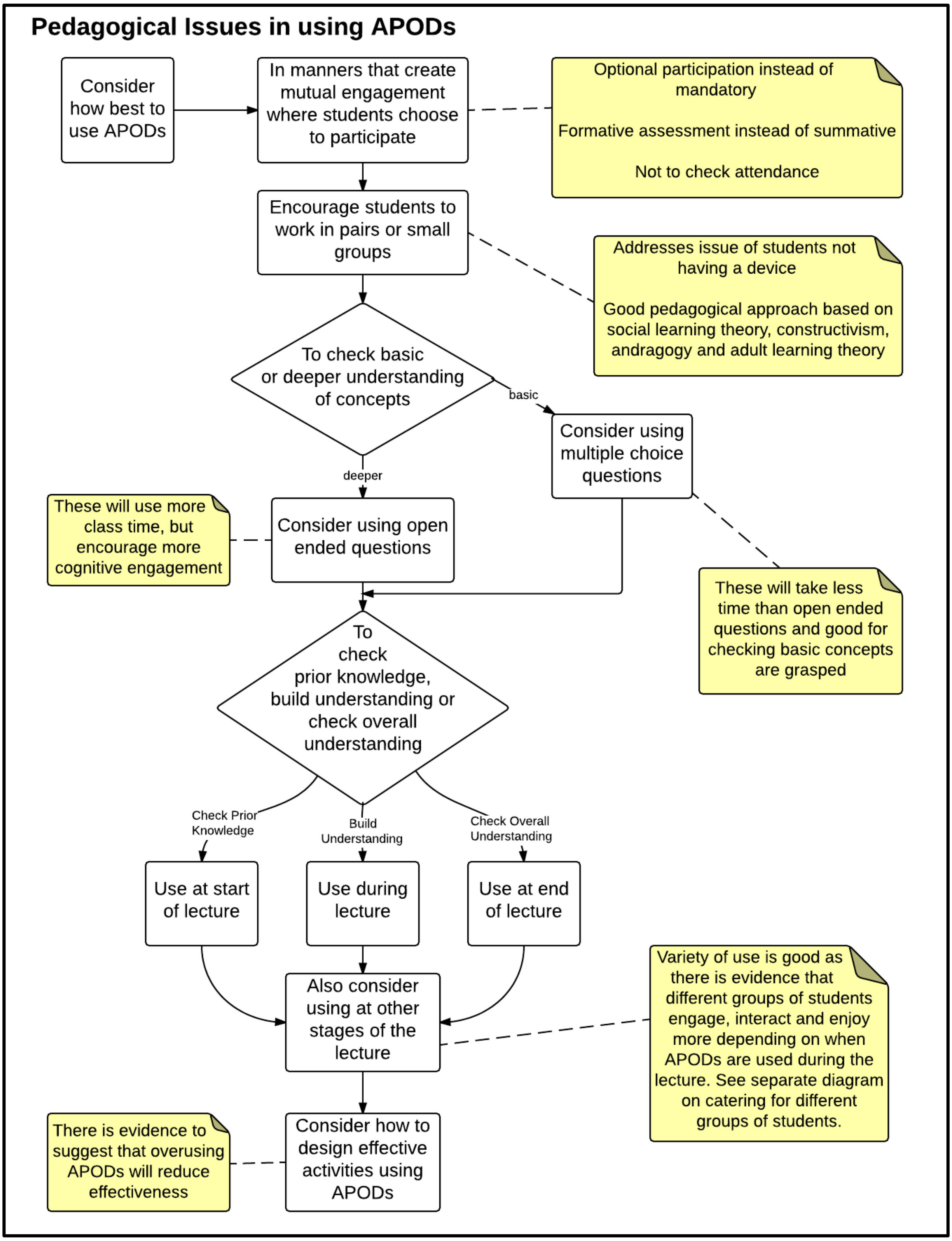

Figure 12 – Addressing Pedagogical Issues in Adopting APODs

7.5 Designing Effective Activities when using APODs

7.5.1 Isssues addressed in the model

When designing effective activities for the use of APODs there are three main issues to be contemplated. First the decision on when to use the APODs during the lecture needs to be based on what the aim of the activity is. Second the mode of the use of the APODs should be determined by the nature of the responses that the lecturer wants to received from the students. Third deciding on whether the responses from the students can change the direction that the lecture heads in. These issues are based on the outcomes of the literature review and the analysis of the findings of this research.

7.5.2 Hypothetical Scenario Demonstrating the Model

The Scenario

Mike is the lecturer for a large second-year management accounting class where the students are going to be introduced to the concept of environmental management accounting (EMA). Mike is wanting to introduce the concept of EMA at the start of a lecture and encourage the students to think about the relevance of EMA to a number of situations. After this, the lecture will cover how EMA is implemented in organisations.

Use of the Model

As Mike is wanting to encourage the students to think about EMA is relevant to a number of situations prior to covering how EMA is implemented the lecture could commence with an introduction to the concept of EMA. This could then be followed by a APODs based activity where the students discuss in small groups how EMA is relevant to particular organisations in the form of a mini-case study where each group is asked to submit answers to between two and three open-ended questions. Mike could then give feedback on the submitted answers. This approach is using a combination of "looking at problems before the means of solving them are not known" and "checking understanding during the lecture". Depending on the ways in which Mike deaks with students' responses, the approach has the potentinal to be consistent with contingent teaching and question driven instruction.

7.5.3 Diagram Depicting the Model

A diagram setting out the decisions to be made when designing effective activities using APODS is shown in Figure 13. This diagram moves through deciding when to use APODs duing a lecture, using APODs to direct what happens during a lecture, and different ways in which APODs can be used at the end of a lecture.

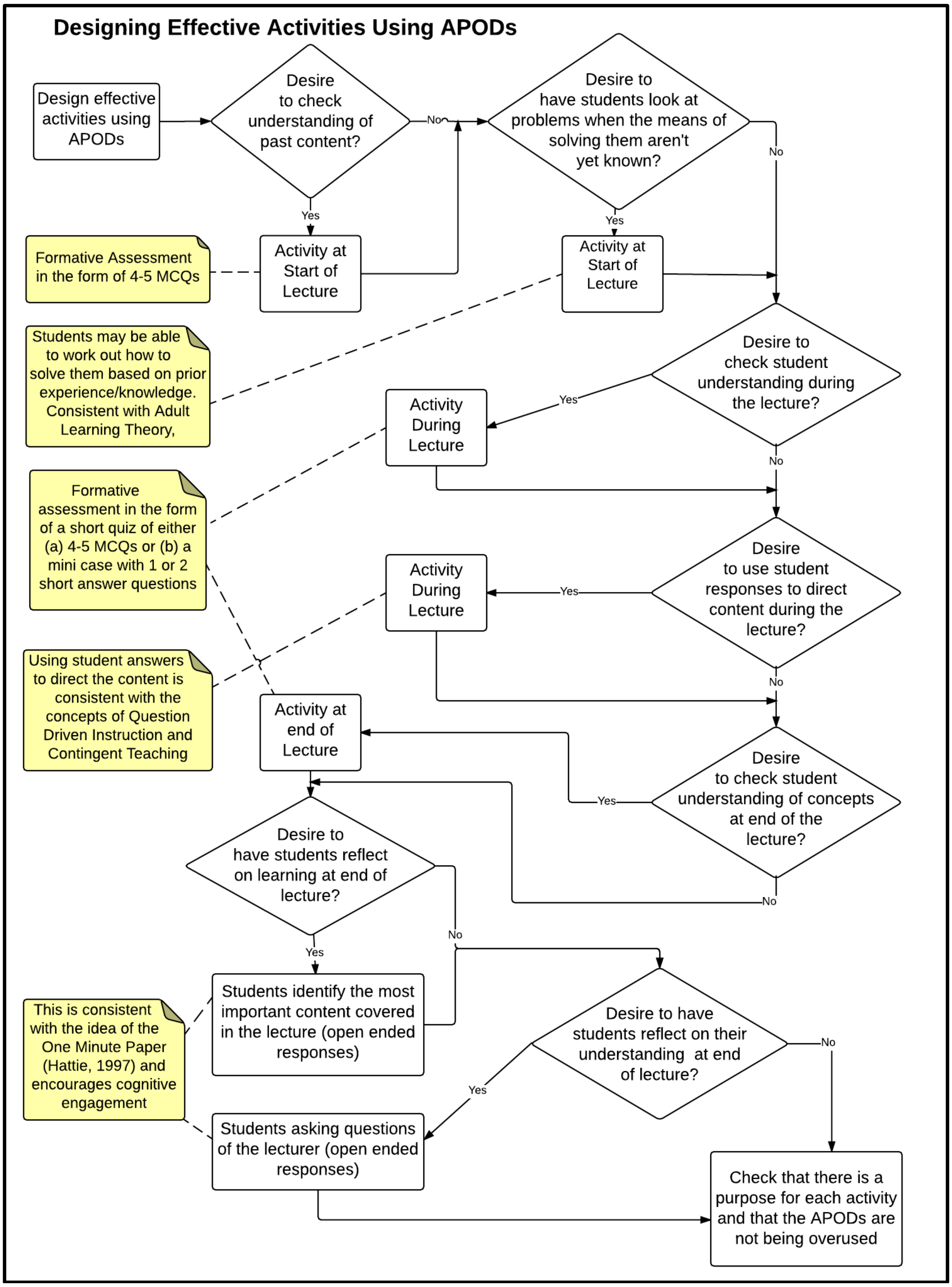

Figure 13 – Design of Effective Activities Using APODS

7.6 Using APODs to Cater for Different Groups of Students

7.6.1 Isssues addressed in the model

APODs can be used in a variety of ways to cater for different groups of students. The different groups can be related to age (see Table 103, page 320); to gender (see Table 104, page 321); to English language background (see Table 105, page 321); and potentially to the where students are on the introversion/extroversion spectrum (see Table 106, page 323). These issues are based on the outcomes of the literature review and the analysis of the findings of this research.

7.6.2 Hypothetical Scenario Demonstrating the Model

The Scenario

Grace is teaching courses at a number of different levels across different disciplines. In most of her lectures there is close to an even split of female and male students, however in some courses there are a big range of ages, with some of the students being willing to answer questions verbally, even though the classes are quite large. Grace is contemplating the use of APODs in her lectures and is interested in catering for the variety of students that are in her courses.

Use of the Model

The almost even split of genders in the courses suggests that attention be paid to aspects such as the importance of anonymity which has been shown to be more important to female students than to male students. Consideration needs to be given to the use of APODs during the lecture and for asking questions at the end of the lecture. This is because it has been shown that female student report more cognitive engagement when the APODs are used during the lecture and male students report more cognitive engagement when the APODS are used for students to ask questions at the end of the lecture.

