Effects Of Audience Response Systems On Student Engagement and Participation In Large Undergraduate Education Lectures

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Effects Of Audience Response Systems On Student Engagement and Participation

In Large Undergraduate Education Lectures

by

Aarthi Rajasekaran

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES
IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE
DEGREE OF MASTER OF SCIENCE

GRADUATE PROGRAMS IN EDUCATION
CALGARY, ALBERTA
SEPTEMBER 2013

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Abstract

Technology mediated learning is a regular occurrence in the 21st century classroom. This case study focuses on the use of the SMART Response™ XE Audience Response System in a large undergraduate education lecture. The study aims to address three important questions about engagement, participation, and instruction for teachers and students in large lecture classrooms using Audience Response Systems. Shy and reluctant learners are of special interest in this study. Survey data, instructor, student interviews, and field observations were collected for this study. Study findings indicate benefits for instructors along with an engaged, socially aware group of undergraduate students who inform their learning through reflection and exposure to peer ideas via the audience response system. The system worked flawlessly throughout the semester and encouraged student participation in lectures. Use of the anonymous feature appears to support students in sharing honest perspectives through clicker questions. The open-ended text entry questions despite the 140 character limit seems to engage the digital learner and help them to focus on their learning in the large lecture. Recommendations for ongoing research and instructional practices are given.
Acknowledgements

A lot of people have supported me to pursue this Graduate program and helped make my dream a reality. I would like to take this opportunity to acknowledge their contribution towards this body of work.

First and foremost I am grateful to Dr. Michele Jacobsen – my supervisor for all the support, encouragement and guidance she has shown me throughout the program. I am truly blessed to have worked under this erudite scholar, researcher, writer and teacher. Thank you for believing in me and making this journey possible. You love and support continues to inspire me to be the best in whatever I do. You taught me that I never beat myself about the past and only move forward with the best foot forward. I couldn’t have done any of this without you.

Second, I would like to thank my husband Ram Venkataraman – for his unwavering support, encouragement and unconditional love. Thank you for encouraging me to follow my dream, putting up with my long hours studying past midnight, terrible take outs, waiting up till I got home from a late class, calming my fears of failure, and for just being there rooting for me. When I count my blessings, I count you at least a thousand times. I would have never ventured out to follow my passion if not for you.

I would also like to thank all study participants who made this study possible with their valuable insights and contributions, starting with the professor of the large lecture, her teaching assistant, and students who participated in the study.

Next I would like to thank my family – My Dad Rajasekaran Eswaran, My Mom – Chitra Rajasekaran, My sister – Aparna Rajasekaran, My brother – Aadhithya Rajasekaran. Without you all I would never be the person that I am today. Thanks for all
the love. I also would like to take this opportunity to thank my grandparents, extended family, in-laws, cousins, uncles, and Aunts for their love and for instilling family values that keep me grounded wherever I go. A special mention about my Late Grandmother Rajeshwari Ramanathan and my Late Grandfather Ramanathan Iyer for babysitting me, chiding me when I was up to no good and for all those wonderful summers, and family gatherings. You taught us lessons that can never be learned in a classroom.

A huge thank you to my friends Madhumathy Raghuram, and Divya Shashikant. Thank you girls for putting up with my mood swings and periods of no contact. You both are the perfect remedy for a dull day. You made me realize that geographical distances don’t mean a thing; still kicking myself for not getting that smartphone sooner. Your support, love and encouragement have seen me through a lot of difficult times over the years. I couldn’t be here without you girls. A big hug and thank you.

I would also like to thank fellow students for the hallway banter and sharing my frustrations on a bad day. Thank you for the hope that there is light at the end of the tunnel.

I am also grateful to the Counsellors at the University of Calgary Wellness Centre who helped me through difficult periods away from home. Thank you for helping me make positive changes to my life.

Last but not the least I would like to thank everyone involved in the successful pursuit of my M.Sc program, and the completion of my research study.
Dedicated to My Husband

Ram Venkataraman – My Prayer, Pride & Joy

And

In Memory of My Grandmother

Rajeshwari Ramanathan – A True Woman of Substance
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Epigraph

We might possess every technological resource... but if our language is inadequate,
our vision remains formless, our thinking and feeling are still running in the old
cycles, our process may be 'revolutionary' but not transformative.

- Adrienne Rich
CHAPTER 1 INTRODUCTION

Delivering information to students via lectures is a well-recognized and established method of teaching and learning in post-secondary institutions. For a variety of reasons, such as efficiency and cost-effectiveness, the preferred method of instructional delivery in many large enrolment courses is the large lecture. Lectures and tests are standard features for many students in many large enrolment undergraduate courses (Sharma, Khachan, Chan, & O’Byrne, 2005). The teaching and learning that occurs in these large classrooms is the subject of many research studies. Questions asked include:

- Do students learn? (Sharma et al., 2005)
- What aspects of lectures foster learning? (Sharma et al., 2005)
- Does interaction improve learning?
- Are students engaged in the lecture?

Despite widespread usage, the simple “transmission of knowledge” from the instructor to the student in a lecture may not be the most effective way for students to learn (Dwyer, 1996; Gibson, 2001; Sharma et al., 2005, p. 137). Interaction in lecture has been shown to improve conceptual learning (Hake, 1998; Thornton & Sokoloff, 1998). Many studies have demonstrated that simple changes to instructional strategies can be effective in fostering learning in large lectures. Ebert-May, Brewer, and Allred (1997) used student-centered, in-class experiences and demonstrations in large lectures to simulate learning. In their experimental study of biology undergraduate students and faculty in Northern Arizona University (NAU), they found that active learning strategies such as “cooperative learning combined with an inquiry-based approach promotes effective
Bonwell and Eison (1991) suggest several simple instructional strategies to improve learning in lectures. These include:

- Pausing for a minute or two at different stages of the lecture to allow students to consolidate their notes and reflect on lecture content to improve learning.
- Inserting brief demonstrations or short ungraded writing exercises followed by a class discussion.
- Using feedback lectures which consist of 2 mini-lectures separated by a small-group study session built around a study guide.
- Using guided lectures in which students listen to a 20- to 30-minute presentation without taking notes, followed by each student writing for five minutes about what they remember from the brief lecture and spending the remainder of the lecture in small groups clarifying and elaborating the material.
- Incorporating visual-based instruction to provide a helpful focal point for other interactive techniques.
- Promoting in-class writing exercises is a productive way to involve students in doing things and thinking about the things they are doing.
- Applying cooperative learning strategies such as debates, drama, peer teaching, role playing and simulation.
- Practicing instructional strategies based on problem-solving model include such as the case study method of instruction and guided design (As cited in Bonwell & Eison, 1991, pp. 2-3).
It is unlikely that lectures will be abandoned as a way of providing learning experiences for undergraduate students. Therefore, our research attention is productively focused on how we might combine traditional methods with educational technologies to improve classroom interactivity, the teaching and learning experience in large lectures. Educational technology can bring together existing best practices, educational content, and new technology to provide “valuable learning experiences” by modifying and influencing the design of the conventional classroom and its pedagogy (Jadhav, 2010, p. 3). Interactive learning technologies can help to engage, motivate, enhance and sustain the learning of the 21st century digital learner.

The Problem

The current system of delivering instruction in many undergraduate courses is through large lectures. The number of students in such a lecture can range from 100-500 students. A typical setup of a large lecture often delegates one instructor to deliver instruction to a large number of students simultaneously. While the large lecture format may be one of the most cost effective and efficient ways of delivering instruction in large enrollment courses, they are often not the best platforms for interaction and communication. In addition to delivering quality instruction to students, using a variety of methods to capture student’s attention and keep them focussed on their learning is a challenge for higher education instructors. Audience Response Systems or clickers can greatly enhance the teaching and learning experience in large classrooms by providing instructors tools to communicate and interact with all students in the lecture. SMART Technologies have developed the SMART Response™ XE Interactive Response System that can be used by an instructor to gather responses simultaneously from hundreds of
students in a lecture by posing questions through the response system at any time during their lecture.

**Purpose of the Present Investigation**

The current investigation explores the influence of SMART Response™ XE Interactive Response System on student engagement in large undergraduate education lectures at the University of Calgary. Additionally, the study also examines shy/reluctant learner participation and instructional strategies for questions to be used in conjunction with response systems in the classroom.

All of the undergraduate students enrolled in the ‘Introduction to Educational Studies’ course offered by the Faculty of Education were invited to participate in the study. The SMART Response™ XE system was integrated with the existing projection system and technical infrastructure in the large lecture hall. At the beginning of each lecture, students were provided with hand-held response devices to provide their inputs to questions posed by the instructor during the course of the lecture through the response system. A survey was administered to consenting participants using the response system to gather perceptions on the use of an interactive response system in the classroom. Interviews and focus groups were also conducted to allow students and teaching staff to record their experience of clicker usage in the classroom. In addition, the researcher documented observations and field notes throughout the duration of the study to record both common and unique occurrences. The interactivity provided by the clickers in the large lecture could help engage learners and allow shy/reluctant learners to participate in class discussions.
An Introduction to Audience Response Systems

Audience Response Systems, popularly called “clickers”, can be used to promote interaction between instructors and students in large and small lectures. Audience Response Systems are popular technology aids to assess existing knowledge, test the understanding of new concepts, engage learners, gather student feedback and promote interaction with the instructor as well as between peers. Cain and Robinson (2008) claim that instructors in many disciplines are grasping the “pedagogical value” of Audience Response System technology in large lectures:

From an instructor’s viewpoint, ARSs can be beneficial for peer-learning activities, gathering feedback on student’s understanding of lecture material, identifying student’s misconceptions about content, and enabling the instructor to adapt lectures to address those misconceptions (p. 1).

In the following sections, the components of an audience response system and the evolution of response systems in the classroom are discussed.

Components of an Audience Response System

Handheld clickers that wirelessly transmit response information to a computer system are at the core of any Audience Response System. The size and simplicity of clickers is an asset that can be well used in a large lecture setting. A variety of clickers are available from a number of different manufacturers. However, most Audience Response Systems have some common components. These include:

- Input devices that transmit information.
- A receiver that gathers response from response transmitters.
- Software that aids in aggregating and interpreting all responses.
Burnstein and Lederman (2003) compared a number of electronic response systems that are available for use today. They classified wireless response systems based on the type of frequency they used to transmit information and the capability of response systems in transmitting and receiving information. Based on the type of frequency used to transmit information they identified systems that communicated using RF (Radio Frequency) or IR (Infrared). Deal (2007) identifies another type of response system that uses Wi-Fi computing devices. Wireless response systems can also be classified as one-way or two-way systems depending on their capability to transmit and receive information. One-way systems are capable of either transmitting or receiving information but not both. The communication is limited to one way of transmission only on a set frequency. Two-way systems are capable of both transmitting and receiving information on a set type of frequency. Two-way systems for example, can send a confirmation to hand held devices when a response is recorded by the receiver. Burnstein and Lederman (2003) also identified a third category of a wireless system that are one-way transmitters. These systems do not use a keypad device like a traditional response system. They are simple response systems that employ electronic flashcards.

The way transmitted and received signals are processed varies for different devices and manufacturers. One common feature for all wireless keypad systems used to gather responses, is a software system that gathers, processes, classifies and displays information based on predetermined parameters. There are advantages and disadvantages to using each system. The needs of the students, the pedagogy of the lecture, and proposed uses of the response system in the lecture must be carefully considered before choosing an audience response system to be implemented in the classroom.
IR response systems have a low equipment costs but can support only 40-50 hand held transmitters. They also have a shorter range. RF response systems are more expensive than IR systems. However, RF systems have a longer range and one receiver can support up to 100 transmitters. Most RF systems also allow two-way communication. Hence students receive a confirmation when a response is submitted. Wi-Fi systems use a web based interface for communication. The setup costs for such a response systems are low because all they use existing wireless infrastructure in the campus. However there are few Wi-Fi computing devices that can be used as part of a response system and software portability issues can often disrupt the response entry. Wi-Fi computing devices mostly use full QWERTY keys and can be used to gather open-ended, text entry responses from students.

Deal (2007) summarized the advantages and disadvantages of response systems that use different transmitting frequencies for information exchange and communication. These are tabulated below:

Table 1.1 Advantages and Disadvantages of Various Types of Response Systems (As cited in Deal, 2007, p. 14)

<table>
<thead>
<tr>
<th>System</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infrared</td>
<td>Infrared (IR) systems basically use the same line-of-sight technology that is used in household television remotes.</td>
<td>Most IR systems often offer only one-way communication, which does not allow for confirmation when student’s response has been received.</td>
</tr>
<tr>
<td></td>
<td>They have the lowest overall equipment cost.</td>
<td>They also require the placement of receivers in line-of-sight of students, which often means permanent or semi-permanent installation.</td>
</tr>
<tr>
<td></td>
<td>There are no interference issues from classroom to classroom, as signals do not go beyond the walls of the room.</td>
<td></td>
</tr>
</tbody>
</table>

Deal (2007)
<table>
<thead>
<tr>
<th>System</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Because the clickers must be aimed directly at the receivers in order to work (and thus have high visibility in the classroom, they also reduce the likelihood that students will bring in each other’s transmitters when responses are used for attendance or participation grades.</td>
<td>Each receiver can only support between 40 and 80 transmitters (depending on manufacturer), so multiple receivers are necessary for larger classes. In very large classes, signal reception can be unreliable and have a shorter range. Clicker administration and management can also be expensive.</td>
</tr>
<tr>
<td>Radio Frequency</td>
<td>In radio frequency (RF) systems, the receiver does not have to be placed in line-of-sight of students, allowing for increased portability in hardware solutions. Signal reception is more reliable and has a longer range. RF systems also allow for two-way communication, so clickers can confirm when student’s response has been received.</td>
<td>Low visibility might make it easier for students to cheat the system by bringing in each other’s transmitters when responses are used for attendance or participation grades. RF clickers are more expensive than IR. There is a higher likelihood of interference issues as RF clickers can operate on the same frequencies as Wi-Fi and other RF devices. Clicker administration and management can be expensive.</td>
</tr>
<tr>
<td>Wi-Fi</td>
<td>Wi-Fi systems use a web-based interface for student interaction. These systems allow for text entry and open-ended responses. Students can use a wide variety of Wi-Fi devices.</td>
<td>Requires students to have a Wi-Fi computing device. Fewer choices currently available in the marketplace.</td>
</tr>
<tr>
<td>System</td>
<td>Advantages</td>
<td>Disadvantages</td>
</tr>
<tr>
<td>--------------</td>
<td>---------------------------------------------------------------------------</td>
<td>---------------</td>
</tr>
<tr>
<td></td>
<td>Uses the existing campus wireless infrastructure.</td>
<td></td>
</tr>
</tbody>
</table>

**The Evolution of Audience Response Systems**

The idea of receiving feedback from students in a large lecture has been tried and tested in an effort to increase communication between the student and instructor in a large lecture. One of the first such systems to be used was the “Colourcard feedback technique” (Pickford & Clothier, 2003, p. 81). They explained the use of this technique in the classroom. The system consists of a series of labeled color-coded cards for color blind students. Multiple choice or true/false questions are displayed to the class and students choose a response and physically display their cards. The type of feedback gathered is then used to set the “pace and direction” of the lecture (Pickford & Clothier, 2003, p. 81). The use of audience feedback was then extended to gadgets that transmitted and received information using handheld clickers. Like many technological innovations, the need for improvement drives the evolution (Petroski, 2006). A few of the factors that influenced the evolution of clickers include:

- Class size
- Type of communication in the classroom
- The need for feedback from the response system
- Type of questions used to gather student feedback
- Cost of devices
- Ease of use of software to gather and analyze data
Initially, clickers transmitted and received information in the IR frequency. The drawback of these systems was that they could only support up to a hundred users at a time. This drawback was also observed by Barber and Njus (2007) when they compared various clicker systems to identify the best fit for large classrooms in their institution. Clickers that transmitted through RF transmission were much more suited to large classrooms with more than 100 students. The initial clickers were one way transmitting devices and were capable of transmitting responses to the receiver only. However students indicated a preference to receive some feedback after sending their responses through the receiver. This lead to the development of clickers with LCD screens capable of two-way transmission. The two-way transmission enabled the clickers to receive an acknowledgement once the response information was received by the receiver. Clicker keypad design was limited to numeric or text responses that could work only in conjunction with multiple choice or true/false questions. The lack of open-ended response gathering was a serious flaw in the implementation of these systems in large classrooms. Newer handheld devices with a full keypad that allowed students to type in responses to open-ended questions were introduced. The SMART XE response system used for this study has a full QWERTY keypad and allows users to respond to open-ended questions. With the arrival of smartphones and other Wi-Fi enabled handheld computing devices, the need for a separate handheld device as part of a response system was called into question. Williams and Pence (2011) studied the use of smartphones as tools to enhance learning in large chemistry classrooms. Smartphones can be integrated with response systems with little or no additional cost. Using smartphone devices as learning tools in classrooms allows instructors to turn distraction into engagement (Fang,
The availability of open source applications thorough web capable smart phones and tablets has led to a demand in open source response system software that is readily accessible through any web capable device such as laptops, smartphones, cellphones, tablets, and mp3 players. A key challenge to address with web-capable Audience Response Systems is the connection speed and robustness of the campus wireless infrastructure. Figure 1.1 depicts the evolution of Audience Response Systems with time.