In the courses where there is a range of ages there is a need to be aware of a higher preference for anonymity and value placed on discussion amongst the younger students. However, for the older students who may be more willing to respond verbally, allowing students to respond verbally after anonymous responses would address this aspect. This approach of asking for verbal responses after the anonymous reponses may also cater for students who are more towards the extroverted end of introvert/extrovert sepectrum.

7.6.3 Diagram Depicting the Model

A diagram setting out how APODs can be best used to cater for diversity within groups of students is shown in Figure 14. For each different classification of students, strategies are shown that allow for a cross section of students to be catered for. These are based on the outcomes of the literature review and the analysis of the findings of this research.

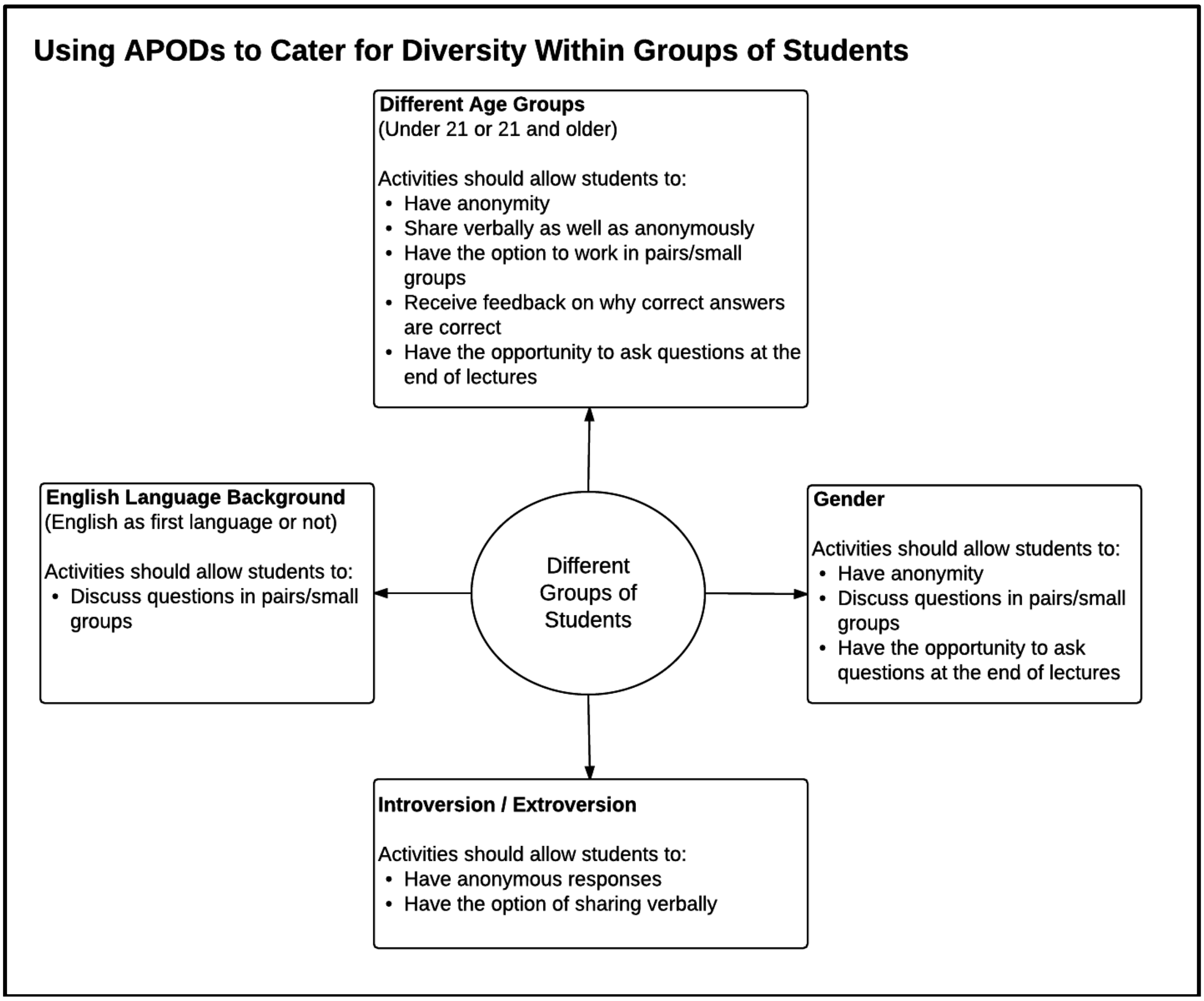

Figure 14 – Using APODs to Cater for Diversity Within Groups of Students

7.7 Benefits of using APODs in Lectures

7.7.1 Isssues addressed in the model

The latter parts of the overarching research question related partly to the benefits of using APODs (sub question 1). There is clear evidence that lecturers and students perceive there are a range of benefits accruing from the use of APODs in large lectures. The eight benefits that can clearly be concluded from this study are summarised in Table 109. These are based on the outcomes of the literature review and the analysis of the findings of this research.

Increasing the participation, interaction and engagement of students significantly with anonymity of responses being a significant factor in this increase.
Lecturers obtaining feedback from students during a lecture so that learning can be checked on is of significant value and enables lecturers to assess how well students are learning and provide feedback to the students during the lecture (whether to confirm that students do understand concepts or to address misconceptions.
Lecturers obtaining feedback from students at the start of a lecture about their prior knowledge and understanding so that it can be used and built on during the lecture.
Students checking on their own learning during lectures to identify concepts that they do understand and misconceptions that they need to address.
Learning being more enjoyable (also known as the purple shirt affect).
Breaking the mold of the traditional lecture.
Learning being more effective and/or authentic.
During live streamed lectures, students who are not physically present are able to interact and participate in ways that would not be possible otherwise

Table 109 – Conclusions Relating to the Benefits of Using APODs in Lectures

Areas where there is less clear evidence relating to the benefits of using APODs in lectures that could provide a basis for further studies include increasing student attendance at lectures; increasing student attention during lectures; the value of discussion amongst students; and the impact on learning performance (although other studies have highlighted that increased interaction, participation and engagement can lead to increased learning performance).

7.7.2 Hypothetical Scenario Demonstrating the Model

The Scenario

A group of lecturers teaching a large statistics course to undergraduate business students have heard about the concept of using APODs in lectures and are unsure of the range of benefits that could result.

Use of the Model

This model sets out the eight main benefits of using APODs in large lectures (see Table 109, page 334). The benefits that are depict in the model (see Figure 15, page 335). In this model the benefits are shown on the inner hub, with the outer hub of the model providing more explanation as to how these benefits present themselves.

7.7.3 Diagram Depicting the Model

A diagram that depicts the eight benefits is shown in Figure 15 (page 335) along with an explanation of each benefit.

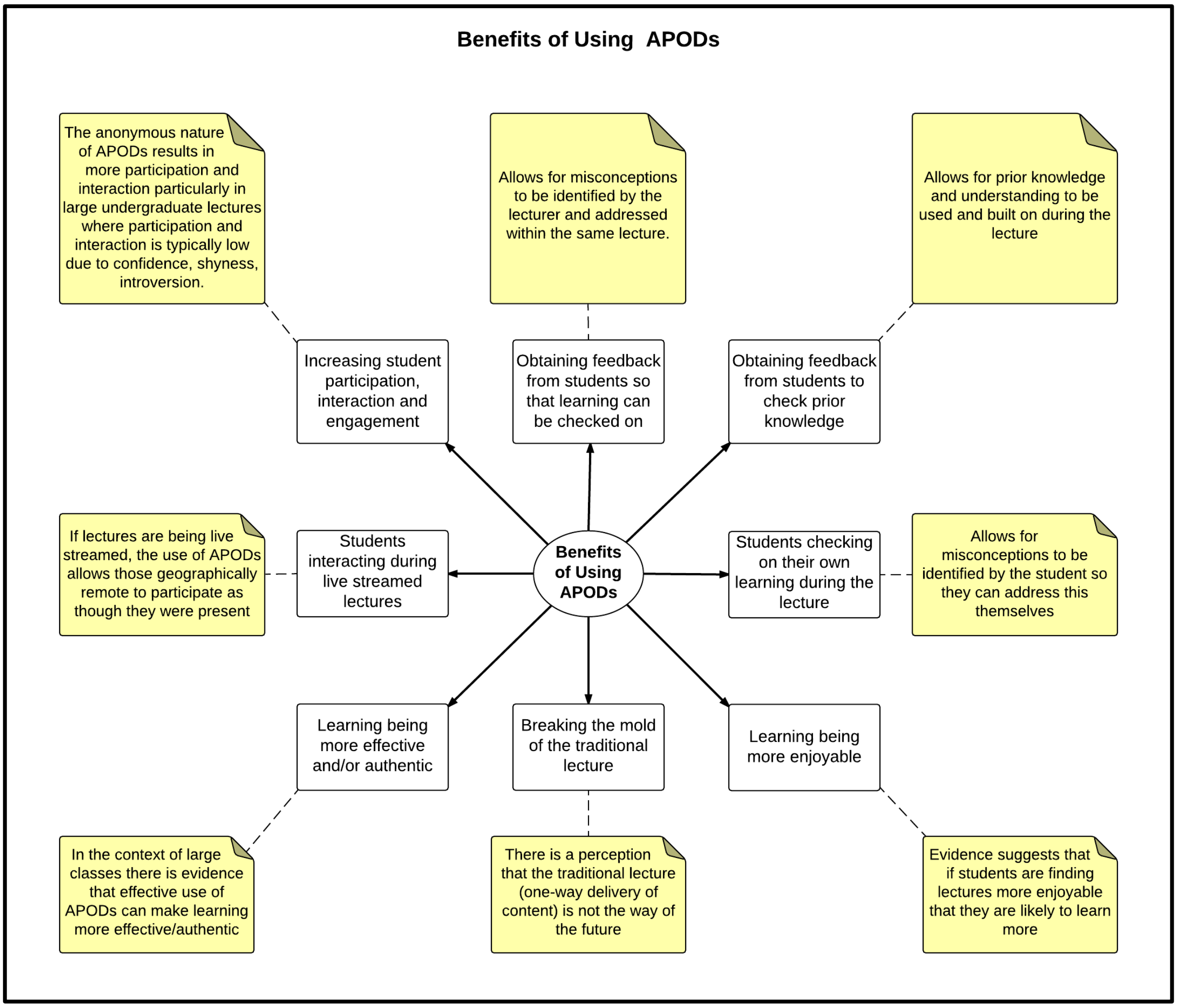

Figure 15 –Benefits of Using APODs in Lectures

7.8 Challenges Involved in using APODs in Lectures

7.8.1 Isssues addressed in the model

The latter parts of the overarching research question related partly to the challenges (sub question 2) with these including issues relating to the cost and simplicity of devices (sub question 4). The challenges involved in using APODSs were grouped into technology based challenges; lecturer based challenges and student based challenges, with the conclusions that have clear evidence relating to these challenges and how they can be dealt with shown in Table 110. These are based on the outcomes of the literature review and the analysis of the findings of this research.

Type of Challenge	Challenge
Technology Based Challenges	The challenge of students not owning or not bringing devices can be addressed through working pairs and small groups as part of the APOD-based activity. This only continues to be a challenge if the use of the APODs is mandatory; being used for summative assessment; used to take attendance where marks are awarded for attendance; and/or where the students can be identified. There is some evidence however that using APODs for activities that are optional and/or formative assessment purposes results is sounder from a pedagogical perspective.
	The challenge of technology not functioning is an issue of significance and highlights the need for good institutional support where an APOD is adopted for general use.
	The quality of WiFi.
Lecturer Based Challenges	Losing time to cover the required course content and not overusing APODs are challenges of significance and related to each other. These challenges should be addressed from a pedagogical perspective.
Student Based Challenges	Students with disabilities may have challenges when it comes to the use of APODs with some of these challenges being addressed through working in pairs and small groups. However, there are some circumstances where the use of APODs enhances the student learning experience in ways that may not have been possible otherwise.

Table 110 – Conclusions Relating to the Challenges of Using APODs in Lectures

Of significance is the relationship of the issue of not all students having access to required devices and the solution of students working in pairs and small groups to address this. This is also consistent with the conclusions surrounding the benefits of APOD use being optional and for formative assessment (as opposed to mandatory, for summative assessment, awarding grades for attendance and identifying students where the benefits are less clear).

The diagram shown shown in Figure 16 (see page 339) depicts a number of issues relating to the cost and simplicity of devices that are significant when it comes to making decisions about the use of APODs in lectures.

There are five areas where there is little evidence in this study relating to the challenges of using APODs in lectures that could provide a basis for further studies. First whether confusion can be created by the discussion of topics. Second whether too much effort can be required by some students.

7.8.2 Hypothetical Scenario Demonstrating the Model

The Scenario

A group of six lecturers teach the core accounting course in an undergraduate business degree. They have been convinced of the benefits of using APODs in large lectures but are wanting to ensure that they have addressed the potential challenges that may emerge as a consequence. All of the lecturers in the group are quite committed to the concept of using APODs, with three of the six lecturers acknowledging that they are not fast adopters of new technology. The institution where they teach has a very good WiFi infrastructure.

Use of the Model

The ease of use of the APOD and the cost to students is not seen as being a big challenge. This is due to the high proportion of students owning appropriate devices (and is even less of a challenge if the APODs-based activities are completed in pairs or small groups). Provided the choice of application does not result in costs to the students, the cost to students is not an issue at all.

Given that this is a group of lectures, some of the focus of the scenario is similar to the the adoption being an institutional decision, with some aspects being similar to an individual decision. There may be some costs to the group in the form of being registered users depending on the application that is adopted. If these costs exist, the group of lecturers could either seek to have the cost included in a departmental budget or seek a special grant to cover the cost (as per the individual path).

The ease of use for the lecturers needs to be considered for the three lecturers who have identified as being slow adopters of new technology. The could be addressed through institutional support from learning advisers, or those in similar roles, or this support could come from other members of the group.

7.8.3 Diagram Depicting the Model

A diagram that depicts the challenges involved using APODs in lectures is shown in Figure 16 (page 339) with the diagram focusing on the ease of use and costs for students, lecturers and their institutions.

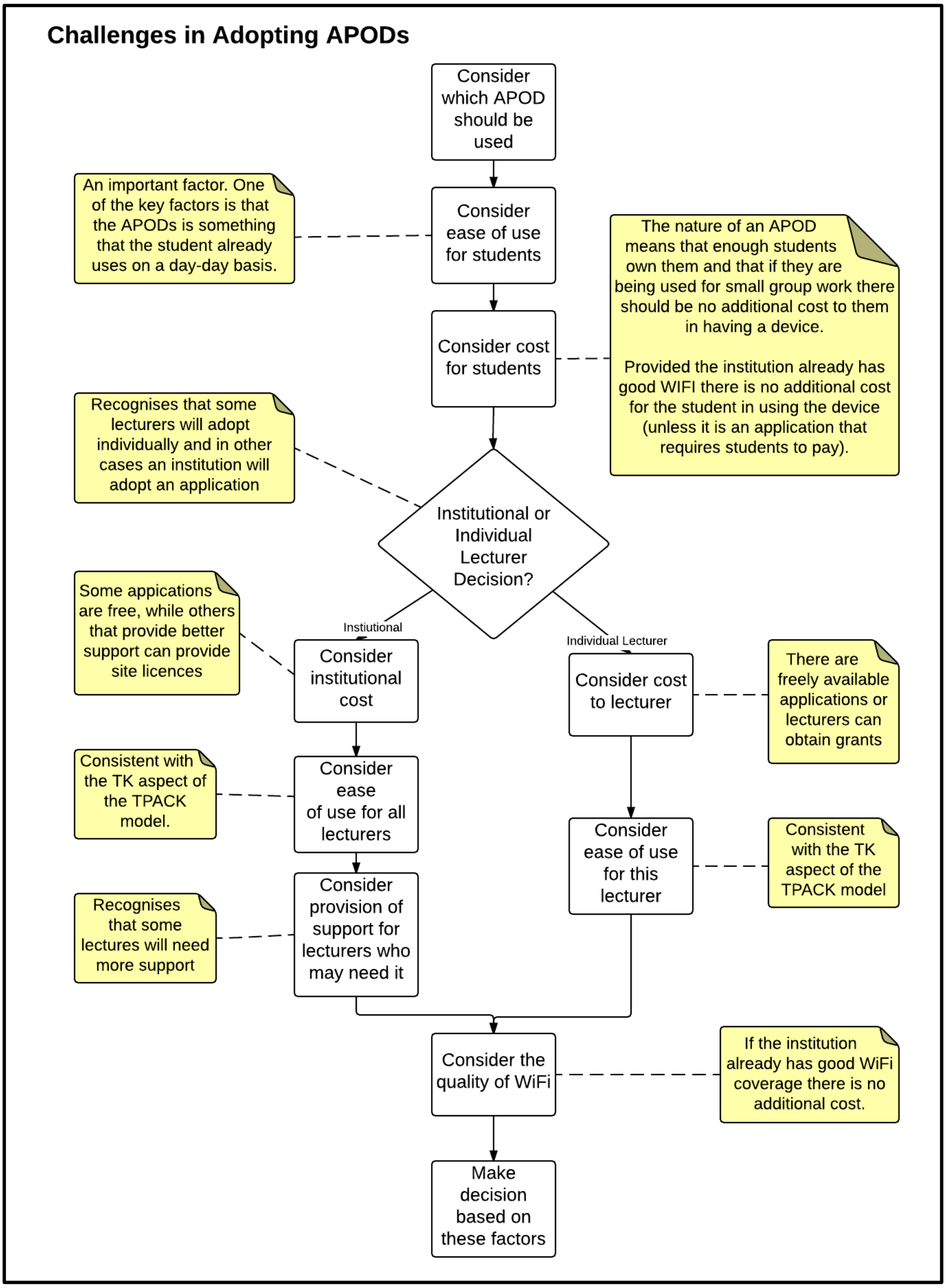

Figure 16 - Addressing Challenges Involved in Adopting APODs

7.9 Implications for Further Research

There are a number of implications for further research arising from this study with these being presented in Table 111 along with an explanation of each implication.

Implication	Explanation
Increasing student attendance.	There was some evidence in this study that (a) the use of APODs in lectures for formative assessment could reduce a drop off in attendance; (b) not allowing students to have phones turned on during lectures could reduce attendance; and (c) forcing students to share verbally can reduce attendance. This is an area where further studies could be conducted.
Increasing student attention.	The increase of student attention during lecturers was not a focus of the research, but there are indications in the findings that the increasing of engagement, interaction and participation also involves the increasing of student attention. This could be tested further in later studies.
The value of discussion amongst students.	The value of discussion amongst the students appeared to be rated as more important by the lecturers interviewed than by the students. A focus for further studies could be on whether there are types of students who benefit more from the discussions than other students.
Impact on learning performance based on modes of use.	Other studies have highlighted that increased interaction, participation and engagement can lead to increased learning performance. This could be the focus of further studies with the aim of investigating the impact on learning performance based on different modes of use of APODS.
Possibility of confusion being created by discussion of topics.	Little attention was paid in this study to whether the discussion of topics could create confusion for students. This issue could be the subject of further studies.
Possibility of some students needing too much effort to use APODs.	Little attention was paid in this study to the concept of some students needing too much effort to use APODs. This concept could be the subject of further studies.
Issues related to students with disabilities.	Aspects of this study highlighted that there are issues to consider for some students with disabilities when it comes to the use of APODS, but that there are other students with disabilities for whom the use of APODs creates learning opportunities that would not otherwise be possible. This issue is one which could form a significant basis for studies in the future.
Comparing of two groups of students covering the same content where the only difference is the use of APODs.	This area for further research was suggested in Flies and Marshall (2006) and is an area that future studies could be based on including the absence of APODs or different modes of use of APODs.
Comparing of one group of students studying two different subject areas where APODs are used in both.	This area for further research was suggested in Flies and Marshall (2006) and would help identify particular subjects where the use of APODs would be more beneficial.
Students seeing that lecturers want to increase student engagement (and have a plan to do so) this in itself can serve to increase student engagement.	This concept emerging from one of the learning advisers could be the focus of further studies that aim to explore the extent that lecturers demonstrating they want to know what students are thinking can increase student engagement.

Whether female students are more likely to use technology like APODs for a specific purpose and whether male students will use technology like APODs for enjoyment.	This stems from the findings where APODs were used for feedback from small group discussions during lectures that showed (a) that female students report significantly more increase cognitive engagement than male students and (b) that male students report significantly higher levels of increased enjoyment than female students.
Comparing the perceptions of students regarding the use of APODs across two courses where the only difference is the use of APODs for summative or formative assessment.	This stemmed from the significant differences between students in courses where APODs were used for summative assessment in one and formative assessment in the other, however the courses were in different subjects and at different levels.

Table 111 – Implications for Further Research

7.10 Final Conclusion

The use of any form of technology in a teaching and learning setting should be consistent with the concept of using technology to address an issue or problem in that setting (Draper & Brown, 2004). It is vitally important that the use of technology is not seen as a "*magic bullet*" (Banks, 2006). The technology "... must be used within the context of the teaching and learning process" (Banks, 2006).