**Figure 1.1 Evolution of Audience Response Systems**

![Diagram showing the evolution of Audience Response Systems](image)

**Conclusion**

Audience Response Systems can be used to increase student’s active participation in large lectures and contribute to a more engaging learning environment in large lectures. Today’s university students do not want to be passive learners receiving information from an instructor in the large lecture format (Broussard, 2012). Student needs and expectations have evolved to where they expect instruction to be tailored to their learning needs and requirements. Students appreciate the ability to communicate with peers and instructors in a dynamic environment that allows questioning, peer discussion, social knowledge construction and instructor feedback (Freeman & Blayney, 2005). Student’s
key information sources have moved from hard bound textbooks to the “cloud” that is freely accessible through an array of web capable devices including laptops, tablets, e-readers, and smartphones making their learning more digital than ever. Capturing the attention of the digital learner in a large classroom with wireless access and web capable devices remains a challenge for instructors who teach large lectures. Faced with this challenge of engaging students and sustaining their attention in the classroom, instructors tend to worry that web capable gadgets are distractions to learning and must be dealt with using a conservative approach including, turning wireless networks off, banning the use of cellphone and other devices, (Glenn, 2010; Zhu, Kaplan, Dershimer, & Bergom, 2011). Trying to keep web capable devices out of the large lecture hall is redundant as we can never quite keep with the creative thinking capabilities of digital learners and the technological innovations including 4G LTE networks and wireless hotspot generating devices. The opportunity for instructors in such a scenario is to incorporate technology in their instruction and active learning environment. So any digital distraction can be a hidden opportunity if integrated with the pedagogy of the lecture. Using clickers in the classroom can create great opportunities for discussion, and student-student and student-instructor interaction. Such technology in the classroom can motivate, gain the attention of tech-savvy students and keep them focused on their learning.

**Thesis Outline**

This thesis contains five chapters. Chapter one introduces the research context, the research problem and the study. Chapter Two reviews relevant literature on the use of audience response systems in large lectures and develops the rationale for this study. Chapter Three details research methodology used to design the research set up, gather
and analyze data. Chapter Four presents an analysis of the collected data. Chapter Five discusses the implications of the research and concludes with a discussion of the results. It also includes recommendations for practice in the classroom and future research.
CHAPTER 2 REVIEW OF LITERATURE

This chapter presents a review of literature on an interactive learning technology called Audience Response Systems. The chapter provides an overview of existing and current research on the use of the Audience Response Systems in large lectures. The chapter begins with an examination of the relationship between the use of Audience Response Systems in large lectures and student engagement. In a second section, this chapter details the use of interactive technology aids to empower reluctant participants in large lectures. The third section, examines relevant literature that discusses instructional strategies and best practices for clicker questions. The chapter finally reviews the current discussions in Audience Response Systems research.

Instruction in the Large Lecture Format

The definition of a large lecture is largely dependent on the perception of the instructor. Any class that feels large in a manner that available resources can no longer cope with the number of students in the lecture and it is not possible to provide individual attention to students is considered a “large lecture” (Christopher, 2003). Large lectures classrooms in the Faculty of Education usually have 100 or more students taught by a single instructor. The traditional approach to lecturing has been to create a learning environment where lecturers talk and students listen (Ayu, Taylor, & Mantoro, 2009). Large lectures in higher education often rely on a passive learning pedagogy where knowledge is transferred from an authoritative source to ready and naïve recipients (Schwartz & Fischer, 2003). Schwartz and Fischer (2003, 2006) describe a central challenge with large lecture style learning – that of passive versus active learning. The curriculum and subject matter covered in large lectures often place great emphasis on
passive lecture style learning guided by a textbook. Assessment expectations are also set based on textbook knowledge (Schwartz & Fischer, 2006). They emphasize the importance of textbooks in a traditional large lecture.

The textbook plays a key role in shaping current modes of teaching and learning. It typically frames the problems of the discipline, offers the solutions, and defines the facts to be presented in the lectures (Schwartz & Fischer, 2006, p. 3).

However, recent research on learning indicates that more emphasis is needed on allowing students to build their own understanding of concepts and to design assessments that can measure this understanding. Active learning allows students to build and rebuild an understanding of concepts in the context of their environment (Schwartz & Fischer, 2006). Students also learn better when they are active in the classroom (Freeman et al. 2007).

Gleason (1986) compiled the potential problems associated with large lectures. These problems include:

- **Large space** - Large lectures take place in a big room, and interaction doesn't feel like personal communication because the instructor is so far away. Tight rows can make group discussion difficult.

- **Isolation** - Large lectures are full of people, mostly strangers, creating a sense for students that what they say and do doesn't matter, leading them to care less about seemingly small distractions (like talking to a neighbor or reading a newspaper), and creating an inhibition about participating in front of a large audience.

- **Group size** - The sheer number of students makes discussion during a regular lecture that includes everyone (or everyone willing to chime in) impossible.
- *Sage on the stage* - The instructor appears impersonal, remote, and inaccessible, and the communication gap between the students and the instructor feels (and may be) very real (Agard, Bowen & Olesova, 2010).

Often in large lectures the student is responsible for any failure and the responsibility of the instructor is limited to transmission of information (Millett, 2002). Despite many shortcomings, the benefits that large lectures offer should not be discounted. Agard, Bowen, and Olesova (2010) observed that though large lectures have shortcomings, they are adopted as a “standard teaching approach” in many institutions because of “low-cost, ease of preparation, and long tradition in education” (Summary section, Point 1). Gleason (1986) summarize why instructors must learn to communicate effectively with students in a large classroom:

...given the current economic state of affairs at most colleges and universities, large courses are not likely to fall from favor. Their pragmatic economics speak an eloquent defense which will probably produce more large courses with even bigger enrollments. For this reason, large-course instructors must come to grips with the impact of these environments on teaching and learning. They must also be provided practical suggestions that will enable them to improve communication with their students (p.20).

Large lecture courses can be effective in providing uniform instruction to a number of students simultaneously. Such large enrollment classes can offer some advantages to students and instructors. These may include:

- Generating a wide variety of interesting ideas and insights from different individuals.
- Providing opportunities for social interaction between students in large groups.
- Demonstrating a greater efficiency in the utilization of resources.
• Building confidence in speaking to large groups of people.

Wolfman (2002) researched the pedagogical advantages of large classes. He found that larger classrooms offered a greater diversity with students from varied backgrounds, cultures and problem solving skills brought together under a single learning platform. Also such large enrollment classrooms offer the advantage of combined resources including communication and learning support aids. It is important for instructors to leverage these pedagogical advantages in order to create an environment most conductive to learning.

The perception of learning in large lectures has also evolved with recent times. Learning in the large classroom is no longer limited to acquiring information from an instructor. Depending upon the instructional design of the course and the teaching strategies used, large lecture learning can provide a social context where knowledge is shared, created and built upon with peer interaction. To support their learning, modern students have instantaneous access to a wide variety of library resources and knowledge on the World Wide Web. With changing times and needs, the environments in large lectures need to shift focus to the learner by establishing a solid foundation of learner centered active learning principles.

**Active Learning vs. Passive Learning in Large Lectures**

The question of whether large lectures can engage learners and encourage active learning is at the very core of this study. However to proceed, an understanding of active learning must be developed. Active learning strategies can be defined as any instructional method that increased got students involved in activity in the classroom rather than just
listening to a lecture (Ayu et al., 2009; Bonwell & Eison, 1991). Prince (2004) outlined the typical characteristics that define active learning:

The core elements of active learning are student activity and engagement in the learning process. Active learning is often contrasted to the traditional lecture where students passively receive information from the instructor (p.223).

Ueckert and Gess-Newsome (2008, p. 49) used four characteristics to describe active learning. These include:

- Engaging with content
- Social interaction
- Considering prior understandings
- Connecting ideas

We must also understand passive learning in order to appreciate the benefits of active learning over passive learning in large lectures. Buckley, Bain, and Luginbuhl (2004) observed that students in a passive learning environment play a latent role in the classroom where they remain anonymous, bored and disengaged from the lecture. The instructor in such a classroom remains the sole source of knowledge.

… the instructor is concerned chiefly with condensing a prescribed body of information from the assigned text into 50-minute “one way” lectures (Buckley et al., 2004, p. 231).

Some research has been done in the use of active learning strategies to engage learners in lecture. Barak, Lipson, and Lerman (2006) used laptops in large lectures to promote active learning. Laptops were introduced to engineering students in a Computers and Engineering Problem Solving course. The laptops provided students an accessible hands-on computing experience in a large lecture setting and allowed them to test new
programing concepts taught in class, giving them immediate feedback on their understanding of new concepts. Their findings indicated that students were positive about the use of laptops in the classroom and felt that this experience gave them hands-on, real world practice in problem solving. Such studies often used technology aids in the classroom with instructional strategies tailored to student needs to promote active learning. However, the line dividing the use of active versus passive instructional strategies is often blurred. In their study of graduate students working towards Master’s Degrees in science education, Schwartz and Fischer (2003) revealed a struggle to recognize the difference between active and passive learning when students are asked to reflect on their own learning and understanding of concepts.

Although they could talk articulately about the value of actively constructing knowledge, they did not realize how much importance they had placed on lectures and other strategies where they passively received information. Their success in high school and college science courses had been based on evaluations of how well they recalled this received knowledge, not how they made sense of this information. The constructivist approach had intellectual appeal, but offered little comfort or guidance in their own learning (Schwartz & Fischer, 2003, pp. 24 - 25).

This underlying struggle in differentiating active and passive learning strategies emphasizes the need to tailor instructional strategies to the learning needs of students. Prince (2004) compiled active learning strategies that were suited for engineering faculty students. These include:

- Active learning that engages students in the learning process by requiring students to do meaningful learning activities in the classroom and reflect about what they are doing.
- Collaborative learning to encourage students to work together in small groups towards a common goal. Learning is embedded in the student interactions and is no more a solitary activity.

- Cooperative learning employs structured group activities where students work towards a common learning goal but are assessed individually based on tenets such as individual accountability, mutual interdependence and interpersonal skills.

- Problem-based learning introduces relevant problems along with instruction to provide context and motivation for learning.

Using such active learning strategies in the classroom will allow students to be part of their learning rather than just passively receive information from a single knowledge source in the form of an instructor. Ueckert and Gess-Newsome (2008) observed that passive learning lead to students becoming bored and apathetic in class. They found that active learning encourages students to recall prior ideas, make connections between them, and engage with the content by creating “new knowledge from their experiences” (p.48).

In an active learning environment, students learn to “take responsibility for their own learning” (p.48). Ueckert and Gess-Newsome also discovered that students actively engage and learn more in an active learning environment.

Bashforth and Parmar (2010) researched active learning by examining the implication of active learning in the current educational scenario.

Active learning can be seen an institutional strategy for the management of a body of students that has not only grown in size but is also increasingly seen as consumers. From this point of view, active learning is seen as a solution to demands for more feedback (Bashforth & Parmar, 2010 p.9).
Bashforth and Parmar used clickers in a social research methods lecture for undergraduate students to promote active learning and methodological literacy among first year undergraduate students. They found that clickers were “powerful tools” for students to gain hands-on experience and reflect on their understanding of quantitative research methods (p.8).

Delivering quality instruction to large groups of students is a significant challenge for instructors in post-secondary institutions. Professors and instructors who teach large lectures are not just required to be proficient in the subject matter but also to know and understand how students learn. Alexander and Murphy (1998) discussed a few principles that can help in creation of a learner centered environment. These include creating a knowledge base, providing motivation and a situation or context for learning to occur. Professors “are also expected to cultivate skills in different methods of teaching and assessment-areas in which they have had little or no preparation” (Bonwell & Sutherland, 1996, p. 3). So, it is important to create additional support on campus for professors who teach large lectures to make them aware of active learning strategies and to support them in using technology enabled learning strategies.

Existing research literature on the large lecture environment indicates that large lectures are not very effective in fostering active learning. There are certain barriers to creating an active learning environment in large lectures. Bonwell and Sutherland (1996) cite five of the most commonly mentioned barriers to using active learning strategies by faculty:

i. One cannot cover as much content in class.

ii. Active learning requires too much instructor time to prepare for class.
iii. It seems impossible to use active learning approaches in large classes.

iv. Materials and resources are lacking.

v. There are many risks to be considered, including how colleagues will perceive the legitimacy of the approaches, how student evaluations might be influenced, and how promotion and tenure might be (Bonwell & Sutherland, 1996, p. 4).

Even with the best active learning strategies, engaging the digital learner can be a challenge, in part because of the array of web-capable devices that may distract students from lecture and in part because lectures are not always the best way to learn. One approach to addressing these concerns is for instructors to use interactive classroom technology such as audience response systems to engage learners and to expand teaching and learning boundaries in large classrooms to include active learning strategies.

**Clicker Usage in the Classroom**

Technology use in the classroom should be closely integrated with pedagogy of the lecture. Gibson (2001) explored the intersection of technology and pedagogy by suggesting measures to plan and implement technology in a classroom. Technology implementation often leads to changes that need to be managed.

So, teachers need to consider the impact of technology use on their own confirmed beliefs about how best to teach….introducing technology to established teaching environments is likely to impact, to the point of change, upon even the most confirmed and well entrenched beliefs. (Gibson, 2001, p. 39)

Gibson (2001) summarized Knapp and Glenn (1996)’s questions that instructors need to consider when planning to implement any new technology in a classroom. These include:

- How will students react to technology?
• How will technology affect our concept of knowledge?
• How will technology change the location for teaching and learning?
• What type of new skills will students need to learn?
• How will the technology change my classroom and my relationship with my students?
• How will technology impact upon the accountability for achievement in my classroom?
• How does this technology work?
• How much time is needed to get ready to use the technology in the classroom?
• How will the technology change my teaching style?
• What kind of classroom management problems may occur if I use technology?

(Gibson, 2001, p. 39)

Tools in the classroom must always be considered to be “in service of the pedagogy” (Johnston & Stoll, 2011, “It's the Pedagogy, Stupid,” Para. 2). Instructors need to consider many factors prior to adopting a new technology aid in their classrooms to understand and prepare for changes in pedagogy, teaching and learning in the classroom. The choice to use an audience response system will be influenced by the instructor and course goals. Burnstein and Lederman (2003) summarized a few questions that an audience response system can help the instructor to gather information on:

• Is the student present in class?
• Have the students read the text before the class?
• Are the students paying attention?
• Do the students remember important facts?
• Are the students thinking?
• Do the students recognize and have a grasp of concepts?
• Can the student work in a group (peer learning)?
• Can students do numerical exercises?
• What do students say about the pace and the interest of the lecture? (Burnstein & Lederman, 2003, p. 343)

The teacher-centered uses of an audience response system described by Burnstein and Lederman (2003) tend to focus on student compliance and content coverage. It is argued in the present scenario, the goal of incorporating clicker based technology in a large lecture should be student-centered, and focused on enhancing the active learning experience for the student. Active learning can be achieved by integrating Audience Response System technology with student-centered pedagogies in the lecture. A student-centered approach to using clickers can improve teaching and learning in the classroom (Bashforth & Parmar, 2010).

Bashforth and Parmar (2010) also identified more student-centered uses for response systems in the classrooms. Figure 2.1 identifies different uses for audience response systems by associating examples of typical uses of audience response systems with technology and pedagogy in a matrix format. Such an association can reveal “unimagined possibilities” for using audience response systems “to improve teaching and learning” (p. 10). This includes technology based uses and technology mediated uses that are closely related to the pedagogy of the lecture. The pedagogy of any lecture can be teacher-centered and student-centered. Teacher-centered pedagogy tend to lean towards
“knowledge instruction” in the classroom while student-centered pedagogy allows “knowledge construction” in the classroom (Gibson, 2001, p. 42).