From this research, it is clear that the use of APODs can enhance student engagement, interaction and participation in lectures. This is provided that the APODs are used in a manner that is pedagogically sound and takes into account the challenges in their use.

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Appendicies

Appendix A
Consent Form and Covering Letter for Lecturer Interviews

The consent form for the lecturer interviews is shown in Figure 17 with the covering letter being shown in Figure 18 and Figure 19.

UC UNIVERSITY OF CANTERBURY Te Whare Wānanga o Waitaha CHRISTCHURCH NEW ZEALAND

Trevor Nesbit
Email: trevor.nesbit@canterbury.ac.nz
PhD Student
School of Educational Studies and Human Development
College of Education
University of Canterbury

"Use of Prevailing Personal Social Communication Technologies to Enhance Student Engagement in Large Lectures"

Consent Form for Lecturers being Interviewed

By signing this consent form I confirm that:

- A full explanation of the above project has been provided to me and I have had the opportunity to ask questions about the project and my involvement in the project.
- I understand that participation in the interview is entirely voluntary.
- I understand what is required of me in my involvement in the project and I understand that I can withdraw from the project at any stage without penalty and without being asked for my reasons for withdrawing.
- I understand that every attempt will be made to keep any information or opinions confidential and that a pseudonym will be used with the aim of preserving my identity in the write up of the research.
- I understand that only the researcher and the researcher's supervisors will have access to the results of the interview and these will be stored on computers that are password protected and owned by the University of Canterbury. The results of the interviews will be deleted after five (5) years.
- I understand the risks associated with my participation in the research. Two of the risks are that my views may be unfairly represented and that it may not be possible to preserve my anonymity. To address these risks I will be provided with a copy of the results of the interview for me to check for accuracy before they are used. If I feel at this point that my anonymity has not been preserved and that I wish it to be preserved, I will be able to withdraw from the study.
- I understand that if I have any concerns questions or concerns about this research they can be addressed to the researcher at the above email address or to the researcher's principal supervisor Dr Billy O'Steen (Billy.Osteen@canterbury.ac.nz).
- I understand that complaints about the research may be addressed to The Chair, Educational Research Human Ethics Committee, University of Canterbury, Private Bag 4800, Christchurch, Email: human-ethics@canterbury.ac.nz.

I have read and understood the above information and consent to the interview

I would like to receive a summary of the results of this phase of the research — Yes/No delete one

Name: .... Signature: .... Date: ....

Return of Form:
A signed copy of this form will be collected by the researcher from the participant at the commencement of the interview.

Figure 17 – Consent form for Lecturer Interviews

UC
UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

Trevor Nesbit
Email: trevor.nesbit@canterbury.ac.nz
PhD Student
School of Educational Studies and Human Development
College of Education
University of Canterbury

***Project:* "Use of Prevailing Personal Social Communication Technologies to Enhance Student Engagement in Large Lectures"**

Dear (Participant Name)

I am a PhD Student in the School of Educational Studies and Human Development at the University of Canterbury. The purpose of my research is to examine how audience response technologies (eg UCanAsk, Socrative, Clickers) can be used to successfully increase student engagement and learning in large lectures.

As part of the research I would like to interview you to gain an understanding of how you use audience response technologies in large lectures for classes that you teach.

Participation in the interview is entirely voluntary. If you do participate, you have the right to withdraw from the study at any time without penalty and without being asked for your reasons. If you withdraw, I will do my best to remove any information relating to you, provided this is practically achievable.

The interview should take approximately 30-40 minutes. The interview will be relatively unstructured but will cover the following topics:

- Your reason(s) for using the audience response technologies as part of your teaching
- How you have used audience response technologies in the past
- How you use audience response technologies currently
- How you plan to use audience response technologies in the future
- The benefits to the students from your perspective
- The benefits for you personally
- Key success factors in using the technologies well
- Potential issues that arise from using the technologies

Only my supervisors and I will have access to the results of the interview and these will be stored on computers that are password protected and owned by the University of Canterbury. The results of the interviews will be deleted after 5 years. Pseudonyms will be used with the aim of preserving your identity in the write up of the results which will take the form of my PhD thesis and paper presented at conferences and submitted to academic journals.

There are few risks associated from your participation in the interview. Two of these are that I may unfairly represent your views or that I may not be able to preserve your anonymity. Once I have transcribed the results of the interview you will be able to check them for accuracy to ensure that they fairly represent your views. If at this point you feel that your anonymity is not being preserved and that you wish it to be preserved, you will be able to withdraw from the study at this point.

Figure 18 – Covering letter for Lecturer Interviews – Part A

I will be able to provide you with a summary of the results of this phase of the project. If you would like to receive this summary, please indicate this at the bottom of the consent form in the place provided.

If you have any questions or concerns about this research they can be addressed to me at the above email address or to my principal supervisor Dr Billy O'Steen (Billy.Osteen@canterbury.ac.nz).

This research project has received ethical approval from the University of Canterbury Educational Research Human Ethics Committee and Complaints may be addressed to: The Chair, Educational Research Human Ethics Committee, University of Canterbury, Private Bag 4800, Christchurch, Email: human-ethics@canterbury.ac.nz.

If you agree to participate in the interview, please sign the attached consent form to indicate your willingness to participate and understanding of what is involved.

Kind regards

Trevor Nesbit

Figure 19 – Covering letter for Lecturer Interviews – Part B

Appendix B
Ethics Approval for Lecturer Interviews

The letter from the University of Canterbury Educational Research Human Ethics Committee granting approval for the interviews of lecturers is shown in Figure 20.

UC
UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

HUMAN ETHICS COMMITTEE

Secretary, Lynda Griffioen
Email: human-ethics@canterbury.ac.nz

Ref: 2014/26/ERHEC

16 June 2014

Trevor Nesbit
Department and Accounting & Information Systems
UNIVERSITY OF CANTERBURY

Dear Trevor

Thank you for providing the revised documents in support of your application to the Educational Research Human Ethics Committee. I am very pleased to inform you that your research proposal "Use of prevailing personal social communication technologies to enhance student engagement in large lectures" has been granted ethical approval.

Please note that this approval is subject to the incorporation of the amendments you have provided in your email of 5 June 2014.

Should circumstances relevant to this current application change you are required to reapply for ethical approval.

If you have any questions regarding this approval, please let me know.

We wish you well for your research.

Yours sincerely

Nicola Surtees
Chair
Educational Research Human Ethics Committee

"Please note that Ethical Approval and/or Clearance relates only to the ethical elements of the relationship between the researcher, research participants and other stakeholders. The granting of approval or clearance by the Ethical Clearance Committee should not be interpreted as comment on the methodology, legality, value or any other matters relating to this research."

F E S

Figure 20 – Letter Granting Ethics Approval for Lecturer Interviews

Appendix C
Screen Shot of First Page of Survey

The first page of the survey (for students in INFO243) is shown in Figure 21

Hi there,

You have been sent the link to this survey because you were enrolled in the following course during semester two of 2014:

INFO243 - Accounting Information Systems at the University of Canterbury

The following survey is part of some research I am doing for my PhD which revolves around the use of technologies like Socrative to increase student engagement during large lectures.

Completing this survey is entirely voluntary. At the bottom of this page you will be asked whether you agree to participate in this research. If you select "Yes" you will be taken to the next page of the survey, and if you select "No" you will not be given access to the survey.

You are welcome to cease completion of the survey at any time and your responses will only be included if you have completed all of the survey.

Included in the survey are some demographic questions about your background, some questions that relate to your preferred learning style and questions about what you thought about the use of Socrative during lectures for the course.

All responses are entirely anonymous and confidential. There are no risks associated with your completion of the survey.The results of the survey will be included in my PhD thesis and may be presented at conferences or published in journal articles.

Even though I am the lecturer for this course, I assure you that it will not be possible to connect any of you with your individual responses. As a result of this, it will not be possible for your answers to any of the questions to have an impact on your results for the course. If you would like to see a summary of the results of the survey, please send me an email.

If you have any questions or concerns about this research they can be addressed to me at trevor.nesbit@canterbury.ac.nz or to my principal supervisor Dr Billy O'Steen (Billy.Osteen@canterbury.ac.nz).

This research project has received ethical approval from the University of Canterbury Educational Research Human Ethics Committee and Complaints may be addressed to: The Chair, Educational Research Human Ethics Committee, University of Canterbury, Private Bag 4800, Christchurch, Email: human-ethics@canterbury.ac.nz.

Kind Regards,

Trevor Nesbit
Senior Lecturer, Department of Accounting and Information Systems
PhD Candidate, College of Education
University of Canterbury
Christchurch
New Zealand

I have read and understand the above information regarding the survey and I agree to participate in the survey

- ○ Yes
- ○ No

Figure 21 – First Page of Survey for INFO243 Students

Appendix D
Ethics Approval for University of Canterbury Version of Survey

The letter from the University of Canterbury Educational Research Human Ethics Committee granting approval to survey students at the University of Canterbury is shown in Figure 22.

UC
UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

HUMAN ETHICS COMMITTEE

Secretary, Lynda Griffioen
Email: human-ethics@canterbury.ac.nz

Ref: 2014/50/ERHEC

1 October 2014

Trevor Nesbit
Department of Accounting & Information Systems
UNIVERSITY OF CANTERBURY

Dear Trevor

Thank you for providing the revised documents in support of your application to the Educational Research Human Ethics Committee. I am very pleased to inform you that your research proposal "Use of prevailing personal social communication technologies to enhance student engagement in large lectures" has been granted ethical approval.

Please note that this approval is subject to the incorporation of the amendments you have provided in your email of 30 September 2014

Should circumstances relevant to this current application change you are required to reapply for ethical approval.

If you have any questions regarding this approval, please let me know.

We wish you well for your research.

Yours sincerely

Nicola Surtees
Chair
Educational Research Human Ethics Committee

"Please note that Ethical Approval and/or Clearance relates only to the ethical elements of the relationship between the researcher, research participants and other stakeholders. The granting of approval or clearance by the Ethical Clearance Committee should not be interpreted as comment on the methodology, legality, value or any other matters relating to this research."

Figure 22 – Letter Granting Ethics Approval for Survey at University of Canterbury

Appendix E
Ethics Approval for CPIT Version of Survey

The letter from the Christchurch Polytechnic Institute of Technology (CPIT) ethics subcommittee granting approval to survey students at CPIT is shown in Figure 23.

Academic Board
Research and Knowledge Transfer Committee, Ethics Subcommittee

CPIT

Memo

To:	Trevor Nesbit
Cc:	Margaret Leonard
From:	RKTC Ethics Subcommittee [contact: Rea Daellenbach, Chair]
Date:	3/11/2014
Re:	**Ethics Application**

Thank you for your application to the CPIT Ethics Subcommittee for a research project titled 'Use of prevailing personal social communication technologies to enhance student engagement in large lectures'. Your application (Reference number 1671) was considered recently by the Ethics Subcommittee and we are pleased to advise that it has been approved.

Please contact the Ethics Committee again if you propose any substantial changes or extensions to this project.

Rea Daellenbach

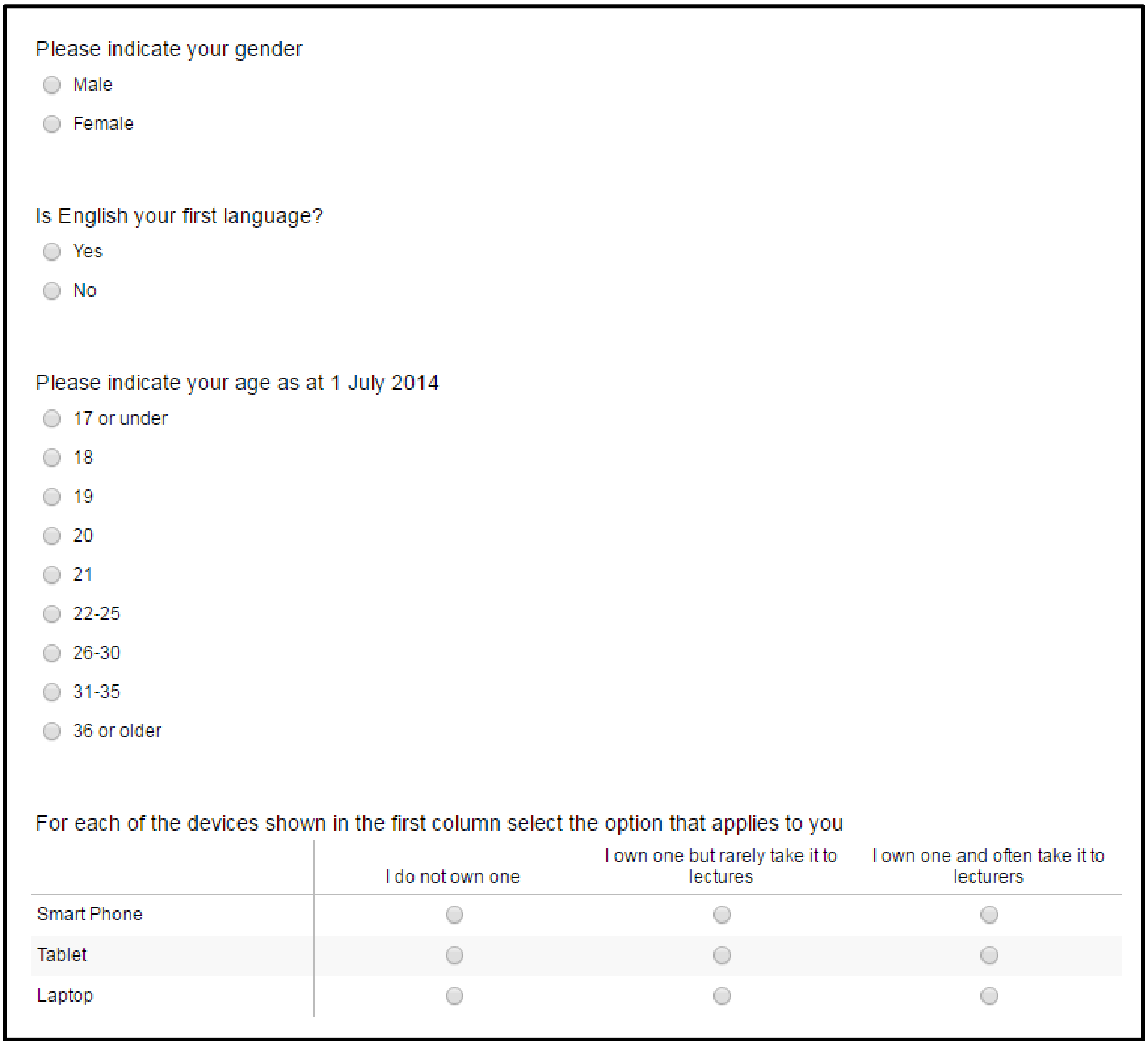
Rea Daellenbach
CPIT Ethics Subcommittee Chair

Figure 23 – Letter Granting Ethics Approval for Survey at CPIT

Appendix F

Complete Copy of Questionnaire Including All Blocks of Questions

Note that the first screen of the survey is shown in Figure 21 in Appendix C. The demographics page of the survey is shown in Figure 24.



Please indicate your gender

- Male
- Female

Is English your first language?

- Yes
- No

Please indicate your age as at 1 July 2014

- 17 or under
- 18
- 19
- 20
- 21
- 22-25
- 26-30
- 31-35
- 36 or older

For each of the devices shown in the first column select the option that applies to you

	I do not own one	I own one but rarely take it to lectures	I own one and often take it to lecturers
Smart Phone			
Tablet			
Laptop			

Figure 24 – Demographics Page of Survey

The block of questions completed by students where the application was used for answering multiple choice questions is shown in Figure 25.

Answering Multiple Choice Questions

During lectures for this course the lecturer asked you to use Socrative to answer multiple choice questions. The questions on this page relate to this.

Please indicate your level of agreement with the following statements:

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Discussing the questions with the person sitting next to me helped my learning	○	○	○	○	○
Thinking about how I would answer the questions encouraged me think more about the lecture content	○	○	○	○	○
Seeing the correct answers to questions that I got wrong helped my learning	○	○	○	○	○
Using Socrative in this way made the lecture more enjoyable	○	○	○	○	○
Using Socrative in this way helped me to feel more engaged during lectures	○	○	○	○	○
Answering questions anonymously using Socrative is a reason why I would choose to use it to answer questions	○	○	○	○	○

In lectures with similar numbers of students as this course

	Often	Sometimes	Occasionally	Almost Never	Never
If the lecturer asks a multiple choice question I would raise my hand to indicate my answer	○	○	○	○	○
If the lecturer asks a multiple choice question I would use Socrative to indicate my answer	○	○	○	○	○

How did you feel about using Socrative in this way?

Figure 25 –Questions for Answering Multiple Choice Questions

The block of questions completed by students where the application was used for students asking questions during lectures is shown in Figure 26.

Asking Questions During Lectures

During lectures for this course the lecturer gave you the opportunity to ask questions or make comments using Socrative . The questions on this page relate to this.

Please indicate your level of agreement with the following statements:

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
The answers to questions asked by other students helped by learning	○	○	○	○	○
Using Soctrative in this way made the lecture more enjoyable	○	○	○	○	○
Using Socrative in this way helped me to feel more engaged during lectures	○	○	○	○	○
I am more likely to ask questions anonymously using Socrative than to ask questions out loud during a lecture	○	○	○	○	○

In lectures with similar number of students as this course

	Often	Sometimes	Occasionally	Almost Never	Never
I would ask the lecturer questions in front of the rest of the class	○	○	○	○	○
I would consider using Socrative to ask the lecturer questions in front of the rest of the class	○	○	○	○	○

How did you feel about using Socrative in this way?

Figure 26 –Questions for Students Asking Questions during Lectures

The block of questions completed by students where the application was for reporting back from small group discussions is shown in Figure 27.

Reporting Back After Small Group Discussions

During lectures for this course the lecturer asked you to discuss questions in small groups and asked for one person in the group to submit the group's answer using Socrative. The questions on this page relate to this.

Please indicate your level of agreement with the following statements:

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Discussing the questions with the person sitting next to me helped my learning					
Thinking about how I would answer the questions encouraged me think more about the lecture content					
Seeing the answers from some of the other groups helped my learning					
The lecturer giving feedback on the answers helped my learning					
Using Socrative in this way made the lecture more enjoyable					
Using Socrative in this way helped me to feel more engaged during lectures					
Answering questions anonymously using Socrative is a reason why I would choose to use it to answer questions					

In lectures with similar numbers of students as this course

	Often	Sometimes	Occasionally	Almost Never	Never
If the lecturer wanted someone to tell the rest of the class about the answer my group had decided on I would volunteer to do this					
If the lecturer wanted someone to use Socrative to share the answer my group had decided on I would volunteer to do this					

How did you feel about using Socrative in this way?

Figure 27 –Questions for Reporting Back from Small Group Discussions

The block of questions completed by students where the application was for reporting back the most important thing covered during a lecture is shown in Figure 28.

Reporting Back About The Most Important Thing Covered in a Lecture

At the end of lectures for this course, the lecturer would sometimes ask you to discuss in small groups what the most important thing covered in the lecture was and then ask for one person in your group to submit your response using Socrative. The questions on this page relate to this.

Please indicate your level of agreement with the following statements:

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Thinking about what the most important thing was encouraged me think more about the lecture content	○	○	○	○	○
Discussing what the most important thing was with the person sitting next to me helped my learning	○	○	○	○	○
Seeing what other groups thought the most important thing was helped my learning	○	○	○	○	○
The lecturer giving feedback on what the class thought the most important thing was helped my learning	○	○	○	○	○
Using Socrative in this way made the lecture more enjoyable	○	○	○	○	○
Using Socrative in this way helped me to feel more engaged during lectures	○	○	○	○	○
Submitting what we thought was the most important thing anonymously using Socrative is a reason why I would choose to use it to do this	○	○	○	○	○

In lectures with similar numbers of students as this course

	Often	Sometimes	Occasionally	Almost Never	Never
If the lecturer wanted someone to tell the rest of the class about the most important thing my group had decided on I would volunteer to do this	○	○	○	○	○
If the lecturer wanted someone to use Socrative to share the the most important thing my group had decided on I would volunteer to do this	○	○	○	○	○

How did you feel about using Socrative in this way?

Figure 28 – Questions for Reporting Back on Most Important Content

The block of questions completed by students where the application was for students asking for something to be explained again at the end of a lecture is shown in Figure 29, with this being the last of the blocks of questions.

Asking For Something to be Explained at the End of a Lecture

At the end of lectures for this course, the lecturer would sometimes ask you to discuss in small groups "If I could ask one question about the content of this lecture, what would it be?" and then ask for one person in your group to submit your response using Socrative. The questions on this page relate to this.