**Figure 2.1 Uses of Audience Response Systems (Bashforth & Parmar, 2010, p. 11)**

In the upper left cell of the Figure 2.1 Matrix, technology based uses such as checking attendance; testing knowledge and comprehension to assess students understanding introduce an active learning dimension in a classroom that might otherwise have one way flow of information from the instructor to the student. These technology based uses add value to students without drastically changing the teaching practices in the classroom and lean towards a teacher-centered pedagogy. The interactive nature of audience response systems can help to sustain student’s attention and break up lectures providing learning moments through peer interaction. These uses are summarized in the upper right cell of the matrix. The lower right cell of the matrix contains uses that pertain to student-
centered pedagogy and allow students more control over the material covered in the lecture and also the technology used in the active learning environment. This includes putting forth open-ended questions that encourage dialogue in the classroom. Activities such as inviting students to design the questions and explaining why some answers are wrong while others are right also encourages critical reasoning skills of students participating in lecture. Bashforth and Parmar (2010) define criteria for the active learning process:

....active learning involves challenging and checking student’s assumptions, opening student’s receptivity, accustoming them to having a voice, helping those with different learning styles and enabling students to take some control and power in the learning process (p. 12).

Bashforth and Parmar’s criteria must be kept in mind while exploring the lower left cell of the matrix contains teacher-centered pedagogical uses such as helping students understand lecture content and promoting discussion. Often in large classes students might be hesitant to ask questions when they don’t understand the nature of the lecture content. Using an interactive technology aid such as an audience response system can facilitate this dialogue between the teacher and the student. An example would be to put forth a question about a recently covered topic in the lecture to test the understanding of students about the lecture content and also make the instructor aware of the difficulties students might be facing to comprehend lecture material.

Usability

To understand the usability of any system, it is important to define it in broad terms. McNamara and Kirakowski (2005) broadly define usability as “how easy a product is to use” (p. 200). This broad definition can further be extended by examining
the “quality of use” and “the quality of experience” (McNamara & Kirakowski, 2005, p. 200). The quality of use perspective, “examines the interactions between the user and the product” (McNamara & Kirakowski, 2005, p. 200). On the other hand, the quality of experience perspective, examines the behavioral and emotional usability of the product (McNamara & Kirakowski, 2005). Behavioral usability refers to the ability to complete some functional or goal-directed task within a reasonable time (Logan, 1994). Emotional usability is the degree to which a product is desirable or serves a need beyond the traditional functional objective (Logan, 1994).

Effective criteria are also needed to compare the Audience Response System under study with a set standard for usability. Quesenbery (2004) suggests 5Es to understand users. The 5Es are:

- **Effective**: How completely and accurately the work or experience is completed or goals reached
- **Efficient**: How quickly this work can be completed
- **Engaging**: How well the interface draws the user into the interaction and how pleasant and satisfying it is to use
- **Error Tolerant**: How well the product prevents errors and can help the user recover from mistakes that do occur
- **Easy to Learn**: How well the product supports both the initial orientation and continued learning throughout the complete lifetime of use.
In the next section, literature on student engagement and audience response systems is reviewed.

**Clickers and Student Engagement**

To study the effects of audience response systems on student engagement, it is necessary to understand the meaning of student engagement. Marcum (2009) defined engagement as an activity that “involves learning, persistence, a social context, a high sense of empowerment and self-organization and an evident case of confidence and efficacy” (p.76). Newmann, Wehlage and Lamborn (1981, 1986, 1989, 1992) provided a more comprehensive explanation of student engagement.

We define engagement in academic work as the student’s psychological investment in and effort directed toward learning, understanding, or mastering the knowledge, skills, or crafts that academic work is intended to promote. Engagement is a construct used to describe an inner quality of concentration and effort to learn. Engagement describes more than motivation... By focusing on the extent
to which students demonstrate active interest, effort, and concentration in the specific work that teachers design, engagement calls special attention to the social contexts that help activate underlying motivation (Newmann, Wehlage and Lamborn, 1992, pp. 11-39).

Vibert and Shields (2003) cautioned against limiting the study of engagement to “individual students and his or her willingness to become involved with a task identified and initiated by the teacher” (p. 225). Viberts and Shields argued that engagement must not be separated from associated social, cultural and political contexts. Ignoring these contexts would mean overlooking the function and nature of engagement. From the review of relevant literature on student engagement it is clear that student engagement can be studied by taking into account the surrounding socio-cultural contexts.

**Improving student engagement with clicker use.**

A lot of research has been done to study student engagement with Audience Response Systems. Cotner, Fall, Wick, Walker, and Baepler (2008) investigated the use of a “rapid feedback assessment system” in a large introductory life science course (p.437). This study began with the question “Can we improve engagement and preparation for exams in large enrollment courses?” (p.437). To answer this question they introduced clickers in three sections of a large introductory life science course. Their findings indicated that feedback assessment systems (clickers) can improve student engagement. The positive results of this initiative has encouraged Cotner et al. to recommend the use of clickers in large lectures to cope with the pedagogical difficulties of the large classroom environment.

Freeman and Blayney (2005) compared student interactions between two accounting classrooms. They alternated the response mod for questions while keeping the
teaching strategy constant. The first of the two weekly classes used Audience Response Systems and the second used a show of hands to collect responses. The authors surveyed students using a paper based survey with Likert scale questions along with open-ended comments. Findings indicated that students found the Audience Response System offered significant advantages over traditional methods used in large lectures. Students reported that using the Audience Response System encouraged them to engage, interact and provide feedback. Data collected for the study lead the authors to conclude that student anonymity using the Audience Response System was responsible for increased engagement and lead to deeper learning, understanding and positive learning outcomes.

Martyn (2007) studied the learning outcomes of clickers in different sections of a computer information systems course. Pretests were administered to determine any statistically significant differences in achievement between the participant groups. Four sections of the course were studied of which two sections used class discussions as an active learning strategy and two sections used Audience Response Systems to facilitate active learning. Student learning was measured at the end of the semester with a comprehensive final exam. A survey was also administered to gauge student perceptions towards active learning techniques. During the course of the study, Martyn found that the use of Audience Response Systems increased active participation and that “the anonymity of responding with a clicker guarantees near or total participation” (p. 72). Analysis of variance of post-test scores of student groups using clickers and the student groups using class discussion revealed that there was no statistically significant difference in test scores between the two groups. This implies that almost no differences were found in student achievement.
Barnett (2006) gathered student perceptions on the use of Audience Response System in large introductory science course lectures. Student perceptions were recorded by interviews and field notes collected during observations of participants in class. In addition, a survey of participants was conducted using open-ended questions. Survey data was analyzed quantitatively and limited to basic descriptive statistics. The research findings indicated that most students liked clickers because they prompted interaction, help them to evaluate their understanding of course concepts. The clickers provided feedback and helped them gauge their performance in comparison to the rest of the class. Barnett (2006) also found that clicker use allowed students to cope with the “dehumanizing aspects” of a large lecture by allowing students to become involved in discussions with peers (p.485). This interactivity aspect of the clickers allows students to be more engaged in the classroom and provides students with a more meaningful learning experience.

Russell, McWilliams, Chasen, and Farley (2011) studied the use of clickers along with case based questions in an introductory course for an accelerated nursing program. They also explored the use of clickers to enhance student’s metacognition, “predictive clinical reasoning” and “clinical judgment” (p.13). Study data was gathered by administering a survey with Likert scale questions to record student perceptions and behaviors to clicker questions and class discussions. The study results indicated that the use of clickers made the class more engaging and helped students to concentrate better in class.

Gauci, Dantas, Williams, and Kemm (2009) investigated the use of Audience Response Systems and evaluated the increased student engagement and learning
outcomes in large lectures for physiology students. Using a mixed methods approach, they collected data from participants using a survey. The survey included both Likert scale and open-ended questions. Interviews were also conducted to gauge the participant’s attitude and opinions about the Audience Response Systems. This study found that the use of the Audience Response System made students feel engaged, “intellectually simulated,” and “motivated to think” (p. 63).

The effect of Audience Response Systems on student learning was also studied by Preszler, Dawe, Shuster, and Shuster (2007). This study aimed to assess the effects of Audience Response Systems on student learning and attitudes in biology courses. This study varied the use of clicker questions in classrooms and compared this variance with performance on exam questions. A user survey was also performed to gather participant opinions on clicker use. Most participants in the study acknowledged that the Audience Response System increased their interest in the course, and improved attendance. In addition researchers stipulated that the positive impact of Audience Response System use in classrooms might be due to increased attention levels, “immediate formative assessment” and “increased discussion” among students (p.30).

**Research Rationale**

While there is some promising research on engagement in several disciplines of study (i.e., accounting, computer information systems, science, nursing, physiology), there is paucity of research on engagement and clicker use with students in education faculties and programs. The current study aims to address the gap in the literature on the use of Audience Response Systems to impact student engagement in large lectures in the Faculty of Education. In part, my master’s research is designed to investigate the effect of
Audience Response Systems on student engagement in large education lectures and to explore student perceptions of any associated learning outcomes in order to address this knowledge gap. The second goal of this study is to study the use of Audience Response Systems to engage reluctant participants in large lectures. A review of literature on reluctant participants and the connection to Audience Response Systems use is presented in the next section.

**Reluctant Participants and Clicker Use**

Beekes (2006) coined the term *reluctant participators* to describe students from other cultures who may not be used to responding spontaneously during class and often fear “losing face” by providing an incorrect response in class (p. 28). Cain and Robinson (2008) noted that the use of an Audience Response System can help instructors gather “true opinions and thoughts” from students (p. 5).

With an ARS, it is possible to know how students truly feel about a given situation, while giving them the security of being anonymous. Anecdotally, one reason that students give for lack of participation in class is that they do not want to risk being wrong in front of their peers. An ARS gives students the chance to interact and offer opinions without fear of public scrutiny for incorrect answers or expressing an unpopular opinion (p. 5).

Graham, Tripp, Seawright, and Joeckel (2007) studied the role of Audience Response Systems in engaging students and empowering reluctant participants. Instructors and students were surveyed as part of the study. The instructor survey focused on strategies for using Audience Response Systems in lectures and the student surveys concentrated on identifying reluctant participators and gathering information about the effect of Audience Response Systems on their participation. Majority of study
participants reported that Audience Response Systems helped them participate in class, focus in class and made the whole “learning experience more enjoyable” (p. 245).

Fies (2005) noted that Audience Response System technology has been used “to engage students who are shy or reluctant to take the risk of public failure” (As cited in Graham et al. 2007 p. 237). Stowell and Nelson (2007) studied the benefits of Audience Response Systems on psychology student’s participation, learning and emotion. A participant survey with questions on a Likert scale was used to measure participant emotions about clicker use before, during and after an event such as a lecture or an exam. Participants were then assigned to four groups – standard lecture, lecture using review questions with hand rising, lectures using review questions with response cards, lectures using review questions with clickers. Various inferential statistics methods were used to analyze and interpret the data collected. Their research findings lead them to conclude that Audience Response Systems provide “an avenue for interaction” for shy students reluctant “to speak or even raise their hands” (p. 257).

From the review of existing literature on reluctant participants, it is evident that audience response systems can be used to explore how this technology might empower reluctant learners, especially those who may not put up their hand to answer a question, or to take part in a discussion, and thus add to this growing body of knowledge. There are a number of reasons why a learner may be a reluctant participant, from being a first year novice post-secondary student, to possible links with gender or culture or some other factor. This study focuses on shy/reluctant learners in large lectures and explores how Audience Response Systems may increase participation.
Exploring Instructional Strategies to Advance Learning in Large Lectures

Identifying instructional strategies associated with increased engagement and learner success is crucial to any instructor tasked with leading a large lecture. The right instructional strategy can be of great pedagogical value in a large lecture setting. A variety of instructional strategies have been tried and tested in conjunction with Audience Response Systems. A review of literature reveals a number of strategies for creating good questions and for promoting student discussion in large lectures.

Beatty (2006) states that the efficacy of Audience Response Systems is highly dependent “on the quality of the questions” (p. 31). This study was done in physics courses, and also identifies some broad strategies to construct good clicker questions. Good questioning strategies include removing non-essentials, and using approaches that invite students to “compare and contrast,” “interpret representations” and “strategize only.” (p. 39)

Lojo (2009) compared the effectiveness of multiple choice and qualitative clicker questions in an introductory operations management course for business majors. Study participants were from two classes. One class used clickers and the other class used traditional lecture methods without using clickers. The performance of the two participant groups in an open-ended quantitative exam and a multiple-choice exam was compared using descriptive and inferential statistical methods. The analysis tested two hypotheses, the first predicting that students using clickers in the classroom will perform better in open-ended quantitative exam questions compared to students who did not use clickers in the classroom. The second hypothesis predicted that students who use clickers in the classroom would perform better in multiple-choice exam questions compared to students
who do not use clickers in the classroom. The study findings indicated that open-ended
questions significantly impacted student performance compared to multiple-choice
questions.

Sullivan (2009) compiled the principles behind the construction of good clicker
questions for testing situations. The guidelines describe how clicker questions must be
designed to simulate the “higher order thinking” of students as in the Bloom’s taxonomy
of cognitive levels. Sullivan’s revised taxonomy of multiple-choice item writing
guidelines address content, formatting, style, and writing concern. These include:

• Content concerns
  o Every item should reflect specific content as specified in a test blueprint.
  o Use novel material to test higher level learning. Paraphrase textbook
    language or language used during instruction when used in a test item to
    avoid testing for simple recall.
  o Base each item on important content to learn; avoid trivial content.
  o Keep the content of each item independent from content of other items in
    the test.
  o Avoid opinion-based or trick items.
  o Keep vocabulary simple for the group of students being tested.

• Formatting Concerns
  o Use the question, completion, and best answer versions of the
    conventional multiple choice, the alternate choice, true-false (TF),
    multiple true-false (MTF), matching, and the context-dependent item and
    item set formats, but AVOID the complex multiple choice format.
• Style Concerns
  o Format the item vertically instead of horizontally.
  o Edit and proof items.
  o Use correct grammar, punctuation, capitalization, and spelling.
  o Minimize the amount of reading in each item.

• Writing the Stem
  o Ensure that the directions in the stem are very clear.
  o Include the central idea in the stem instead of the choices.
  o Avoid window dressing (excessive verbiage).
  o Word the stem positively, avoid negatives such as NOT or EXCEPT. If negative words are used, use the word cautiously and always ensure that the word appears capitalized and boldface.

• Writing the choice
  o Develop as many effective choices as you can, but research suggests three is adequate.
  o Make sure that only one of these choices is the right answer.
  o Vary the location of the right answer according to the number of choices.
  o Place choices in logical or numerical order.
  o Keep choices independent; choices should not be overlapping.
  o Keep choices homogenous in content and grammatical structure.
  o Keep the length of choices about equal.
  o None of the above should be used carefully.
  o Avoid using All-of-the-above.
o Phrase choices positively; avoid negatives such as NOT.

o Make distractors plausible and use typical errors of students to write your distractors.

o Avoid giving clues to the right answer such as:
  - Specific determiners including always, never, completely, and absolutely.
  - Clang associations, choices identical to or resembling words in the stem.
  - Grammatical inconsistencies that clue the test-taker to the correct choice.
  - Conspicuous correct choice.
  - Pairs or triplets of options that clue the test-taker to the correct choice.
  - Blatantly absurd or ridiculous options.

o Use humor if it is compatible with your teaching and learning environment (pp. 340-341).

Martyn (2007) also provided guidelines on use and question design for instructors who plan to implement Audience Response Systems in lectures to promote discussion and engagement, including:

• Keep slides short to optimize legibility.

• Keep the number of answer options to five.

• Do not make questions overly complex.
- Keep voting straightforward – systems allow complex branching, but keep it simple.
- Allow sufficient time to answer questions. Some general guidelines:
  - Classes fewer than 30 students: 15-20 seconds per question
  - Classes of 30-100 students: 30 seconds per question
  - Classes of more than 100 questions: 1 minute per question
- Allow time for discussion between questions.
- Encourage active discussion with the audience.
- Do not ask too many questions; use the ARS for the key questions.
- Position the questions at periodic intervals throughout the presentation.
- Include an “answer now” prompt to differentiate between lecture slides and interactive polling slides.
- Use a “correct answer” indicator to visually identify the appropriate answer.
- Include a “response grid” so that students know their responses have been registered.
- Increase responsiveness by using a “countdown timer” that will close polling after a set amount of time.
- Test the system in the proposed location to identify technical issues (lighting, signal interference, etc.)
- On the actual day of the session, allow time to set out of the clickers and start systems.
- Rehearse actual presentation to make sure it will run smoothly.
• Provide clear instructions on how to use the clickers to the audience.