Please indicate your level of agreement with the following statements:

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Thinking what questions I would ask with the person sitting next to me made me think more about the lecture content					
Discussing what questions I would ask with the person sitting next to me made me think more about the lecture content					
Seeing the questions asked by other groups helped me think more about the lecture content					
The lecturer answering the questions that were asked helped my learning					
Using Socrative in this way made the lecture more enjoyable					
Using Socrative in this way helped me to feel more engaged during lectures					

In lectures with similar numbers of students as this course

	Often	Sometimes	Occasionally	Almost Never	Never
If at the end of the lecture the lecturer asks "are there any questions" and there is something I was wondering about, I would ask about it in front of the class					
If at the end of the lecturer the lecturer asked for any questions to be submitted using Socrative I would consider doing so					

How did you feel about using Socrative in this way?

Figure 29 –Questions for Students Asking for something to be Explained Again

Appendix G
Consent Form and Covering Letter for Student Focus Groups

The consent form for the student focus groups is shown in Figure 30 with the covering letter being shown in Figure 31 and Figure 32.

UC UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

Trevor Nesbit
Email: trevor.nesbit@canterbury.ac.nz
PhD Student
School of Educational Studies and Human Development
College of Education
University of Canterbury

"Use of Prevailing Personal Social Communication Technologies to Enhance Student Engagement in Large Lectures"

Consent Form for Focus Group

By signing this consent form I confirm that:

- A full explanation of the above project has been provided to me and I have had the opportunity to ask questions about the project and my involvement in the project.
- I understand that participation in the focus group is entirely voluntary.
- I understand what is required of me in my involvement in the project and I understand that I can withdraw from the project at any stage without penalty and without being asked for my reasons for withdrawing.
- I understand that every attempt will be made to keep any information or opinions confidential and that a pseudonym will be used with the aim of preserving my identity in the write up of the research.
- I understand that only the researcher and the researcher's supervisors will have access to the results of the focus group and these will be stored on computers that are password protected and owned by the University of Canterbury. The results of the focus group will be deleted after five (5) years.
- I understand the risks associated with my participation in the research.
- I understand that if I have any concerns questions or concerns about this research they can be addressed to the researcher at the above email address or to the researcher's principal supervisor Dr Billy O'Steen (Billy.Osteen@canterbury.ac.nz).
- I understand that complaints about the research may be addressed to The Chair, Educational Research Human Ethics Committee, University of Canterbury, Private Bag 4800, Christchurch, Email: human-ethics@canterbury.ac.nz.

I have read and understood the above information and consent to participate in the focus group

I would like to receive a summary of the results of this phase of the research Yes/No
delete one

Name: .... Signature: .... Date: ....

Return of Form:
A signed copy of this form will be collected by the researcher from the participant at the commencement of the focus group.

Figure 30 – Consent form for Focus Groups

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

Trevor Nesbit
Email: trevor.nesbit@canterbury.ac.nz
PhD Student
School of Educational Studies and Human Development
College of Education
University of Canterbury

***Project:* "Use of Prevailing Personal Social Communication Technologies to Enhance Student Engagement in Large Lectures"**

Dear (Participant Name)

I am a PhD Student in the School of Educational Studies and Human Development at the University of Canterbury. The purpose of my research is to examine how audience response technologies (eg UCanAsk, Socrative, Clickers) can be used to successfully increase student engagement and learning in large lectures. During 2014 your class was surveyed as part of the research.

As part of the research I would like you to participate in a focus group to help me gain a clearer picture of the benefits and challenges involved in using audience response technologies in large lectures.

Participation in the focus is entirely voluntary. If you do participate, you have the right to withdraw from the study at any time without penalty and without being asked for your reasons. If you withdraw, I will do my best to remove any information relating to you, provided this is practically achievable.

The focus should take approximately one hour. The focus group will be relatively unstructured but will cover the following topics:

- How you feel about the use of audience response systems in lectures
- What you see as being the benefits of using audience response systems from a student perspective
- What you see as being the benefits of using audience response systems from a lecturer perspective
- What you see as being the challenges of using audience response systems from a student perspective
- What you see as being the challenges of using audience response systems from a lecturer perspective
- Key success factors in using the technologies well

Only my supervisors and I will have access to the results of the focus group and these will be stored on computers that are password protected and owned by the University of Canterbury. The results of the interviews will be deleted after 5 years. Pseudonyms will be used with the aim of preserving your identity in the write up of the results which will take the form of my PhD thesis and paper presented at conferences and submitted to academic journals.

There are few risks associated from your participation in the focus group. One of the risks is that members of the focus group may not maintain the anonymity of the

Figure 31 – Covering letter for Student Focus Groups – Part A

others that are participating. It will be expected that what is discussed during the focus group will be kept confidential by everyone involved.

I will be able to provide you with a summary of the results of this phase of the project. If you would like to receive this summary, please indicate this at the bottom of the consent form in the place provided.

If you have any questions or concerns about this research they can be addressed to me at the above email address or to my principal supervisor Dr Billy O'Steen (Billy.Osteen@canterbury.ac.nz).

This research project has received ethical approval from the University of Canterbury Educational Research Human Ethics Committee and Complaints may be addressed to: The Chair, Educational Research Human Ethics Committee, University of Canterbury, Private Bag 4800, Christchurch, Email: human-ethics@canterbury.ac.nz.

If you agree to participate in the interview, please sign the attached consent form to indicate your willingness to participate and understanding of what is involved.

Kind regards

Trevor Nesbit

Figure 32 – Covering letter for Student Focus Groups – Part B

Appendix H

Ethics Approval for University of Canterbury Version of Survey

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

HUMAN ETHICS COMMITTEE

Secretary
Email: human-ethics@canterbury.ac.nz

Ref: 2014/50/ERHEC Amendment 1

19 April 2016

Trevor Nesbit
Department of Accounting & Information Systems
UNIVERSITY OF CANTERBURY

Dear Trevor

Thank you for your request for an amendment to your research proposal "Use of prevailing personal social communication technologies to enhance student engagement in large lectures" as outlined in your email dated 3rd March 2015. I am pleased to advise that this request has been considered and approved by the Educational Research Human Ethics Committee.

Please note that should circumstances relevant to this current application change you are required to reapply for ethical approval.

If you have any questions regarding this approval, please advise.

We wish you well for your continuing research.

Yours sincerely

Nicola Surtees
Chair
Educational Research Human Ethics Committee

Figure 33 – Letter Granting Ethics Approval Student Focus Groups

Appendix I

Questions Asked in Surveys

The Appendix sets out the questions that were asked in the surveys.

Survey Questions Asked Where APOD used for MCQ Questions in Lectures

Where the application had been used to ask the students multiple choice questions (AMAP500, COSC368 and ECON105) they were asked to rate their level of agreement with six (6) statements on a five step Likert Scale from strongly agree through to strongly disagree, with the statements being shown in Table 112.

MCQ-A	Discussing the questions with the person sitting next to me helped my learning
MCQ-B	Seeing the correct answers to questions that I got wrong helped my learning
MCQ-C	Using <name of application> in this way made the lecture more enjoyable
MCQ-D	Using <name of application> in this way helped me to feel more engaged during lectures
MCQ-E	Thinking about how I would answer the questions encouraged me think more about the lecture content
MCQ-F	Answering questions anonymously using <name of application> is a reason why I would choose to use it to answer questions

Table 112 – Statements to Rate Re Use for Multi-Choice Questions

Where the application had been used to ask the students multiple choice questions (AMAP500, COSC368 and ECON105) they were asked to rate their level willingness to use the application to answer multiple choice questions or participate non-anonymously by raising their hands. These questions are shown in Table 113.

MCQ-G	If the lecturer asks a multiple choice question I would raise my hand to indicate my answer
MCQ-H	If the lecturer asks a multiple choice question I would use <name of application> to indicate my answer

Table 113 – Statements to Rate Re Frequency of Actions for Multi-Choice Questions

Survey Questions Asked Where APOD used for Feedback from SGD in Lectures

Where the application had been used so that students could have small group discussions and submit their responses to open ended questions (INFO243 and MPAC607) the students were asked to rate their level of agreement with seven statements on a five step Likert Scale from strongly agree through to strongly disagree, with the statements being shown in Table 114.

SGD-A	Seeing the answers from some of the other groups helped my learning
SGD-B	The lecturer giving feedback on the answers helped my learning
SGD-C	Discussing the questions with the person sitting next to me helped my learning
SGD-D	Using <name of application> in this way made the lecture more enjoyable
SGD-E	Using <name of application> in this way helped me to feel more engaged during lectures
SGD-F	Thinking about how I would answer the questions encouraged me think more about the lecture content
SGD-G	Answering questions anonymously using <name of application> is a reason why I would choose to use it to answer questions

Table 114 – Statements to Rate Re Use for Responses from Small Groups

Where the application had been used so that students could have small group discussions and submit their responses to open ended questions (INFO243 and MPAC607) the students were asked to rate their level willingness to use the application to provide feedback from small group discussions or to do so non-anonymously. These questions are shown in Table 115.

SGD-H	If the lecturer wanted someone to tell the rest of the class about the answer my group had decided on I would volunteer to do this
SGD-I	If the lecturer wanted someone to use <name of application> to share the answer my group had decided on I would volunteer to do this

Table 115 – Statements to Rate Re Frequency of Use for Small Group Responses

Survey Questions Asked Where APOD used for Students to Indicate Most Important Content from Lecture

Where the application had been used so that students could report back at the end of a lecture on what they thought the most important content in the lecture was (INFO243) the students were asked to rate their level of agreement with seven statements on a five step Likert Scale from strongly agree through to strongly disagree, with the statements being shown in Table 116.

MIC-A	Seeing what other groups thought the most important thing was helped my learning
MIC-B	The lecturer giving feedback on what the class thought the most important thing was helped my learning
MIC-C	Discussing what the most important thing was with the person sitting next to me helped my learning
MIC-D	Using <name of application> in this way made the lecture more enjoyable

MIC-E	Using <name of application> in this way helped me to feel more engaged during lectures
MIC-F	Thinking about what the most important thing was encouraged me think more about the lecture content
MIC-G	Submitting what we thought was the most important thing anonymously using <name of application> is a reason why I would choose to use it to do this

Table 116 – Statements to Rate Re Use for Reporting Back on Most Important Content

The students were also asked to rate how frequently they would use the application for indicating the most important content covered in the lecture or complete a corresponding activity non-anonymously with these questions being shown in Table 117.

MIC-H	If the lecturer wanted someone to tell the rest of the class about the most important thing my group had decided on I would volunteer to do this
MIC-I	If the lecturer wanted someone to use <name of application> to share the most important thing my group had decided on I would volunteer to do this

Table 117 – Statements to Rate Re Frequency of Reporting on Most Important Content

Survey Questions Asked Where APOD used for Students to Ask Questions at End of Lectures

Where the application had been used so that students ask questions at the end of a lecture about the content (INFO243) the students were asked to rate their level of agreement with six statements on a five step Likert Scale from strongly agree through to strongly disagree, with the statements being shown in Table 118.