• Do not overuse the system or it will lose its “engagement” potential. (As cited in Martyn, 2007, p. 73)

Caldwell (2007) compiled common uses of clicker questions in the classroom. Common uses of clicker questions include:

1. to increase or manage interaction, through questions that:
   • start or focus discussions (Jackson & Trees, 2003)
   • require interaction with peers (Knight & Wood, 2005)
   • collect votes after a debate (Draper, 2002)

2. to assess student preparation and ensure accountability, through:
   • questions about reading or homework ((Knight & Wood, 2005)
   • prelab questions

3. to find out more about students, by:
   • surveying student’s thoughts about lecture pace, effectiveness, style, or topic
   • polling student opinions or attitudes
   • probing student’s pre-existing level of understanding
   • asking how students feel about clickers and/or active learning

4. for formative (i.e., diagnostic) assessment, through questions that:
   • assess student’s understanding of material in lecture
   • reveal student misunderstandings of lecture (Wood, 2004)
   • determine future direction of lecture, including the level of detail needed
• test student’s understanding of previous lecture notes
• assess student’s ability to apply lecture material to a new situation
• determine whether students are ready to continue after working a problem (Poulis, Massen, Robens, & Gilbert, 1998)
• allow students to assess their own level of understanding at the end of a class (Halloran, 1995)

5. for quizzes or tests (Draper, 2002). Although reports of using clickers for summative high-stakes testing are relatively rare. Quiz questions typically check whether students are:

• paying attention
• taking good notes
• preparing for class or labs
• keeping up with homework
• actively thinking
• able to recall material from previous lectures

Existing research clearly provides a number of tested strategies for constructing good clicker questions and instructional strategies for implementing clicker use in large lectures. Instructional strategies that best advance the learning of education students and engage them in deeper thinking are the most valuable to instructors who aim to design instruction that promotes active learning in large lectures. A review of existing literature across the broad spectrum reveals that Audience Response Systems can be valuable tools for instructors to achieve desired engagement and active learning results in the large
lecture classroom and for all students to be able to contribute to the learning environments in large lectures.

**Current Discussions in the Use of Audience Response Systems**

Research on interactive classroom teaching and learning technologies is a continuous and ongoing process. Often, one research finding lays the foundation for another. Exploring the current research and discussion on the use of audience response systems since this study was initially designed has broadened my scope and sowed the seeds for future research initiatives. Broussard (2012) studied the application of clickers to cater to the demands of “electronically savvy” nursing students (p.3). She observed:

> ..today’s learners have been socialized towards expectations of rapid information exchange in sound bites, instant gratification, and a tendency towards reduced or non-textbook reading (p.3).

The purpose of the study was to discuss in theory “pedagogical methods” for clicker usage in theoretical nursing classes to “achieve desired learning outcomes” (p.3). The author concluded that using cutting edge technology in the classroom enhanced the instructor’s ability to teach in a way that was meaningful, interactive and concrete for students.

Fifer (2012) studied student perceptions of clicker use in nursing classrooms. The goal of this study was to explore innovative ways to engage students and simulate learning. First year nursing students were surveyed and interviewed on the use of classroom response systems in large nursing lectures. The study findings indicate that students found that the clicker use made their learning more enjoyable, focused on key
knowledge and gauged their understanding of subject matter. Students also liked the instant feedback and ease of use.

Williams and Pence (2011) explored the use of smartphones as powerful tools in a chemistry classroom. They recognized the easy availability of smartphones such as iPhone, Android and Blackberry devices for students enrolled in chemistry course. This leads them on a path to explore in theory some of the common applications of smartphones in the classroom. Applications include:

- Access to chemistry applications that deliver facts, study guides, and interactive molecular structure constructions and web resources from publishers.
- Augmented reality applications in the classroom that provide easy ways to connect information through physical objects. Example includes 2D barcodes such as QR codes.

Williams and Pence (2011) recognized the possibilities of using smartphones for learning in a chemistry classroom such as:

- In-depth learning
- Autonomous and individualized learning
- Empirical Investigation
- Ease the process of conducting research on subject matter

This literature review of current research conducted over the past two years reveals a visible shift towards integrating smart phones with audience response systems. The smartphone platform has also generated open source software accessible to all users. This will considerably reduce costs of incorporating audience response systems in institutions.
and open doors to many more large classrooms to the use of audience response system and creating an active learning environment for students.

**Conclusion**

In this chapter, previous research on promoting active learning and engagement in large undergraduate lectures by using clickers was summarized, and the benefits of using clickers for reluctant participants were discussed. Chapter Three describes the design of the present research study and how it was conducted in order to address the knowledge gaps identified through the literature review.
CHAPTER 3 RESEARCH METHOD

This chapter details the research methodology used in this study. The chapter begins by identifying the research questions at the core of this study. Second, the research design for the study is described along with the rationale for the selection of the case and the case study research methodology. Third, a description of the research site and technology implementation in the large lecture classroom is provided. The research process is then elucidated by including methods of sampling, data collection and data analysis. The chapter finally culminates with a brief note reviewing the ethical principles guiding this study.

Research Questions

Research questions are at the core of a research study and ground the research by defining its scope. The current study is focused on finding answers to three fundamental questions about the use of Audience Response Systems in large education lectures. The questions at the core of this case study are:

1. How do audience response systems impact student engagement in large education lectures?
2. How do audience response systems empower and engage reluctant participants?
3. Which instructional strategies for audience response system questions work best to advance student learning in large education lectures?

Research Design

The current study is designed as an exploratory case study employing mixed methods – both qualitative and quantitative methods for data collection and analysis. Using a case study research methodology to study an intrinsically interesting
phenomenon or situation allows the researcher to interpret the findings and develop an informed understanding in the context of the phenomenon under study (Merriam, 1998). Eisenhardt (1989) recognized case study as a research method or strategy that focuses on the dynamics present within single settings (p. 534). Hence, using a case study methodology will also allow the researcher to understand and interpret student engagement in its innate social and cultural contexts. Considering the nature and context of the study and the associated research questions, a case study research methodology was considered the best approach to understand the phenomenon under study. The phenomena on which the current study focuses, is the use of Audience Response Systems in large lecture teaching and learning with student teachers in a Faculty of Education. Typically, a number of undergraduate courses in the Faculty of Education are offered in the large lecture format. Merriam (1998) rationalizes that a case study might be selected for its uniqueness, and can offer revealing insights about a phenomenon by creating knowledge that we otherwise might not have access to. As student-teachers, Faculty of Education students can offer unique perspectives as future educators and as learners themselves on the use of interactive classroom technology in large lectures. The current investigation has been conceptualized as a single, case-based research study and examined the use of an interactive classroom technology, namely the SMART™ XE response system, in large lectures and its influence on student engagement in large education lectures. It can be expected that this study will add to the existing literature on the use of audience response systems in large lectures and bridge a gap in the literature by contributing the perspectives of student-teachers who are taking courses in a large lecture format.
This single, case-based research study includes several characteristics of a qualitative research study in education as described by Merriam (1998, pp. 6-8). This case study exemplifies these essential characteristics in its design. First, Merriam outlines the importance of gathering data by understanding that participant perspectives about a phenomenon are often built from their own social experiences.

“The key concern is understanding the phenomenon of interest from the participant’s perspectives and not the researcher’s” (Merriam, 1998, p. 6)

The primary goal of this study was to understand the effect of audience response systems on student engagement in large education lectures from the perspectives of the students taking courses in the large lecture format over one study term. Second, Merriam advocates that the researcher should be the primary instrument for data collection and analysis, which was the approach adopted for this study. Third, Merriam also promotes fieldwork in the data collection process. In this study, the researcher conducted research first hand, in the field – in this case, the large lecture, undergraduate classroom. The researcher was present in the large lecture classroom throughout the course of the term to collect data and to observe first-hand how education students used the SMART Response™ XE clicker in the classroom. Fourth, Merriam prescribes that the use of an inductive strategy towards data analysis and that themes, categories, typologies and concepts be inductively derived from the data. The current study builds an understanding of student engagement in large education lectures by identifying recurring themes in focus group and interview data, the observation data and the survey data. Fifth, Merriam recommends that the research findings be presented in a richly descriptive manner. In addition to the qualitative data collected for this study, quantitative data has also been
collected on the form of participant survey on the use of the SMART Response™ XE system in the classroom. The findings of this study are presented as both descriptive qualitative and quantitative summaries to provide directions for future research studies in this area.

Data collected from multiple sources needs to be combined together to arrive at a solid understanding of the phenomenon under study. Yin (2003, p. 14) indicates that case studies often rely on multiple sources of data that converge in a triangulating manner for greater validity and reliability of the findings. Data collected for the present mixed methods case study includes field observations recorded while the response systems were used by students in class. Students were also invited to participate in focus groups to record their perspectives. Feedback was gathered from the professor who taught the course and the graduate teaching assistant who helped the professor. This case study acknowledges the vital role played by the professor and the teaching assistant in the use of the SMART Response™ XE in their classroom. Hence they were also invited to contribute their views to the case study in a structured interview. Both the professor and teaching assistant were closely involved in the implementation of the SMART Response™ XE system in their classroom and integrating the response system with the pedagogy of the lecture. At the end of the semester, all student participants were invited to participate in a survey administered through the SMART Response™ XE system. The data from such diverse sources was analyzed in the context of each other to converge into one robust set of findings. The results of this study were derived by combining data from various sources including field observation notes, interviews with students and instructors, and survey with students that identifies patterns of participation, learning and
pedagogy that influence student engagement in large education lectures. A triangulated analysis of all data sources and a description of combined findings are described in detail in Chapters four and five.

**Case Study Rationale**

The researcher carefully studied various case studies and the research literature to select the appropriate case for this study. Once the case for the study was defined, the researcher explored various methodologies that could be used to best explain the case or system under study. The following sections describe in detail the rationale for selecting the case and the rationale for the research method used in this study.

**Rationale for Selection of the Case**

Yin (2003, p. 1) suggests that case studies are used in many situations to contribute to the knowledge of individuals, groups, organizations, social, and political phenomena. Eisenhardt (1989, p. 534) confirms the use of case study in diverse contexts by providing various examples of research studies that employed a case study approach. These include studies about organizational decision making processes, implementation processes, political events and organizational change management. Merriam (1998, p. 27) concludes that the single most defining characteristic of a case study is in clearly identifying the object of study in the case. Smith (1978) provides the notion of a case as a *bounded system*. In the current case study the bounded system is provided via the SMART™ XE response system used in the first year undergraduate education large lecture. This study aims to examine the unique interactions and influences that the use of the SMART™ XE response system can provide in a large first year undergraduate classroom. The goal of this study is to observe and describe any improvements that
interactive classroom technology such as Audience Response Systems, may bring to
student engagement, to shy/reluctant learner participation, and to instructional strategies
in a large lecture format Faculty of Education undergraduate classroom at the University
of Calgary.

The SMART™ XE response system is an interactive classroom communication
technology that can be adapted for use in large and small lectures. The whole system can
be integrated with the existing technology infrastructure in the classroom such an
installed computer console. Alternatively, the response system can also be controlled
from an instructor’s laptop computer. The response system allows the instructor to pose
various questions to students during the lecture. The students can then use a hand held
clicker SMART Response™ XE device to type in and submit their responses. The basic
functions of the SMART Response XE clicker have been depicted in Figure 3.1.

**Figure 3.1 The SMART Response™ XE Clicker**
Responses sent from various clickers are then compiled by the SMART Response™ system and results can be instantly displayed for the class. The researcher aims to study the effect of the SMART Response™ XE system on student engagement and its influence on instructional strategies for questions posed through the system to create teaching and learning opportunities in the classroom.

The researcher was involved as a research assistant in the Jacobsen and Davis (2011) study that investigated the use of student response system to extend the thinking of pre-service teachers at the University of Calgary. As a member of the research team, the researcher assisted in data collection, conducted focus groups, transcribed interviews and analyzed survey data. The research experience as a graduate research assistant piqued the researcher’s curiosity about the use of interactive classroom technology in large lectures. The researcher wanted to examine further the influence of audience response systems on student engagement and also to better understand how interactive classroom technology aids might affect shy/reluctant learner participation in large lectures. Further, the researcher also wanted to identify how the technology could be seamlessly integrated with the pedagogy of the lecture by identifying instructional strategies to enhance the learning environment for student’s in a large lecture. The next section describes the rationale for the research method used in this case study.

**Rationale for Research Method**

Various research approaches have been used to study the use of clickers in large lectures. Freeman and Blayney (2005) used a quasi-experimental research design for their action research project. They compared the use of traditional show of hands and Audience Response System to promote interactive learning environments using Likert
scale paper based survey. Martyn (2007) also used a quasi-experiential design to study the effectiveness of clickers compared to classroom. To measure the learning outcomes, a pretest on the course content was administered at the beginning of the semester and the scores were compared to those on a comprehensive final test at the end of the semester. Stowell and Nelson (2007) researched the benefits of Audience Response Systems on psychology student’s participation, learning and emotion using quantitative research methods. A 75 item survey was split and administered to participants at different points during the research to measure student experience with clicker use. Lojo (2009) compared the effectiveness of multiple choice and qualitative clicker questions in an introductory operations management course for business majors. This study used a quasi-experiential quantitative methodology to test two hypothesis based on known findings from the research literature on the benefits of clicker use in the classroom. Hypothesis 1 was that students using clickers would perform better on open-ended quantitative exams compared to students who don’t use clickers. Hypothesis 2 was that students using clickers will perform better in multiple choice questions compared to students who don’t use clickers.

Reviewing existing literature of studies that used different research methods for data collection and analysis, allowed the researcher to examine the current study closely in context of the research site, and participants. Graham et al (2007) used a mixed methods design to research using an Audience Response System to empower reluctant participants. This study closely mirrors the current study on the effects of Audience Response Systems on student engagement. Surveys conducted among participants included closed-response Likert scale questions coupled with open-ended response
questions to gather student opinions and perceptions on the Audience Response System (Graham, et al, 2007). Knowledge of other studies lead the researcher to understand that a mixed methods study building on the rich variety of qualitative and quantitative data was the best approach for the current case study. A mixed methods study builds on the synergy and strength that exists between quantitative and qualitative research methods to understand a phenomenon more fully than is possible using either quantitative or qualitative methods alone (Airasian, Gay, & Mills, 2005, p. 462). The current exploratory mixed methods case study uses qualitative and qualitative data to develop an understanding of student engagement and reluctant learner participation in large lectures of the Faculty of Education in the University of Calgary. The following section provides a brief description of the SMART Response™ XE response system used in the large education lecture which is the bounded system in the current case study.

Conceptual framework.

The conceptual framework for this study is based in part on Graham et al. (2007)’s study – “Empowering or compelling reluctant participators using audience response systems.” This study researched the effect of audience response systems on student engagement, their impact on reluctant participants, and explored the best pedagogical uses of audience response systems that offered the most value to students. The study was part of a campus wide pilot implementation of audience response systems and surveyed students from many faculties including chemistry, biology, statistics, education and marriage, family and human development. Drawing upon the Graham et al. (2007) study, the present study investigated how the use of Audience Response Systems in large education lectures empowers reluctant participants.
Graham et al. (2007) designed their implementation study around three research questions on student engagement, shy/reluctant learner participation and pedagogical uses of Audience Response Systems. The study had a large sample size (n=688). All participants (Faculty and students) were surveyed with Likert style questions (omitting the neutral category) and a few open ended questions. Participants were given the option to participate in follow up interviews for open ended questions if desired. Three types of reluctant participators were identified:

- Students who want to know their peers’ opinions but are reluctant to share their own.
- Students who are hesitant to ask questions in class when they do not understand the material.
- Students who prefer classes without student participation (p.242).

Once the required data was collected, Graham et al. (2007)’s analysis involved statistical methods such as correlation, t-test and analysis of variance.

The current investigation of the effects of SMART Response ™ XE on student engagement large education lectures uses a case study methodology. The sample size is limited to about Eighty-six participants. Both qualitative and qualitative data have been gathered for this mixed methods exploratory study. Data collection instruments include student survey, staff and student interviews and classroom observations. The twenty-six item survey also includes questions from Graham et al. (2007)’s study to explore responses from shy/reluctant learners.
The analysis of collected data is discussed in detail in Chapter Four. The Case: SMART™ XE Response System in the Large Education Lecture

A review of literature in Chapter two documented the use of interactive classroom technologies such as an audience response system in large lectures to facilitate communication and learning in the classroom. The SMART Response™ XE interactive response system consists of a handheld clicker device – the SMART Response™ XE clicker and a RF SMART Response™ receiver depicted in Figure 3.2.

**Figure 3.2 The SMART Response™ Receiver**

One SMART Response™ receiver can support up to 100 handheld clickers. In the current study, two receivers were used to support 160 clickers used in the large lecture. The response system can be operated in two user modes – anonymous and non-anonymous. In the anonymous mode of operation, users are signed into the response system without any identifying details and hence responses gathered are not traced back to any single student and only displayed as aggregated numbers or textual responses. In the non-anonymous mode, every student is signed into the system with specific identity information. Hence it
is easy to identify which student is providing what response. Once the entire infrastructure to use the response system in the ‘Introduction to Educational Studies’ classroom was in place, undergraduate students were gradually introduced to the system over a period of two weeks before the system was used regularly in the classroom. Five storage cases containing about forty clickers each were placed in various locations around the classroom to facilitate easy access to the clickers. One of these cases is depicted in Figure 3.3.

**Figure 3.3 Clicker Case Placed at Various Locations in the Large Lecture**

Students entering the classroom would then be able to retrieve a clicker for their use before they took their seats for the lecture.

During the course of the lecture, the professor would ask clicker questions and allow time for students to send in their responses anonymously using the clickers. Once
all of the responses were received, the group results were displayed to the class, usually as a pie chart or bar graph. Clicker results were used by the instructor to sponsor interactive discussion with the students and to advance in the topic of the lecture. Questions were paced with the pedagogical flow of the lecture and included opinion based multiple choice, multiple response, open-ended text entry, true/false and yes/no opinion questions.

The large lecture under study had 160 students enrolled for the Fall 2011 term. With such a large number of students in the classroom it is often physically impossible for students to interact with all of their peers. Also time constraints would make it difficult for every student to put forth their opinions in an open discussion. Space and time restrictions on interaction and participation can further add to the difficulties faced by shy/reluctant students to offer or share their opinions during a discussion.

The researcher observed and kept field notes about changes, the introduction of the SMART Response™ XE interactive response system appeared to bring to the teaching and learning environment in the large lecture. The researcher also recorded interactions that appeared to enhance discussion, peer awareness and moments that helped in the construction of social knowledge in the classroom. The unique interactions of the SMART ™XE interactive response system, its influence on the large lecture pedagogy and instructional strategies, student engagement, shy/reluctant learner participation, peer awareness and discussion in the large lecture classroom all contribute to the unique case that is the subject of the current study.
Research Site

The research was conducted in Fall 2011 term at the University of Calgary. The researcher studied the effects of the use of audience response systems with 160 first year undergraduate students in their first semester ‘Introduction to Educational Studies’ course offered by the Faculty of Education. The one hour fifteen minutes long lectures were held bi-weekly between 3:30 pm and 4:45 pm from September through December 2011. The ‘Introduction to Educational Studies’ lecture was held in a large lecture hall with a capacity of 200 students at the University of Calgary. A picture of the large lecture hall has been presented in Figure 3.4.

Figure 3.4 The Large Lecture Classroom

The educational studies course offers students in concurrent programs a glimpse into the diversity in the study of education before they can transition into a B.Ed. program. The lecture is designed to present a comprehensive picture of the depth and complexity of educational studies. The lectures are designed to help first year students to
understand the various dimensions to educational studies including disciplines such as psychology and sociology. In addition, the lecture also provided an open thinking platform for students who wanted to know more about educational studies and envision their role as possible educators and teachers in the future by introducing them to the various issues and expectations surrounding teaching and learning today. The lecture topics include the evolving teaching strategies associated with emerging technological and societal trends and meeting diverse student needs.

**Technology Implementation in the Large Lecture Hall**

The SMART Response™ XE system needed to be integrated with the existing technology infrastructure in the large lecture classroom where the lecture was being held. The existing infrastructure consisted of a console machine connected to the classroom audio-visual systems in the lecture hall including the overhead projection systems. Communication Media facilitators coordinated with the IT personnel of the Faculty of Education to install SMART™ Notebook software and the SMART Response™ receivers in the console machine present in the lecture hall. The SMART Notebook and SMART Response software was also installed in the researcher and professor’s laptop computers. The researcher and her supervisor invited the professor teaching the large lecture to a discussion about clicker implementation and its pedagogical implications. This discussion yielded some key decisions about clicker implementation in the classroom including:

- Holding a trial run of the clickers before introducing them in the classroom to prevent any technical problems in the response system when being used by students during a lecture.
• Using the clickers in the anonymous mode to gather diverse opinions and to encourage discussion.

After the response system was installed in the large lecture, the system was tested with a trial run before using the clickers in a live lecture, to ensure that the system worked smoothly without any interruptions. The trial run was conducted with five handheld clickers at different locations in the classroom to test the signal reception by the receiver. Of the five clickers, three clickers were connected to the first receiver and two were connected to the second receiver, to check if both the installed receivers functioned as intended. After a successful trial run, the clickers were introduced to undergraduate students in the next scheduled lecture.

During the first class in which clickers were used, undergraduate students were oriented to the use of clickers. Several demonstration slides were presented that explained the functionality of various keys on the handheld devices and the steps involved in submitting responses to clicker questions. Students were asked to connect their handheld devices to the receiver. Student responses were displayed on the large screen.

For each lecture, slides were created using PowerPoint and displayed to the class on the instructor’s laptop connected through the console to the overhead projection system. The clicker questions were created on SMART™ Notebook and displayed to the class using the console machine. The researcher toggled between the instructor’s laptop and the console computer in the classroom when a clicker question was posed to the class. When the instructor wanted to ask a clicker question to the class, the overhead projection system was switched from the instructor’s laptop to the console computer. Once the responses were received, the results were displayed to the class. The results
were saved for future use and reference of the instructor and the researcher. The SMART Response™ XE interactive response system implementation in the large lecture classroom was successful and there were no system crashes or hitches while using the response system throughout the semester in the large lecture classroom.

**Flow of Information in the SMART Response™ XE Interactive Response System**

Depending on the pedagogical needs, the instructor put forth various questions to the class during the course of the lecture using the SMART Response™ XE interactive response system. The questions included opinion based multiple-choice, multiple response, yes/no, true/false, and open-ended text entry questions. When a clicker question was posed to students, the data projector display was switched from the instructor’s laptop displaying lecture slides to the console machine that displayed the clicker questions. To initiate the database, the question is started using the SMART Notebook Response software. Once the question is started, a signal is sent to each clicker and the choices for answering the question are displayed on the hand held SMART Response™ XE clicker device. For an opinion based multiple choice or multiple response question, the options are displayed as the letters such as A, B, C or D. An example of one such multiple response question has been provided in Figure 3.5.

Students would see the question and the corresponding options on the projection screen in the classroom, choose an answer and submit their chosen answer using the handheld clicker. The response from each hand held device would be recorded by the SMART Response receiver, and processed by the SMART Notebook Response software to generate aggregated results using a visual representation such as pie charts or bar graphs.
3 When should a student be expelled from school?

A Mental abuse (e.g. cyber bullying, harassment or teasing)
B Physical abuse
C The possession of an illegal substance
D The possession of a weapon (knife, gun)
E A verbal threat.
F The student should not be expelled
Open-ended questions were posed that required that students enter a text response of up to 140 characters, similar to the size of a tweet. The same process also applies for text entry questions, so the question is displayed on the projection screen, students submit a textual answer using the clicker, and the responses from each clicker are recorded by the SMART Response receiver. However, one difference is that responses for open-ended text entry questions are compiled and displayed by the SMART™ Notebook software in a tabular form. An example of text entry responses compiled by SMART™ Notebook for the open-ended question – ‘Consider an example where the environment created certain disadvantages for certain learning needs’ was used during one of the lectures. The question was put forth to students using the SMART Response™ XE system as an open-ended text entry question. Students were given sufficient time to respond to the question by typing in the responses using the SMART™ Response XE clicker. Once all responses were received the results were displayed to the classroom. The professor then allowed students to read peer responses and used the responses as a starting point for a discussion on how variables in the learning environment in classrooms can hinder learning. A small sample of responses for the question as displayed to students in the classroom has been provided in Figure 3.6.
The flow of information in the SMART Response™ XE Interactive Response System can be summarized as follows:

- Clicker question is displayed to the students during the course of the lecture. Question types can include multiple choice, multiple response, true/false and open-ended text entry questions.
- The question is started by the instructor on the SMART™ Notebook and response software.
• Students signed in anonymously can then see the various options for the questions on their hand held SMART Response™ XE clickers.

• Students then choose an answer from the given options or type in their responses for open-ended questions and submit their answers to the system.

• The responses are received by the SMART Response™ XE receiver. A confirmation message is sent to the clicker device from which the response is received and displayed as ‘submitted’ to the clicker device

• The responses are then transferred to the SMART Notebook and response software installed in the computer connected to the SMART Response XE receiver.

• While the question is open to responses, the instructor can see the number of students that have signed into the response system and the number who have answered the question.

• When all responses have been received, the instructor stops the question and this allows the SMART Notebook and Responses software to analyze the results.

• The results of the question can be displayed immediately to the class. Responses for multiple choice, multiple response, true/false, yes/no questions are displayed in terms of percentage for each response option represented in a pie chart or bar graph. Responses for open-ended, text entry questions are compiled in a table and can be displayed as such to the class.

It is important to understand that this flow of information can take as little as sixty seconds from first posing the question to displaying the results depending upon the nature of the question and the directions given by the instructor. Figure 3.7 depicts the flow of
information in a classroom using the SMART Response™ XE interactive response system.

**Figure 3.7 Continuous Flow of Information through the Response System in the Classroom**

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**Research Process**

The research process for the current study began with seeking ethics approval for the research design and protocol from the University. The ethics approval was granted by the Conjoint Faculties Research Ethics Board (CFREB) of the University of Calgary on August 18, 2011. As the study evolved, a change in the research site was made and
subsequently a modification was filed with the CFREB for approval. The modifications approval was granted by CFREB on October 3, 2011. A copy of the ethics approval and subsequent modification for the research study are found in Appendix A.

After obtaining ethics approval, the researcher and her supervisor visited and observed the ‘Introduction to Educational Studies’ lecture to gauge the needs of the student and professor teaching the large lecture course. An assessment was also made of the inherent technological infrastructure in the classroom. Once the initial assessment was made, the SMART Response interactive response system was installed in the classroom and tested to address any technical concerns in the system before students began using the clickers in the classroom. The SMART Response XE interactive response system was introduced to students in October 2011 and was used in the classroom through December 2011.

Informed consent was sought from students in the classroom to participate in observations, focus groups, and surveys. Consent forms as provided in Appendix B were distributed to students in lecture without the instructor or graduate teaching assistant present, and students were given time to read and understand the type, nature and timeline of the research. The researcher also explained finer details of the consent including what type of information would be collected and that participation was voluntary. Students were also informed about the researcher’s website where an electronic copy of the consent form was available for viewing and downloading. Informed consent as depicted in the Faculty consent form in Appendix C was also sought from the Professor of the large lecture and her teaching assistant in private away from the large lecture classroom, to participate in interviews.
Once consent forms were collected, students who consented to participate in the focus groups were contacted via email to set a convenient time aside to participate in focus groups. Focus groups were held in a neutral environment behind closed doors in a meeting room of the Faculty of Education. All interviews were recorded on an audio recording device. Field observations were documented by the researcher during every lecture in which the clickers were used from October 2011 through December 2011.

At the end of the semester, students were invited to participate in a twenty-six item Likert scale survey on clicker usage in the lecture. The survey was administered in class by the researcher using the SMART Response™ interactive response system. The instructor and graduate research assistant were not present during the administration of the survey. The data was recorded and saved for future reference and analysis of the researcher using the SMART™ Notebook and Response software. The Professor teaching the large lecture and the graduate teaching assistant were also interviewed about the use of clickers in their lecture, in a structured interview at the end of the term. The next section elaborates on the methods used for sampling, data collection and analysis.

**Sampling Method**

A researcher has a wide variety of study subjects to choose from. The researcher thus needs to consider where to observe, when to observe, whom to observe, and what to observe. In short, sampling in field research involves the selection of a research site, time, people and events (Burgess, 1982, p. 76). The current study concentrates on the effects of Audience Response Systems on students in large education lectures. For this specialized study, participants need access to the technology of interest, and while using the technology will be interacting in a classroom environment; hence, random assignment is
difficult. A convenient sampling technique was the best approach to sample research participants for this study. A potential study site was sought by approaching all of the professors who were assigned to teach large lectures to find one who was interested and willing to use the clickers as a regular part of their lecture teaching. Research participants for this case study included a professor, a graduate teaching assistant and all enrolled undergraduate students in the first year ‘Introduction to Educational Studies’ course offered in the large lecture format in the Faculty of Education at the University of Calgary.

**Data Collection and Analysis**

Eisenhardt (1989) determined that case studies typically combine data collection methods such as interviews, questionnaires and observations. The current study relies on multiple data collection methods including classroom observation and field notes, student survey, student focus groups and instructor interviews. Based on these data collection methods, the researcher devised various protocols to be used as data collection instruments in the study. These include:

- Instructor interview protocol as detailed in Appendix D.
- Student interview protocol as detailed in Appendix E.
- Student survey questions compiled in Appendix F.
- Classroom observation protocol outlined in Appendix G.

These research instruments were devised by the researcher from a review of the literature and by drawing upon her experience as a research assistant in Jacobsen and Davis (2011)’s study investigating the use of response systems to engage, monitor and extend the thinking of pre-service teachers. The survey instrument was designed using
Swan et al. (2008)’s Community of Inquiry (CoI) survey instrument. The researcher reviewed existing literature on the use of audience response systems in large education lectures to gather an understanding of how interactive classroom technology can engage learners by creating an active learning environment and encourage shy/reluctant learner participation. Based on Graham et al. (2007)’s study on empowering reluctant participants using clickers, the researcher incorporated survey items #5, 10, 11, 13, and 15 that would specifically collect survey data that would yield insights into the experiences of shy and reluctant participants. The researcher also decided to limit the number of questions in the classroom survey to twenty-six to reduce participant fatigue from a long survey as recommended in the Jacobsen and Davis (2011) study.

Two types of data have been collected for this exploratory mixed methods case study – qualitative and quantitative data. Qualitative data collected for study includes student focus groups, instructor interviews, field notes and observations. One student interview and two instructor interviews conducted over the course of the semester. All interviews were recorded using an audio device and were transcribed by the researcher. The transcribed conversations were then studied using thematic analysis. Field notes and observations collected by the researcher over the course of the semester were analyzed using qualitative content and descriptive analysis. Quantitative data was collected with the student survey and was analyzed using descriptive statistics. The next few sections elaborate on each data collection method used for this study and the approach to analyzing the data collected.
**Interviews and Focus Groups**

Focus groups and interviews were designed to allow the researcher to gain an in-depth understanding about how participants perceived the use of audience response systems in a large classroom.

**Student focus groups.**

Students who consented to participate in focus groups were contacted through email to request and schedule a convenient date and time. Several students consented to be part of focus group for the study. All of these volunteers were provided with three options to schedule interview dates and times. Students were also asked to suggest a convenient date and time if none of the options provided by the researcher suited their schedule. Once a preferred date and time was indicated by a participant, the researcher confirmed availability and sent the participant the venue of the meeting which was a meeting room in the Faculty of Education. The primary aim of arranging a different venue for the participant was to put them at ease, enable a measure of anonymity and allow them the opportunity to provide honest opinions about clicker usage in the classroom in a neutral and secure closed door setting. During the course of the semester, a total of seven students consented to participate in focus groups. All consented students were contacted through email and two students responded with their chosen time and date to participate in the focus group. The remaining five consented students were sent two reminders inviting them to participate in the study. Two of the seven students agreed to schedule interview times. However, only one student arrived to participate in the focus group. Before the commencement of interviews, the researcher instructed the participants not to use names, aliases or any such identifying information. During the interview with
the student participant, the researcher asked questions about clicker usage in the classroom. The participant would then provide their views. The questions designed for use during focus groups have been listed in Appendix E. The whole exchange was recorded on an audio recording device so that it could be transcribed for data analysis.