QEL-A	The lecturer answering the questions that were asked helped my learning
QEL-B	Using <name of application> in this way made the lecture more enjoyable
QEL-C	Thinking what questions I would ask made me think more about the lecture content
QEL-D	Discussing what questions I would ask with the person sitting next to me made me think more about the lecture content
QEL-E	Seeing the questions asked by other groups helped me think more about the lecture content
QEL-F	Using <name of application> in this way helped me to feel more engaged during lectures

Table 118 – Statements to Rate Re Use for Asking Questions at End of a Lecture

The students were also asked to rate how frequently they would use the application for asking questions at the end of a lecture or complete a corresponding activity non-anonymously with these questions being shown in Table 119.

QEL-G	If at the end of the lecture the lecturer asks "are there any questions" and there is something I was wondering about, I would ask about it in front of the class
QEL-H	If at the end of the lecturer the lecturer asked for any questions to be submitted using <name of application> I would consider doing so

Table 119 – Statements to Rate Re Frequency for Asking Questions at the end of Lecture

Appendix J
Results of Non-Parametric Tests

A series of non-parametric tests were conducted using SPSS to determine if there was a statistically significant difference between groups of respondents of the Likert scale based questions that were answered in the student surveys. In all cases the significance level used was 0.05. This appendix produces the results of these tests. For each statement in each test the null hypothesis was that there was not a significant different between the two groups of respondents. In all cases the Mann-Whitney tests was performed, except in one case (shown in Table 126) where the Mann-Whitney test was not able to be performed due to the distribution of the data. In this case the difference in medians test was able to be calculated.

Multiple Choice Question Mode – COSC368 Students v ECON105 Students

Statement	Mann-Whitney Test P-Value	Null Hypothesis	Significant Difference
MCQ-B	0.036	Reject	Yes
MCQ-A	0.838	Retain	
MCQ-C	0.335	Retain	
MCQ-D	0.450	Retain	
MCQ-E	0.486	Retain	
MCQ-F	0.128	Retain	
MCQ-G	0.108	Retain	
MCQ-H	0.559	Retain	

Table 120 – Non-Parametric Test of Significance between COSC368 and ECON105

Multiple Choice Question Mode – All Female Students v All MaleStudents

Statement	Mann-Whitney Test P-Value	Null Hypothesis	Significant Difference
MCQ-F	0.000	Reject	Yes
MCQ-A	0.198	Retain	
MCQ-B	0.255	Retain	
MCQ-C	0.108	Retain	
MCQ-D	0.110	Retain	
MCQ-E	0.589	Retain	
MCQ-G	0.596	Retain	
MCQ-H	0.708	Retain	

Table 121 – Non-Parametric Test of Significance between Genders

Multiple Choice Question Mode – All Students Under 21 v All Students 21 and Older

Statement	Mann-Whitney Test P-Value	Null Hypothesis	Significant Difference
MCQ-F	0.053	Reject	Yes
MCQ-A	0.438	Retain	
MCQ-B	0.290	Retain	
MCQ-C	0.616	Retain	
MCQ-D	0.656	Retain	
MCQ-E	0.970	Retain	
MCQ-G	0.283	Retain	
MCQ-H	0.607	Retain	

Table 122 – Non-Parametric Test of Significance between Age Groups

Multiple Choice Question Mode – Based on English Language Background of Students

Statement	Mann-Whitney Test P-Value	Null Hypothesis	Significant Difference
MCQ-A	0.238	Retain	
MCQ-B	0.683	Retain	
MCQ-C	0.476	Retain	
MCQ-D	0.682	Retain	
MCQ-E	0.276	Retain	
MCQ-F	0.344	Retain	
MCQ-G	0.763	Retain	
MCQ-H	0.141	Retain	

Table 123 – Non-Parametric Test of Significance Based on English Language Background

Small Group Discussion Mode – INFO243 Students v MPAC607 Students

Statement	Mann-Whitney Test P-Value	Null Hypothesis	Significant Difference
SGD-H	0.005	Reject	Yes
SGD-A	0.987	Retain	
SGD-B	0.556	Retain	
SGD-C	0.084	Retain	
SGD-D	0.455	Retain	
SGD-E	0.232	Retain	
SGD-F	0.210	Retain	
SGD-G	0.328	Retain	
SGD-I	0.152	Retain	

Table 124 – Non-Parametric Test of Significance across INFO243 and MPAC607

Small Group Discussion Mode – All Female Students v All Male Students

Statement	Mann-Whitney Test P-Value	Null Hypothesis	Significant Difference
SGD-F	0.042	Reject	Yes
SGD-A	0.307	Retain	
SGD-B	0.308	Retain	
SGD-C	0.756	Retain	
SGD-D	0.518	Retain	
SGD-E	0.770	Retain	
SGD-G	0.384	Retain	
SGD-H	0.325	Retain	
SGD-I	0.737	Retain	

Table 125 – Non-Parametric Test of Significance across the Genders

Small Group Discussion Mode – All Students Under 21 v All Students 21 and Older

Statement	Median Test/ Mann-Whitney Test P-Value	Null Hypothesis	Significant Difference
SGD-H	0.036/XXX	Reject/XXX	Yes
SGD-A	XXX/XXX	XXX/XXX	
SGD-B	XXX/XXX	XXX/XXX	
SGD-C	0.128/XXX	Retain/XXX	
SGD-D	0.850/XXX	Retain/XXX	
SGD-E	0.529/XXX	Retain/XXX	
SGD-F	0.178/XXX	Retain/XXX	
SGD-G	0.261/XXX	Retain/XXX	
SGD-I	0.681/XXX	Retain/XXX	

Table 126 – Non-Parametric Test of Significance by Age

Small Group Discussion Mode – Based on English Language Background of Students

Statement	Mann-Whitney Test P-Value	Null Hypothesis	Significant Difference
SGD-F	0.009	Reject	Yes
SGD-A	0.314	Retain	
SGD-B	0.174	Retain	
SGD-C	0.903	Retain	
SGD-D	0.177	Retain	
SGD-E	0.229	Retain	
SGD-G	0.665	Retain	
SGD-H	0.127	Retain	
SGD-I	0.115	Retain	

Table 127 – Non-Parametric Test of Significance Based on English as a First Language

Small Group Discussion Mode – INFO243 Only – Female Students v Male Students

Statement	Mann-Whitney Test P-Value	Null Hypothesis	Significant Difference
SGD-D	0.048	Reject	Yes
SGD-A	0.539	Retain	
SGD-B	0.681	Retain	
SGD-C	0.923	Retain	
SGD-E	0.732	Retain	
SGD-F	0.287	Retain	
SGD-G	0.684	Retain	
SGD-H	0.407	Retain	
SGD-I	0.447	Retain	

Table 128 – Non-Parametric Test of Significance across the Genders for INFO243 Only

Small Group Discussion Mode – INFO243 Only – Students Under 21 v Students 21 and Older

Statement	Mann-Whitney Test P-Value	Null Hypothesis	Significant Difference
SGD-B	0.011	Reject	Yes
SGD-C	0.027	Reject	Yes
SGD-A	0.791	Retain	
SGD-D	0.759	Retain	
SGD-E	0.189	Retain	
SGD-F	0.181	Retain	
SGD-G	0.340	Retain	
SGD-H	0.336	Retain	
SGD-I	0.881	Retain	

Table 129 – Non-Parametric Test of Significance by Age

Small Group Discussion Mode – INFO243 Only – Based on English Language Background of Students

Statement	Mann-Whitney Test P-Value	Null Hypothesis	Significant Difference
SGD-I	0.041	Reject	Yes
SGD-H	0.007	Reject	Yes
SGD-B	0.407	Retain	
SGD-E	0.895	Retain	
SGD-A	0.843	Retain	
SGD-G	0.597	Retain	
SGD-D	0.817	Retain	
SGD-C	0.140	Retain	
SGD-F	0.205	Retain	

Table 130 – Non-Parametric Test of Significance Based on Language Background (INFO243)

Most Important Content Mode – INFO243 Only – Female Students v Male Students

Statement	Mann-Whitney Test P-Value	Null Hypothesis	Significant Difference
MIC-A	0.713	Retain	
MIC-B	0.746	Retain	
MIC-C	0.812	Retain	
MIC-D	0.286	Retain	
MIC-E	0.350	Retain	
MIC-F	0.183	Retain	
MIC-G	0.812	Retain	
MIC-H	0.681	Retain	
MIC-I	0.779	Retain	

Table 131 – Non-Parametric Test of Significance across the Genders

Most Important Content Mode – INFO243 Only – Students Under 21 v Students 21 and Older

Statement	Mann-Whitney Test P-Value	Null Hypothesis	Significant Difference
MIC-A	0.385	Retain	
MIC-B	0.592	Retain	
MIC-C	0.592	Retain	
MIC-D	1.000	Retain	
MIC-E	0.408	Retain	
MIC-F	0.065	Retain	
MIC-G	0.113	Retain	
MIC-H	0.079	Retain	
MIC-I	0.145	Retain	

Table 132 – Non-Parametric Test of Significance by Age

Questions at End of Lecture Mode – INFO243 Only – Female Students v Male Students

Statement	Mann-Whitney Test P-Value	Null Hypothesis	Significant Difference
QEL-C	0.048	Reject	Yes
QEL-D	0.001	Reject	Yes
QEL-A	0.215	Retain	
QEL-B	0.288	Retain	
QEL-E	0.249	Retain	
QEL-F	0.056	Retain	
QEL-G	0.101	Retain	
QEL-H	0.288	Retain	

Table 133 – Non-Parametric Test of Significance across the Genders

Questions at End of Lecture Mode – INFO243 Only – Students Under 21 v Students 21 and Older

Statement	Mann-Whitney Test P-Value	Null Hypothesis	Significant Difference
QEL-A	0.034	Reject	Yes
QEL-B	0.048	Reject	Yes
QEL-C	0.030	Reject	Yes
QEL-D	0.004	Reject	Yes
QEL-E	0.245	Retain	
QEL-F	0.080	Retain	
QEL-G	0.211	Retain	
QEL-H	0.166	Retain	

Table 134 – Non-Parametric Test of Significance by Age

Appendix K
Open Ended Responses Regarding use of APODs for Multiple Choice Questions

The responses to the open-ended question of "How did you feel about using <name of application> in this way?" when the application was used for multiple choice questions shown in Table 135. There were 28 responses to the question out of the 66 valid responses to the survey from these groups of students.