**Instructor interviews.**

The professor who taught the large lecture and the graduate teaching assistant were invited to contribute to the study by providing their opinions about the use of Audience Response System technology in the Introduction to Educational Studies in the classroom. After receiving the consent of the professor and the teaching assistant, the researcher sent separate emails to both the professor and the teaching assistant to choose a convenient day and time for the interview. The teaching assistant was first interviewed in a neutral closed door meeting room in the Faculty of Education, during the course of the Fall 2011 semester. The interview was also recorded using an audio recording device to be transcribed for data analysis in the future. The professor was interviewed towards the end of term after the end of classes due to time and scheduling constraints. The meeting was held in the professor’s office in the Faculty of Education. The professor and teaching assistant interviews were structured based on questions provided in Appendix D.

**Analysis of interview and focus group data.**

Recorded interviews were transcribed by the researcher. An open coding approach to the first review of the transcripts revealed a few common themes. The researcher then analyzed the data thematically to understand the recurring themes that emerged from multiple perspectives.
Survey

The survey instrument used to gather quantitative data from participants was designed around the research questions of this study. A review of literature also revealed a comprehensive list of survey items that could elicit student responses. Swan et al. (2008) developed the Community of Inquiry (CoI) framework for survey instruments. Using the CoI framework, Swan et al. (2008) grouped survey items based on teaching presence, social presence and cognitive presence. Graham et al. (2007) used specific survey items at crucial points in the survey to identify shy/reluctant learners participating in the study. Drawing on the Graham et al. (2007) study, the current study includes four items aimed to gather responses from shy/reluctant learners. The questions used in the classroom survey of response systems have been compiled in Appendix F.

The survey was administered to consented participants from the class in the large lecture classroom before the commencement of the lecture. Students were asked to respond to twenty-six questions about the use of the SMART Response™ interactive response system in the class using a Likert scale. All survey questions were presented as ordinal Likert scales, with 5 options ranging from 1 (Strongly Agree), through 5 (Strongly Disagree). The survey was administered in class by using the available response systems in class in the anonymous mode with minor modifications. Two SMART response receivers were connected to the researcher’s laptop to accommodate the maximum number of consented participants to participate in the survey. The survey questions were created in a separate file by the researcher on the SMART Notebook and response software. These questions were displayed during the survey on the projection screen using the class projection system directly from the researcher’s laptop computer.
for participants to read and comprehend before they submitted an answer. In addition, the researcher also read the questions out loud to the class before proceeding to the next question. Two means were used to increase the number of participants in the survey. First, for the benefit of participants who arrived late for the survey, questions remained open in the response system from the start to finish of the survey. This option allowed answers for any question to be submitted at any time during the duration of the survey in the classroom. Second, participants who arrived after the commencement of the survey were provided with a sheet with the full list of survey questions so that they could still submit answers to all survey questions from start to finish. Approximately seven additional participants were accommodated with these two measures. Survey data was recorded by the SMART™ Notebook and response software on the researcher’s laptop computer for data analysis in the future.

**Analysis of survey data.**

Surveys are valuable tools to collect diverse opinions from a large number of participants at the same time. The 26 item survey was presented to participants using a Likert scale to capture quantitative data from eighty three participants. The survey was administered using the SMART XE audience response systems in the anonymous mode. The survey data recorded on the SMART Notebook and Response software was then exported to Microsoft Excel. The data set displayed by participant and their responses for each survey item was then imported to SPSS to facilitate various statistical analyses. Data from the participant study were analyzed using descriptive statistics.
**Observations**

The researcher recorded observations using a defined observation protocol during every class when clickers were used during the lecture from October to December 2011. Field notes were also compiled on technology implementation and usage in the classroom. Observations recorded included:

- Changes in student behaviors and interactions while answering clicker questions.
- Instructional intent of clicker questions.
- The impact of clicker questions on students.
- Ease and adaptability of the SMART Response™ interactive response system.

All field notes and observations were recorded by the researcher who ensured that no identifying information was collected on the participants along with the observations. The observation protocol used to collect observational data during the course of the lecture has been outlined in Appendix G.

**Analysis of observational data.**

An open coding review of recorded observations was followed by thematic analysis of recorded observations and field notes to consolidate and synthesize the key themes. Unique themes were then identified based on incidents or observations that were interesting and fell outside of the key themes. A descriptive analysis of the recorded observations was also done to compare and identify emerging themes from the first few classes when clickers were introduced through the classes towards the end of term.

**Data Triangulation**

In a mixed methods study, the merits of both qualitative and quantitative data are used to better understand the research phenomena from both a global and a particular
perspective. The research questions also need to be considered carefully in the context of the research methodology, outlined for this study. The use of both qualitative and quantitative data collection methods raises important questions about validity and reliability. Joppe (2000) defined reliability as the extent to which results are consistent over time and an accurate representation of the total population under study is referred to as reliability and if the results of a study can be reproduced under a similar methodology, then the research instrument is considered to be reliable. (p. 1)

Cook and Campbell (1979) offer a comprehensive insight about validity in educational research by differentiating statistical, construct, internal and external validity, which are commonly and readily associated with quantitative methods. However, with regard to qualitative methods, the concept of validity is understood in a different way, and includes criteria such as trustworthiness/credibility, dependability, transferability and confirmability. The current study will consider all validity criteria as they relate to the research methods, both at the study level (internal) and also to take into account the external validity of the study. These might include conflicting findings from the quantitative and qualitative investigations; either portion of the mixed methods study negate the standards set by the other. In addition the study would use Greene, Caracelli, and Graham (1989)’s evaluation principles including triangulation, complementarity and expansion while analyzing data.

- **Triangulation** is often used to indicate that more than two methods are used in a study with a view to double (or triple) checking results. This is also called "cross examination" (Cheng, 2005). Triangulation is a powerful technique that facilitates validation of data through cross verification from more than two sources. It tests
the consistency of findings obtained through different instruments. In a case study, triangulation will increase chances to control, or at least assess, some of the threats or multiple causes influencing results (Greene et al., 1989).

- **Complementarity** clarifies and illustrates results from one method with the use of another method. In our case, in-class observation will add information about the learning process and will qualify the survey results and descriptive statistics (Greene et al., 1989).

- **Expansion** provides richness and detail to the study exploring specific features of each method (Greene et al., 1989). In this study, the integration of several data collection procedures will expand the breadth of the study and likely enlighten the more general debate on student participation using clickers in large lectures.

### Ethical Considerations

The current case study commenced by seeking and obtaining ethics approval from the Conjoint Faculties Research Ethics Board (CFREB) of the University of Calgary. Since the current study involves interacting and collecting data from human subjects, care was taken at every stage of the research study to adhere to the ethical guidelines and principles. The participation for the study can be ethically summarized as informed, voluntary, anonymous, and confidential. Consent for participation in the study was sought after informing all participants about the various stages of the study and type and use of the information collected from them. Care was taken to ensure that no instructors or teaching assistants associated with student evaluation and grading were present during recruitment and consent seeking, and that they were absent from the distribution of surveys and collection of data, and absent during student interviews. These research steps
were implemented in order to reduce or eliminate the possibility of students feeling the coerced into participating in the study by their instructors. Also the consent forms were made available for viewing through the researcher’s website – http://eprofilearthir.weebly.com/masters-research.html. Participants could access and download the consent forms at a later date if they feel the need to review or revoke consent to participate in the study. All data collection instruments including surveys, focus groups, and classroom observations did not collect any identifying information to protect student confidentiality. Focus groups were invitation only events, held behind closed doors in a neutral, secure environment away from the classroom. Survey data was collected from participants though a survey administered in the classroom using the SMART Response™ XE system; the professor and teaching assistant were not present during the survey. The SMART Response™ XE system was installed and operational through the console machine present in the classroom. However to maintain participant confidentiality, the researcher chose to connect two additional receivers to her laptop computer and administer the survey from a password protected, researcher controlled computer for enhanced data security. This ensured that only the researcher had access to the survey data. During the course of the term about seven participants consented to participate in focus groups for the study. Despite email invites and reminders only one participant registered her views and perspectives. The researcher also considered using an incentive such as gift cards to encourage undergraduate students to volunteer for a focus group. However, the incentive method did not reflect on the purpose of this study – to gather honest, diverse opinions about the use of the SMART Response XE interactive response system in the classroom. Hence it was decided not to use any incentives to
recruit more participants for focus groups and interviews. In summary, ethical guidelines have modeled and shaped this study at every stage since its inception.

**Conclusion**

The methods of data collection and analysis were chosen to reflect the true nature and purpose of this study. The effect of audience response systems in large education lectures has been studied in its natural social context in the current case study. To ground the research, two types of study data have been collected and triangulated – qualitative and quantitative data. Qualitative data collection through interviews and focus groups employed a structured approach with specific questions in relation to research questions at the core of this study. Using interviews and focus groups allowed the researcher to gain an in depth understanding about how participants perceive the use of audience response systems in a large classroom. Quantitative data collected through the twenty-six item Likert scale survey, allowed the researcher to draw out responses from all participants including shy/reluctant learners in the large lecture. The current case study thus aims to present a comprehensive picture of student engagement and participation in large lectures, using a rich source of qualitative and quantitative data. A detailed description and analysis of findings are presented in chapters Four and Five.
CHAPTER 4 DATA ANALYSIS

This chapter presents an analysis of data collected for this mixed methods, exploratory case study. The chapter is divided into three sections. The first section presents an analysis of data to understand the relationship between the SMART™ XE Interactive Response Systems and student engagement in large lectures. The next section interprets data pertinent to the impact of Audience Response Systems on student participation in large lectures. The final section of this chapter compiles and analyzes data relevant to active learning initiatives that advance student learning in large education lectures. Figure 4.1 provides a comprehensive map of this chapter.

Figure 4.1 Outline Map of Chapter Four

Impact on Student Engagement

Sharma et al. (2005) declared that interaction and engagement are “fundamental to student learning in large lectures” (p. 137). The SMART™ XE interactive response system can be used to promote interaction and increase engagement in large lectures by
facilitating student-teacher and student-student conversations. All three of the study participant interviewees (100%) unanimously agreed that the implementation of the response system appeared to increase student engagement in the lectures. However each participant differed in the view of the extent to which the system impacted engagement in the classroom.

The stark contrast of a conventional large lecture compared to an interactive large lecture using clickers was provided by the course instructor:

“...clickers... create a more interactive environment with your students, so it is not just passive learning, particularly in large lectures, where a tendency is for the instructor is to just give a full lecture with very little opportunities for dialogue and debate.”

The instructor further elaborated on why she chose to use the system in her classroom. Her comments were recorded in the interview as follows:

“I wanted to see to what extent it [clickers] would enhance or detract... given that I do try to create a very interactive environment in my large lectures. For me it was an interesting experience to see if I could expand the ways in which I would interact with [my] students.”

The teaching assistant thought that students had to be engaged to provide an answer to the clicker questions. His comments were recorded in the interview as follows:

They [students] are...engaged... To understand what the question is, so that they can make it appropriate.... response to the question.... It [clickers] engages them more so, than normal.

The student on the other hand felt that clickers increased participation, provided space for more than one opinion. Her thoughts on students were summarized in the interview comments as follows:
“I think there was more participation... in the classroom and again more opinions were being voiced... And I think it was more lively.”

Students indicated high levels of agreement with several survey items related to engagement when using a clicker device to communicate with the instructor and with peers in a large lecture. Table 4.1 presents data from survey items that gathered student responses on clicker use and engagement in lecture. A descriptive analysis of the twenty-six survey items reveals:

1) The median value for the “strongly agree/agree” percentages of responses for all survey items is 57.5%
2) The median value for the “neutral” percentages of responses for all survey items is 20%
3) The median value for the “strongly disagree/disagree” percentages of responses for all survey items is 17%

These median values can serve as a point of reference to help determine if survey responses fall under the lower or higher end of the spectrum.

An analysis of responses to “student engagement with clickers” items indicated that the majority of students “strongly agreed/agreed” that ideas and issues raised during discussion with clicker questions kept them thinking about these ideas and issues after lecture (62%). There was a high level of agreement with two other items considering the median value of “strongly agreed/agreed” responses for the twenty-six item survey (57.5%):

1) Using clickers in the classroom helped me pay attention and stay focused on the lecture (53%), and
2) Course activities using the clickers piqued my curiosity (54%).

Almost half of the respondents “strongly agreed/agreed” with two items:

1) By using clicker questions, the instructor encouraged me to explore new concepts in this course (45%), and

2) Getting to know other course participants’ views via peer discussion about clicker questions gave me a sense of belonging in the course (46%).

Table 4.1 Survey Responses to “Student Engagement with Clickers” Items (n=83)

<table>
<thead>
<tr>
<th>Item</th>
<th>Question</th>
<th>Percentage</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Agree/Strongly Agree</td>
<td>Neutral</td>
<td>Disagree/Strongly Disagree</td>
</tr>
<tr>
<td>24</td>
<td>Ideas and issues raised during discussion associated with clicker questions kept me thinking about these ideas and issues after lecture.</td>
<td>62%</td>
<td>18%</td>
<td>17%</td>
</tr>
<tr>
<td>20</td>
<td>Course activities using the clickers piqued my curiosity.</td>
<td>54%</td>
<td>24%</td>
<td>19%</td>
</tr>
<tr>
<td>3</td>
<td>Using clickers in the lecture helped me pay attention and stay focused during the lecture.</td>
<td>53%</td>
<td>20%</td>
<td>24%</td>
</tr>
<tr>
<td>14</td>
<td>Getting to know other course participants’ views via peer discussion about clicker questions gave me a sense of belonging in the course.</td>
<td>46%</td>
<td>27%</td>
<td>25%</td>
</tr>
<tr>
<td>4</td>
<td>By using clicker questions, the instructor encouraged me to explore new concepts in this course.</td>
<td>45%</td>
<td>25%</td>
<td>30%</td>
</tr>
</tbody>
</table>

Field observations collected by the researcher also corroborate the interview and survey findings about student engagement. Clickers were introduced in the lecture with
one brief ten minute demonstration about the system. In subsequent weeks, the students quickly adapted to the use of the new technology and used clickers in every lecture to answer questions. It was notable that though not all students were vocal during class discussions, every student in the class had a clicker and answered clicker questions from the instructor during lecture. This observation is also shared by the professor who noted that "everybody was engaging" when she used the clickers. According to the professor, the clickers provided "one more opportunity for student engagement" and allowed her to "engage students who otherwise wouldn’t be engaged in the lecture". When questioned about how the clickers affected student engagement in lecture, the teaching assistant offered the opinion that the system was more effective with students who tend to be distracted more in class:

“For students who are automatically good and automatically naturally engaged, maybe not. But for the borderline ones, the ones who are maybe kind of half there mentally, I think that it would engage them more. It would increase their engagement in my opinion.”

This opinion is also shared by the student interviewee who agreed that it was a “good way to engage learning in the classroom”.

The review of literature in the second chapter detailed Marcum (2009) and Newmann, Wehlage, G.G, and Lamborn (1992) definitions of student engagement. Drawing on these definitions, the analysis of data under the theme of student engagement focuses on the extent to which students “demonstrate active interest, effort, and concentration” during lecture. This focus on student engagement in large lecture reveals social contexts that appear to motivate learners in the large lecture environment. Areas of focus include:
Capturing learner attention in a clicker classroom.

Understanding interactions between students and the instructor.

Revisiting course content by reflecting on information and knowledge from clicker questions.

In the next few sections, learner attention, interaction and reflection will be explored in the context of the study findings.

**Attention**

Glenn (2010) raises an important question about student attention in lecture by stating that student attention should go beyond simple retention of information to “*help use information in new ways*”. Audience response systems are intended to capture and retain student attention to receive instruction, interact with peers in the classroom and build an understanding of concepts being discussed in lecture. The professor shared a key observation about times that students were asked to answer questions using clickers—“*they perked up.*”

“So if people have drifted off there is some way to bring people back in to respond to the question.”

The notion that attention must move further than to just help students retain information from lecture by allowing them to apply the information to form their perspectives was also well demonstrated by the usage of clicker questions in lecture. The professor used the clicker questions to allow students to provide their own responses, gather an idea of the broad classroom opinion by sharing question results with the class and to enhance their collective understanding by an open class discussion. The instructor believed that the clickers
“always brought them back to the task and they thought ‘oh! Now I actually need to think about it so now I have to respond to the question. As opposed to ‘I can turn off mentally if I really don’t want to pay attention to the point. And now I am being asked to play it out, to think about what my perspective was, I might not have been paying attention for the last 5 minutes. So there is something about bringing them back on task and getting the back focused about what are the themes, it’s not just talking, but what is the kind of the issue in the clicker questions.”

This notion is also shared by the student interviewee who thought using clickers was a good way of capturing student attention and using that to advance learning in the large lecture:

“...it’s kind of a way of increasing the student’s awareness of the subject. Like they pay attention more because since you have it in your hand you would tend to answer the question anyway.”

The increased attention observed when clicker questions were used was also recorded consistently in the researcher’s classroom observations. For example, during one of the large lectures two questions were posed about alternative education programs in Alberta. The first text entry question asked students to name one alternative education program in Alberta. The second yes/no question asked whether single gender schools should be allowed. Majority of the students who responded to the question said yes (56%). In the discussion that followed, the professor linked the discussion to the results of the first question about alternative education streams. Students appeared to pay more attention to the discussion and more students came forward to participate in the class discussion once the questions were linked to the general topic of the lecture. Figure 4.2 illustrates the responses to the yes/no single gender school question used in the lecture.
Digital learner.

Distractions in the digital classroom are manifold. Examples include various gadgets such as laptops, mobile phones and a campus wide access to the World Wide Web. It will be impractical to address each distraction with stringent usage rules alone (Glenn, 2010). Digital learners are adept in using various gadgets in their everyday life. This comfort in technology use can be used to enhance learning in a technology-mediated lecture. The teaching assistant shared the opinion that student’s relative ease with
technology posed an additional challenge to instructors in lecture to engage students in the classroom.

“I think they are very good at tuning out... when they have so many gadgets that surround and distract them... I think it’s more challenging as an educator right now to impart knowledge than any time before, because of all the kind of technology that surrounds us, it can...... help them learn, at the same time... it can distract them especially if whoever teaching is not engaging students.”

The professor also appeared to share this view but added that clickers brought back distracted students to the class discussions.

“If you are making a point for 5-10 minutes and see either people trying to drift off either trying to check their phone messages or do distracting activities.... I am noticing people trying to veer off and do other things on their laptops. They were checking internet sites and what not. But the clicker usually brought people back on task with... one or two exceptions.”

Survey responses also indicate that 54% of student respondents “strongly agreed/agreed” that course activities using clickers piqued their curiosity. The student interviewee provided more instances where she was distracted and then paid attention to the classroom discussions as a result of using the hand held clickers even if she did not participate in the discussion that followed.

“Sometimes I look at my phone... So I guess when I have a clicker in my hand, I feel more engaged. And I am more likely to pay attention rather than look at my phone. I am more likely to be engaged and listen to the discussions.”

The teaching assistant went further to mention that using “mobile individualized devices” to gather feedback, further “enriched” student learning experience considering that students were using educational technology – a key theme of the class.
Interaction

Large lectures take place in a big room, and interaction can rarely feel like personal communication because the instructor is so far away. Tight rows can make group discussion difficult (Gleason, 1986). The teaching assistant felt that clickers “humanized” these large classrooms by facilitating instructor-student interaction. He further elaborated that in a traditional large lecture class students often can go a whole term without ever speaking in class.

“In large classrooms... students will go the whole term and never speak, never have any dialogue or put any sort of idea of their own in the classroom. And that I think, you can say that’s not education at all. That’s treating a student like a kind of a machine, sponge, where you have inputs, outputs to insert this into the student and then produce that... so I think that it [clickers] humanizes a little bit these large classrooms.”

Survey results indicate that 46% of the respondents “strongly agreed/agreed” that getting to know other course participants’ views via peer discussion in response to clicker questions gave them a sense of belonging in the course. In addition to providing a platform for interaction in large lectures, the professor was appreciative that clickers provided time for students to interact and develop their own understanding of the ideas discussed in lecture.

“It created a necessary pause and an informal moment for them to just collaborate with students so it wasn’t just the clicker response but in other moments that they can take a breather and synthesize the material of the 15 minutes before and have a moment to debate.”

The instructor also felt that the clicker questions facilitated a positive dialogue among students about course topics.
“For the most part there was a discussion that occurred while they were giving in their clicker responses. And at one point, I thought ‘Oh this is a time for them to... get off topic. But what I was actually noticing is that they have been talking about the issue.”

Observation data reveals that clicker questions were associated with starting a discussion among peers while students answered the clicker question. The results of the clicker question, when shared back by the instructor, facilitated the transition into an open class discussion of the issue. It was observed that peer discussion was a constant occurrence throughout the term whenever clickers were used during lecture. Students, the researcher observed, talked about the question either before they put in their entries or after, but there was an audible discussion when the question remained open to receive answers from students.

The current study employed clickers in a large lecture to facilitate interaction. Data from student and instructor interviews, along with survey responses and classroom observations, reveal a variety of interactions in the clicker classroom. These include student-student, student-technology and student-instructor interactions.

**Student-student interaction.**

Clickers were observed to increased dialog among students in the large lecture – before, during and after clicker use. The professor observed that clickers “generated conversation” even before students provided a response to the clicker question. She also noted that clicker use tended to increase discussion while students were providing responses using clickers.

“It actually created further dialog... it provided a space for the dialog while they are doing the clicker response.”
The dialogue helped foster a peer opinion awareness and social learning environment.

One student interviewee noted that:

“...it was interesting to see the different opinions on the pie graph. I thought it was really interesting to like compare different opinions as opposed to comparing different opinions around your neighbors because you really don’t get the consensus.”

An analysis of the researcher’s field observations reveals an interesting trend when the discussion revolved around a contentious or controversial issue. The clickers were used in the anonymous mode throughout the semester, in an effort to gather honest opinions from every student without the fear of repercussion or ridicule. Often the display of results progressed into a meaningful class discussion. As the semester progressed students were becoming more comfortable and bold enough to reveal their response to the clicker question and also to elaborate why they provided such a response to the question. The teaching assistant for the large lecture also shared the same observation:

“It really got some people whispering. But I kind of think that’s a result of the student expression that has been going on in the class and it has been helped by the clickers where now you can getting people you know in the second half of the semester becoming more courageous to say things.”

So, it was observed that clicker use increased student-student interaction, and also lead to more public sharing and linking one’s self to perspectives over the duration of the semester. It is also important to understand how the SMART Response™ System, facilitated student-teacher interaction in the large lecture.

**Student-teacher interaction.**

Clickers were instrumental in facilitating interaction between students and the professor in the large lecture. Dialogue between students and professor is often difficult
in a large lecture (Gleason, 1986). The professor in the current large lecture was quick to recognize the benefits of clickers in large lectures.

“I think it’s wonderful, working wonderfully for this course. I could see a lot of different opinions... and I was quite surprised that students were very open about what they were willing to say...”

This observation demonstrates the adaptability of this technology to suit the course, instructor and student needs. The system worked really well for this course by bringing out opinions and helping students gain a broad scope of understanding of their peer’s views and to participate in and contribute to class discussions.

**Reflection**

Reflection is a thought process that can be developed and maintained to support “*continuous learning*” and “*personal or professional development*” (Sen, 2010, p. 81). Reflection is an important tool for students because it is closely related to critical thinking and decision making (Koufogiannakis, 2010). This reflective thought process is essential for students to develop their own understanding of course concepts from the consolidated class view provided by the clicker questions. There were several ways that reflection was promoted through the use of clickers.

**Reflect on course content.**

Students develop their own understanding of course concepts by reflection on course content and peer/class discussions allow students to play an active role in their own learning process (Ayu et al., 2009, p. 711). Sixty-two percent of survey respondents “strongly agreed/agreed” that the ideas and issues raised during discussions associated with clicker questions kept them thinking about these ideas and issues after lecture.
However forty-four percent of the respondents also indicated that using clicker questions to reflect on course content helped them understand fundamental concepts in this class. It is also important to note that 71% of survey participants indicated that comparing their response to the group’s response trends displayed in the clicker question results helped them to better understand their own perspectives and views. Figure 4.3 compiles the student response trend in survey items about reflecting on course content.

**Figure 4.3 Student Response Trend in Reflecting Course Content**

![Bar Chart]

- Clicker questions to reflect on course content helped me understand fundamental concepts: 44%
- Ideas and issues raised during discussion associated with clicker questions kept me thinking about these after class: 62%
- Comparing my response to the group’s response trends helped me to better understand my own perspectives and views: 71%

The teaching assistant also opined that reflection allows students to be engaged in the classroom. He said:

> “It’s getting them to engage if we are getting to ask them a question. Through a clicker, it’s getting them to think about that question. Think about what’s a reasonable answer.”

The professor looked at the time taken for clicker questions as moments that broke from instruction and purposefully allowed for reflection. She felt that:

> “it actually provides a pause actually as a point of reflection in what was interesting ... we were providing a response question.”
Knowing what students understood by engaging, interacting and reflecting in the classroom would be difficult without some form of assessment. Discussed in the next section is how formative and summative assessment combined tends to help the instructor identify knowledge gaps and gauge student understanding of course concepts.

**Assessment.**

Assessment of students can be formative or summative. Formative assessment allows instructors to recognize positive achievements and to plan appropriate next steps (Harlen & James, 1997). Summative assessment systematically records the overall achievement of a student (Harlen & James, 1997). The professor and teaching assistant were asked about their preference in the use of clickers for assessment. The professor opined that using clickers to assess participation or the level of engagement in the course was ‘an unfair assessment of one’s learning.’ She further elaborated that this was one of the reasons why she chose to use the system anonymously and not link student clicker use with a participation grade. This statement could be well applied to shy/reluctant students in the large lecture who may not put forth their opinions but still have an in-depth understanding of the lecture content. She further elaborated that it could be used as a quick formative assessment tool:

“...most lectures would use it as a retaining of a particular idea more as a quick formative assessment of the idea that was just thought or the reading from the previous week. So what did you learn? What are the key points?”

However, the professor indicated that she would “hate to use it [clicker] as a summative assessment [tool].” The teaching assistant was also in favor of using clickers in formative assessment since clickers “aid formative learning.” He further added,
“Just getting them to think about something which they haven’t thought about before that’s formative assessment, where we are... forming it.”

It is hence clear that both the professor and the teaching assistant in the course prefer to use clicker questions towards a formative assessment strategy rather than a summative assessment strategy. The student participating in the focus group was also questioned about using clickers for formative and summative assessment. She offered the opinion that best use would be for course evaluations.

Participant opinions on the use of clickers for assessments appear to vary across the spectrum. It can only be speculated why using clickers for assessment is less popular among this study group. The students in the ‘Introduction to Educational Studies’ large lecture were first year undergraduate students who may not have much experience learning in a technology mediated large lecture and its applications. Also for instructors, the key to using clickers for assessments may be linked to identifying which student provided what response. Using the system in the anonymous mode makes it impossible for the instructor to know what a particular student said over time through the response system. Hence any assessment made through anonymous clicker question responses can only inform about the general opinion of the class and group formative assessment.

**Student Participation**

The impersonal nature of large lectures can make it difficult for all students to participate in class discussions (Thoennessen, Kashy, Tsai, & Davis, 1999). The tight rows in these lectures limits group discussion to the students who are adjacent (Geske, 1992; Gleason, 1986). The SMART™ XE Interactive Response System was used in the large lecture in an effort to promote student participation in the lecture and the class
discussions. The professor of the large lecture agreed that the large lecture format makes it difficult for everyone to speak in class. She opined that “in a large lecture..... it is impossible for everyone to speak and some people don't have the comfort level of speaking.” The professor further elaborated that clickers provided her an opportunity to help students find a voice and share their views in class.

“clickers... I think the most opportunity they provided for me is to allow them to find a voice but not feel threatened by giving a perspective, particularly if their perspective was in the minority, if it was not the dominant view of the class, it would allow for them to express themselves and not feel vulnerable by having to admit their position.”

The teaching assistant went further to say “clickers add even more [a new dimension] to it in terms of dynamics and student participation.” He felt that the use of clickers aligned well to the fundamental need where “everybody wants to be heard..... And these clickers... are empowering and it reminds the student that what they think matters.” The student in her interview also felt that there was “more participation... in the classroom and... more opinions were being voiced. And...it was more lively. The professor opined that with a clicker, “students who don't really speak a lot in class but really want to voice their opinion have a chance to” share their opinions with the class.

**Shy and Reluctant Learners**

The impersonal atmosphere in a large lecture may increase the reluctance of students to participate in a large discussion ‘for the fear of saying something foolish’ (Geske, 1992, p. 151). The professor agreed that using an audience response system in class to gather student responses, provided “a voice to those people who are shy or less comfortable public speaking but still want to voice their opinions.” The student, who
admitted during the interview that she was always shy to share her views in class, provided a unique perspective by saying that:

“We were just more engaged and we have that opportunity [to voice an opinion]. It’s not like the other people are preventing them from that opportunity.”

This statement seemed to reiterate the restrictive nature of a large lecture for a student who is shy and reluctant to share their views in class during a discussion. She felt that with the clicker system in class, “everyone gets a say.... I get to understand more of what’s going on. I can voice what I want to say.” For shy/reluctant learners the large lecture format seems to pose a formidable challenge when it comes to participating in an open class discussion. The student summarized this by saying:

“..in an open class discussion, you are more limited. You are more likely to have the same people talk. So I think...open-ended questions are better.”

The teaching assistant was also sympathetic to the challenges faced by shy/reluctant students in the large lecture format. He opined that when it came to the question of “students who don’t talk so much, yes of course I think it is [anonymous mode clicker question] obviously less, it’s less putting you in a spot. Everyone is equal that way.” He further elaborated on how the SMART Response™ XE system provided more opportunities for a shy student to express themselves in the large lecture and created a level ‘playing field’ to all students to share their views.

“..the fact that your participation or your expression of ideas does not have to be... a factor of your personality... everyone is... equally free to express themselves... everyone is on the same playing field. So it... makes it a little more fair in terms of which ideas get heard and which ideas don’t. it is almost kind of a.... social justice that this allows... people who are... reluctant to speak their minds,
that their ideas don’t just sort of get pushed to the side... simply because they don’t have the proper form to express themselves, where they can do so without having to be a certain personality.”

Student responses to survey items about shy/reluctant learner participation are compiled in Table 4.2.

**Table 4.2 Survey Responses to “Shy/Reluctant Learner Participation” Items (n=83)**

<table>
<thead>
<tr>
<th>Item</th>
<th>Question</th>
<th>Percentage</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Agree/</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Strongly</td>
<td>Neutral</td>
<td>Disagree/</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Agree</td>
<td></td>
<td>Strongly Disagree</td>
</tr>
<tr>
<td>16</td>
<td>The clickers were instrumental in helping me provide my thoughts and opinions in a large classroom.</td>
<td>74%</td>
<td>13%</td>
<td>13%</td>
</tr>
<tr>
<td>13</td>
<td>I am interested to know the opinions of other students in class. (Graham et al 2007)</td>
<td>73%</td>
<td>10%</td>
<td>16%</td>
</tr>
<tr>
<td>10</td>
<td>I prefer classes where I have opportunities for participation and interaction. (Graham et al 2007)</td>
<td>62%</td>
<td>18%</td>
<td>18%</td>
</tr>
<tr>
<td>5</td>
<td>I am hesitant to ask questions when I don’t understand the lecture material or the nature of course work. (Graham et al 2007)</td>
<td>45%</td>
<td>20%</td>
<td>33%</td>
</tr>
<tr>
<td>11</td>
<td>I prefer classes where I am not required to participate. (Graham et al 2007)</td>
<td>42%</td>
<td>26%</td>
<td>32%</td>
</tr>
<tr>
<td>15</td>
<td>I am reluctant to share my opinions in class. (Graham et al 2007)</td>
<td>37%</td>
<td>27%</td>
<td>34%</td>
</tr>
<tr>
<td>6</td>
<td>The immediate feedback and results from clicker questions helped me understand my</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Item</td>
<td>Question</td>
<td>Percentage</td>
<td></td>
<td>Mean</td>
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<tr>
<td></td>
<td></td>
<td>Agree/</td>
<td>Disagree/</td>
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<td></td>
<td></td>
<td>Strongly</td>
<td>Strongly</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Agree</td>
<td>Disagree</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Strongly</td>
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<tr>
<td></td>
<td></td>
<td>Agree/</td>
<td>Disagree/</td>
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<tr>
<td></td>
<td></td>
<td>Strongly</td>
<td>Strongly</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Agree</td>
<td>Disagree</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Strongly</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

An analysis of survey results for shy/reluctant learner participation items reveals that a majority of students (73%) wanted to know the opinions of other students in class. In an attempt to understand what percentage of respondents were shy/reluctant participators in lecture, the researcher used Graham et al. (2007)’s analysis method of using specific survey items as markers to quantify the possible proportion of this type of learner. Figure 4.4 represents the student response trend for survey items related to shy/reluctant learner participation. Survey items used as markers are:

1) I am interested to know the opinions of other students in class (Graham et al, 2007).