Course	Resp-onse	Gender	English 1st Lang	Age	Comment
COSC368	1	Male	Yes	21	It was a great way to gauge understanding of the material as we were going over it.
COSC368	2	Female	Yes	20	Engaging, unique learning experience
COSC368	3	Male	Yes	22-25	Very high level of student engagement compared to any other course I've done at <name of institution>
COSC368	4	Male	Yes	21	Because it is anonymous, I didn't feel any pressure to get answers right. It also definitely made me feel more engaged, as I didn't want to miss any questions or any information that might be useful to answer questions, and we would often discuss answers with our peers.
COSC368	5	Male	Yes	26-30	I enjoyed the use of <name of application> for answering questions, it did keep me engaged as some lectures i would drift off and not pay as much attention
COSC368	6	Male	Yes	20	You don't want to say stuff out loud if you are not 100% confident in your answer so <name of application> is good for getting the answer out of you without potentially embarrassing you
COSC368	7	Male	Yes	26-30	Great
COSC368	8	Female	Yes	20	Are there other ways to use <name of application>?
COSC368	9	Male	Yes	22-25	<name of application> allows for you to say your answer without the fear of getting it wrong infront of the class.
AMAP500	1	Female	Yes	20	I found that <name of application> was a good learing tool it helped you prepare for the questions on paper and also got the whole class working together or in groups. <name of application> is also a good way to see what the majourity of people know and what may need to be worked on

AMAP500	2	Male	Yes	26-30	I think it is a great tool the differentiates from other lectures. My teaching friends in the states use a similar programme regularly in high schools to encourage active learning and participation.
AMAP500	3	Female	Yes	26-30	I sit at a table with four other people and we always discuss the question and would use the only laptop available which belonged to <name of student> and would answer based upon majority rules. / <name of application> is very straight forward and easy to use.
AMAP500	4	Female	Yes	31-35	Effective way to engage my thought process
ECON105	1	Female	Yes	18	Within the first half of the course I had the app and used it sometimes however due to phone issues had to later delete the app. So It was useful to have the <name of application>/questions on the projector as well. / / Overall I think using these in-class activities are great for learning.
ECON105	2	Male	Yes	17 or under	It was enjoyable and broke the monotony that often arises when listening for extended periods of time, as it allowed the communication to flow in 2 directions. Props to <name of lecturer> for using this tool.
ECON105	3	Male	Yes	19	I believe <name of application> is a wonderful learning tool as nobody can look down at you or know that you answered incorrectly as only you know you got it wrong or right, i would compare the system to the clickers in STATS which worked equally well
ECON105	4	Male	Yes	18	Good, makes it a lot easier than speaking up in a lecture, more involved
ECON105	5	Female	Yes	17 or under	I think the <name of application> app is fantastic. It's used in another one of my lectures and the explanation it provides if you get an answer wrong is well worth while. It is also good because the lecturer has just explained the information and you can try it out straight away rather than waiting for the tutorial the following week.
ECON105	6	Male	Yes	18	It helps to see how much of the content I can really understand in a way that is similar to the exam but also is engaging and fun
ECON105	7	Female	Yes	19	<name of application> was good as it was anonymous so people could try and work out from the teaching what was the right answer but they didn't need to put up their hand
ECON105	8	Male	Yes	18	I feel like <name of application> is quite a good tool to get students participating in lectures even if I am unable to access it myself. discussing with peers about the questions was useful and the lecturer telling us why we were wrong was quite helpful too.

ECON105	9	Female	Yes	18	I really enjoyed using the app and would recommend it. It really helps with keeping interested and actually applying the content to real problems - very quickly shows you whether you understand it or not and then it is easy to ask questions after the class.
ECON105	10	Male	Yes	19	It's good, easy use
ECON105	11	Female	Yes	18	Pretty good, nice and interactive without me feeling embarrassed about getting the wrong answer
ECON105	12	Female	Yes	18	I really enjoyed using this app, as it gave me a chance to answer the questions asked anonymously- personally I am worried about saying the wrong answer often so I will not voluntarily verbally answer, but this app helped with my learning.
ECON105	13	Female	Yes	19	It made me feel better about participating and more confident in my learning
ECON105	14	Male	Yes	18	Uninterested
ECON105	15	Female	Yes	18	Very interactive and fun way to learn

Table 135 – Responses to "How do you feel about using APODs for MCQ Questions

Appendix L

Open Ended Responses Regarding use of APODs for Responses from Small Group Discussions

The responses to the open-ended question of "How did you feel about using <name of application> in this way?" when the applications was used for sharing responses from small group discussions are shown in Table 136. There were 19 responses to the question out of the 63 valid responses to the survey from these groups of students.

Course	Resp-onse	Gender	English 1st Lang	Age	Comment
MPAC607	1	Female	No	26-30	I think this is an innovative way to lead discussion in class. However, i prefer the lecture combine the face-to-face discussion and <name of application> discussion together, according to different question type
MPAC607	2	Male	Yes	31-35	It is alright to use. It seems to be a better tool for polling opinions (in an anonymous mannner) rather than presenting identified group voices on a certain topic. Group voices seem to be better if they are naturally voiced than via a system such <name of application>.
MPAC607	3	Female	Yes	36 or older	It helped to get contributions from everyone even people who are shy
MPAC607	4	Female	Yes	31-35	I happily participate and answer/ask questions in class so I'm happy to share my thoughts in whatever medium and for them to be made public from <name of application> if I was aware that my response would be. I would word my response more fully if I knew it was going to name me/my group
MPAC607	5	Female	Yes	36 or older	Thought it was an excellent way of seeing others answers and like the fact it was anonymous
MPAC607	6	Female	Yes	36 or older	To be honest, I didn't get a lot out of this. Probably because I don't have a problem speaking in lectures. But for people who are too shy, I can see that it would improve their experience.
MPAC607	7	Female	Yes	22-25	It was productive and helped me apply course theory to situations. It also helped me become more engaged in the class and helped improve ties with my classmates.

MPAC607	8	Female	Yes	31-35	Highly interactive and advanced technology for knowledge sharing in the class
MPAC607	9	Male	No	26-30	I felt <name of application> us a best tool to express the ideas in the class Spontaneously.Its fast too.
MPAC607	10	Female	No	22-25	It did make students to be more engaged, and it encourages more people to share their ideas, however it is purely visual aid, it could be less efficient for people who learn better with audio aid, and there are times it became inefficient when people share random things without enough clarification.
MPAC607	11	Male	Yes	22-25	I found the use of <name of application> a very useful learning tool. Although the answers weren't always right, it encouraged me to think about the question and how it may relate to the lecture content. It was a very easy to use and comfortable way testing myself to see how much I knew/have learned about the topic.
INFO243	1	Female	Yes	22-25	I think its a great way as I'm someone who would never ask a question or answer a question in class and it's also very intimidating when the teacher points you out in class to make you answer a question. Its almost enough to make you not want to attend that class. So <name of application> is so much better.
INFO243	2	Male	Yes	22-25	Good, useful tool and Lecturer guides us and explains important points when seeing our answers.
INFO243	3	Male	Yes	21	A brilliant tool that aided learning and effectively separated theory from practical learning. This shift in lecture styles throughout the course of the lectures aided my engagement with the content.
INFO243	4	Male	Yes	22-25	I think provided you have sufficient time to cover the content for the lectures and have mini '<name of application> segments' its definitely a positive experience. / / Maybe even just have the questions at the end, and allow for everyone to 'ask questions' using <name of application> during the lecture.
INFO243	5	Male	Yes	21	Good, <name of application> was a good anonymous way of answering without being worried you may stumble
INFO243	6	Male	Yes	26-30	More freedom to express ideas in relation to questions
INFO243	7	Male	Yes	22-25	Good, Lecturer explaining in depth the questions and guiding mis aligned students
INFO243	8	Female	Yes	36 or older	its a great tool to get more students to give answers to the teacher, so many students won't say an answer out aloud in a lecture.

Table 136 – Responses to "How do you feel about using APODs for Responses from SGD

Appendix M

Open Ended Responses Regarding use of APODs for Responses Regarding the Most Important Content from a Lecture

The responses to the open ended question of "How did you feel about using <name of application> in this way?" when the applications was used for sharing what the most important content was in a lecture are shown in Table 137. There were 11 responses to the question out of the 35 valid responses to the survey from these groups of students.

Resp-onse	Gender	English 1st Lang	Age	Comment
1	Male	Yes	20	The same line of reasoning applies as the last question, though in reviewing what the most important thing of the lecture was, because it is at the end of the lecture, often when time is nearly out (or maybe we're going over time), it raises the time cost of effort and makes reason #1 more problematic. / / Also, I don't sit with anyone else in lectures so don't discuss my ideas with 'my group' as such (its all internally thought of)
2	Male	Yes	19	It gave the topic rounding and gave us key points to focus on.
3	Male	Yes	19	it was a good program to use in class, it allowed people to share opinions without anyone knowing who's opinion it was
4	Male	Yes	19	I didn't usually bother with this at the end of the class.
5	Male	Yes	21	<name of application> was a great way of getting the message across as to what points were the most important for each lecture
6	Male	Yes	20	really helpful, makes it less intimidating
7	Female	Yes	36 or older	An excellent way to keep studentsi nterested and engaged
8	Female	Yes	20	I thought it was good but I preferred the questions that were about specific content.
9	Male	Yes	20	mostly a waste of time
10	Male	Yes	19	It was engaing and made myself think about what we just learnt or were about to do
11	Male	Yes	20	Is the way forward.

Table 137 – Responses to "How do you feel about using APODs for Reporting on MIC

Appendix N
Open Ended Responses Regarding use of APODs for Responses Regarding Asking Questions at the End of a Lecture

The responses to the open ended question of "How did you feel about using <name of application> in this way?" when the application was used for asking questions at the end of a lecture are shown in Table 138. There were 6 responses to the question out of the 29 valid responses to the survey from these groups of students.

Resp-onse	Gender	English 1st Lang	Age	Comment
1	Male	Yes	20	Again, I don't mind asking such questions, especially 1 on 1 with the lecturer as people are leaving the lecture. But hearing other people's questions and having them explained (especially as even thinking and articulating a question to ask can be difficult), was quite helpful. I enjoyed the additional participation that was created.
2	Female	Yes	22-25	Someone else in our group who had their laptop would answer
3	Female	No	19	Sometimes a useful question might appear that I wouldn't have thought of.
4	Male	Yes	19	When other students asked questions it tested my knowledge as I wanted to see if I could answer their questions. It also helped clarify points I was a little confused on.
5	Female	No	20	Socrative id good.
6	Male	Yes	20	Is the way forward.

Table 138 – Responses to "How do you feel about using APODs for Asking Questions