2) I am reluctant to share my opinions in class (Graham et al., 2007).

3) I am hesitant to ask questions when I don’t understand the lecture material or the nature of course work (Graham et al., 2007).

4) I prefer classes where I am not required to participate (Graham et al., 2007).

5) I prefer classes where I have opportunities for participation and interaction (Graham et al., 2007).
Building upon Graham et al. (2007) items about reluctant participators, the following summary explores findings from this case study:

1) Students who may be classified as shy/reluctant learners want to know peers’ opinions but may be reluctant to share their own opinions. This may include respondents in this study who answered “strongly agree/agree” to survey items: ‘I am interested to know the opinions of other students in class’ (73%) and ‘I am reluctant to share my opinions in class’ (37%).

2) Students who may be classified as shy/reluctant learners are hesitant to ask a question in class when they don’t understand the material. This includes respondents in this study who answered “strongly agreed/agreed” to survey items: ‘I am hesitant to ask questions when I don’t understand the lecture material or the nature of course work’ (45%), which may indicate that close to half of the class are shy/reluctant to speak up in lecture and ask questions.

3) Students who may be classified as shy/reluctant learners prefer classes where they are not required to participate. Respondents in this study who answered
“strongly disagree/disagree” to: ‘I prefer classes where I have opportunities for participation and interaction.’ (36%) and answered “strongly agree/agree” to: ‘I prefer classes where I am not required to participate (42%) may be the shy/reluctant learners.

An analysis of the survey items related to shy/reluctant participants reveals that a large percentage of respondents (40-45%) appear to fit into Graham et al. (2007)’s category of shy/reluctant participants. Using Graham et al. (2007)’s questions, a majority of students surveyed (74%) reported that clickers were instrumental in helping them share their thoughts and opinions in a large classroom. Thirty-four percent of the students surveyed reported wanting to know peer’s opinions coupled with a reluctance to share their own opinions publicly in class. Almost half of the survey respondents (45%) reported that they were hesitant to ask questions in class when they don’t understand lecture material or the nature of the course work. An analysis of the student survey also reveals that 42% of the students surveyed preferred classes where they are not required to participate. While Graham et al. (2007) identified three sub-groups in the reluctant participators in large lectures (students reluctant to share opinions; Hesitant to ask questions; students preferring courses that do not require them to participate), the researcher in this current study did not separate the shy/reluctant learner survey respondents groups. The entire sample of shy/reluctant learners was thus treated as one unit considering the sample size in the student survey.

Providing opinions anonymously.

When it comes to providing opinions, the teaching assistant felt that students are “less afraid to speak up like say after they do something with the clickers, then they are
less afraid or more encouraged to go ahead and say something that might be controversial. Because they have seen that other students have controversial ideas as well through the clickers or texts.” The anonymity feature embedded in the response system in the professor’s view seems to “provide a safeguard” for students to express themselves in the large lecture without making them feel vulnerable. She felt that “…clickers provided an opportunity for those to voice their opinion particularly if they were not holding the dominant view.” While discussing the use of anonymity feature of the SMART Response™ XE system in her class, the professor, felt that being anonymous made “… people. More comfortable... to take more extreme viewpoints” without feeling vulnerable. This confidence was also recorded in the researcher’s classroom observations. As the term progressed, students were more vocal about voicing their opinions in discussions. Even though clicker questions were anonymous, students were comfortable enough to reveal their responses and also elaborate on why they provided such a response. This shift was surprising even to the professor who often used clicker questions to kindle discussions for highly contested or controversial issues. The professor attributes increased student confidence to using the response system in class with the anonymous feature to kindle class discussions.

“You have the option of... being anonymous and then yet they are so confident enough to say ‘I said yes and I said no’ no you know and this is why I said that’. You know they were very forthcoming and I noticed that there weren’t so many of those responses, but as we went along, there were quite a few students that went along and said… you know what, I said yes and this is why….I was really surprised by how articulate people got when they started using these systems.”
The student who was interviewed about the use of clickers in the large lecture also agreed that anonymity provides “a comfort level of making your own response” without the fear of repercussions. Sharing question results in class also seemed to create awareness about what their peers are thinking. The comfort of knowing that peers also shared their views created an unspoken “solidarity” on an issue helped them speak more confidently about their views. The professor agreed with this idea and said:

“I think it gave people confidence to just speak out... there is not just one person that took my perspective, there were 10. There were 15 that actually said I am going to take... [a] very strict stance on something. So you are thinking, actually if I am going to speak up, somebody else is going to support me.”

The teaching assistant also felt that “the freedom of keeping your identity safe” allowed students to be “more authentic” while providing responses through clickers.

**User Experience**

The SMART Response™ XE clicker usage was demonstrated to all students when the system was first introduced with a PowerPoint presentation to the class. Students were shown how to connect to the class (the SMART Response receiver), to receive and send response to questions posed by the instructor during lecture. Student survey reveals high levels of agreement to survey items about user experience with clickers in the classroom. Table 4.3 compiles survey items that sought student responses about their user experience with clickers.
Table 4.3 Survey Responses to “User Experience with Clickers” Items (n=83)

<table>
<thead>
<tr>
<th>Item</th>
<th>Question</th>
<th>Percentage</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Agree/Strongly Agree</td>
<td>Neutral</td>
<td>Disagree/Strongly Disagree</td>
</tr>
<tr>
<td>12</td>
<td>I felt comfortable interacting and participating in lecture discussions using clickers</td>
<td>78%</td>
<td>12%</td>
<td>9%</td>
</tr>
<tr>
<td>17</td>
<td>The anonymity of using the clickers helped me provide honest opinions and responses to clicker questions.</td>
<td>74%</td>
<td>15%</td>
<td>11%</td>
</tr>
<tr>
<td>23</td>
<td>Comparing my response to the group’s response trends helped me to better understand my own perspectives and views.</td>
<td>71%</td>
<td>12%</td>
<td>15%</td>
</tr>
<tr>
<td>18</td>
<td>Audience response questions and discussions help me to develop a sense of collaboration.</td>
<td>63%</td>
<td>22%</td>
<td>13%</td>
</tr>
<tr>
<td>25</td>
<td>I would you like to see clickers used more widely as a learning tool in the teacher education program.</td>
<td>57%</td>
<td>24%</td>
<td>17%</td>
</tr>
<tr>
<td>26</td>
<td>I would like to use clickers as a learning tool in my own classroom.</td>
<td>53%</td>
<td>17%</td>
<td>27%</td>
</tr>
<tr>
<td>19</td>
<td>Using a clicker in a large lecture format helped me communicate with the instructor.</td>
<td>45%</td>
<td>32%</td>
<td>21%</td>
</tr>
</tbody>
</table>

An analysis of survey items related to user experience reveals the group response trends compiled in Figure 4.5. Data indicates that the majority of students (78%) felt comfortable interacting and participating in lecture discussions using clickers. Four other
user experience survey items where students indicated that they “strongly agreed/agreed” are:

1) The anonymity of using the clickers helped me provide honest opinions and responses to clicker questions (74%).

2) Comparing my response to the group’s response trends helped me to better understand my own perspectives and views (71%).

3) Audience response questions and discussions help me to develop a sense of collaboration (63%), and

4) I would you like to see clickers used more widely as a learning tool in the teacher education program (57%).

Almost half the survey respondents “strongly agreed/agreed” to two survey items:

1) I would like to use clickers as a learning tool in my own classroom (53%).

2) Using a clicker in a large lecture format helped me communicate with the instructor (45%).

Figure 4.5 Student Response Trend for User Experience Survey Items
The researcher’s field notes indicate that, after the first class no student required any assistance to sign into the system and respond to questions. Everybody just went in and figured it out. Only two instances of clickers not turning on due to battery issues were recorded during the term. Two hundred clickers were available for use to about hundred and sixty students. Hence in both cases students were immediately provided with an alternative clicker to sign in and use in class without any delays during lecture. The unresponsive clickers were also sequestered until batteries were replaced to prevent any other student from getting them in subsequent lectures. The professor also concurred with the ease of the use of the response system and felt that the SMART Response™ XE employed “a very user friendly technology.” The professor also felt that more work needs to be done in the area of professional development for instructors “in terms of how best to use it and to expand upon the basic knowledge”. This professional development, she felt “...could build upon that foundation of” basic knowledge “and develop it in a much more holistic manner.” She also felt that using the system in class for an instructor meant having a lot of support from teaching/technology assistants.

“...the issue of picking up the clickers, taking the clickers, making sure that the equipment is there, making sure the batteries are working. And they are not an issue, but they are a consideration in terms of how much they are going to implement it and who would be responsible for it, what would be the implications for that. So a lot of it is just support mechanisms to allow for that device to occur in a seamless manner.”

Hence from an instructor point of view the user experience of the system was also closely related to support, training and professional development to implement and use this technology in a “robust way” in the classroom.
Technology benefits.

An analysis of the researcher’s field notes indicates that the SMART Response™ XE system technology benefitted both the teaching staff and students using the clickers to provide a response during lecture. The teaching assistant for the course felt that the clickers worked in this classroom environment. He summarized his views in interview as follows:

“It works with our gadget kind of world you know where everyone’s got iPhones and iPods and I think that young people can relate to that kind of... Using that kind of a gadget, because that’s the world we live in now. It’s these sorts of things hand held and giving... Expressing yourself through electronic type hand held gadgets, that’s the world we live in now.”

The clickers he felt was a great tool for the instructor to quickly get “an idea of what the class might think about a certain issue.” The professor also echoed this view and felt “that you can get really quick feedback” using clickers in a large lecture. This method of gathering quick responses the teaching assistant felt, was “especially valuable when it comes to... social issues or” any other issue, “...young people are dealing or facing with, which a professor might not...” otherwise be aware of. He also felt that using such innovative technology to gather student responses en masse in class was appropriate for a course “about introduction to educational studies” that also includes “technology in education.” Students now get to see this theme “being applied right in the classroom.” In his view, using this clicker technology in this lecture was “perfect” for this class. The technology he further elaborated went further than just allow students to respond to questions posed by the instructor and would be great to gather formative student feedback about the course. He recorded this view in the interview as follows:
“This... technology will really invigorate a student’s response to courses, like student feedback, student evaluation... rather than being just some test you sort of do through the end, you get an idea throughout the whole course about student ideas, student’... points of view about the topics and I think eventually this would be good for course evaluations.”

The biggest benefit of this technology for all involved according to the teaching assistant “is the integrity of the responses.” Interactive clicker technology he felt, reminds the student in the large lecture that what s/he thinks and says matters. His comments during the interview were recorded as follows:

“Old methods of lecturing, they are disempowering. They make them [students] feel just like.. they are just a bump on a seat, what they thinking, doesn’t matter. .... the subtle lesson that’s being learned with... this sort of technology reminds us students we care about these students.”

The most value according to the professor was the anonymity feature that provided a “voice” to everyone especially when discussing controversial or highly contested issues.

The student felt that the QWERTY keypad of the XE response system was very helpful in texting responses to clicker questions. The researchers classroom observations have also recorded student feedback about the SMART Response™ XE systems.

Students provided feedback that they were aware of peers from other faculties were also using clicker technology for their courses. Some of these clicker systems used smartphones and some others where the handheld devices needed to be purchased as part of the course requirements. The consensus was that most of these systems used by their peers were quite basic in their function and nowhere as good as the SMART Response™ clicker system. This observation is also supported by student survey results that indicate
that more than half of the students (57%) would you like to see clickers used more widely as a learning tool in the teacher education program. 53% of the students surveyed also indicated that they would like to use clickers as a learning tool in their own classroom in the future. The use of clicker technology among prospective teachers and educators, seems to have had a positive influence on them about the use of technology as pedagogical tools to enhance learning in the classroom.

Active Learning

Research has revealed mounting evidence that lecturing is a “relatively ineffective pedagogical tool” to promote conceptual understanding (Knight & Wood, 2005, p. 298).

Learners at all levels gain meaningful understanding of concepts primarily through active engagement with and application of new information, not by passive listening to verbal presentations (Knight & Wood, 2005, p. 298)

The SMART Response™ XE response system was used in the lecture to increase interaction and facilitate discussion on course topics during lecture. When asked about how clickers influence interactions in the large lecture, the professor opined that:

“…clickers …push their own parameters of their learning style, …in terms of actively engaging with the question themselves to say, ‘Ok where do I stand in a particular issue? Is my viewpoint being influenced or shifted given the nature of the topic, given the nature of some of them that are rising in any particular issue?’ So I think it pushes some people out of their boundaries probably in a positive way.”

The goal for the instructor it appeared was to direct students to question their existing knowledge and beliefs and actively engage with the content dealt with in the class. The student echoed understanding of this goal for the lecture in her interview and felt that the instructor used clicker questions to actively foster learning by “challenging
our perspectives.” The professor also observed that when questions were posed, the “clickers always brought” students back to the task “to respond to the question.” As opposed to “I can turn off mentally if I really don’t want to pay attention to the point. And now I am being asked to... to think about what my perspective was, I might not have been paying attention for the last 5 minutes.” It appears that “there is something.. bringing them [students] back on task and getting students to focus on the theme of the class. It.. challenges people’s...views on education.” By challenging known beliefs and perspectives, students open their mind to “other aspects of education” and learn to apply new information towards conceptual understanding of course themes. The goal of using these questions was to help students “make a distinction between the life as a student and life as a professional educator and just making distinctions in the argument.” Clickers provided instant access into student’s minds and thought processes (Broussard, 2012). Student’s views on course content came to the forefront when results were displayed to the class. This also allowed deeper discussion to increase understanding of critical information (Broussard, 2012, p. 5). The student during her interview also echoed this view and admitted that clickers help her “see the overall picture of education and the types of issues that are out there and we will have to face as teachers.”

Social Learning

Social learning is often facilitated by peer discussion. This discussion can help build understanding of critical concepts even if no one in the group initially knows the correct answer (Smith et al., 2009). The professor for the large lecture course observed that “for the most part there was a discussion that occurred while” students were using clickers. She also admitted that when the discussion seemed to extend beyond the
reasonable length of time to answer a clicker question, she felt “this is a time for them to get off topic.” But then she began to notice “that they have been talking about the issue” being highlighted in the clicker question. This is also recorded by the researchers classroom observations – students seemed to be involved in discussion before, during and after they had responded to clicker questions. The number of small discussion groups seemed to greatly increase once students had responded to clicker questions and continued until the professor displayed the results of the clicker questions to the class. The display of results seemed to take even the professor by surprise and created new “teachable” moments for her based on the results.

“Given the nature of the topic, I think I have a sense or perception of what I where the poll would be and the you get a poll and it is drastically different from your perspective and you kept thinking. ‘Oh! This is actually much more contested.’ ... I have stopped and thought I know I have other slides that I want to get to but actually there is a teachable moment here because of what just happened here... I just had a number of viewpoints expressed in this way so I thought the direction of the topic was here.”

The teaching assistant for the large lecture also said, using clicker questions to gather student viewpoints “can help the professor to be more relevant.” Information from the clicker question results can be valuable to gain “some understanding” about students, “make you learn things that you didn’t know, didn’t realize about that class.” He further elaborated that the question results also benefitted students.

“That’s [clicker question results] another positive aspect because it is just not information for the professor, but also students finding out that there is a lot that maybe think like them or conversely don’t think like them”
One important benefit of seeing different opinions displayed in the question results was that students could instantly “compare different opinions” across the entire classroom “as opposed to comparing different opinions around your neighbors because you really don’t get the consensus.” Examining clicker question response data within a large class, ‘helps students apply sociological concepts and fosters greater awareness for how social and cultural contexts shape beliefs and behavior’ (Mollborn & Hoekstra, 2010, p. 21). Knowing what peers are thinking, according to the teaching assistant, helps students to feel “like they have a sense for the ideas of others which they would not normally have.” This understanding helps foster a “sense of community” and seems to take away from the impersonal atmosphere in a traditional large lecture format course. The teaching assistant summarized this view by saying with clicker questions, “you get a sense for how people think in…. this kind of community of sorts which is the classroom. So in a way it does…make the classroom a bit of a community... because ideas can be shared so easily and anonymously.”

**Question types**

Clickers provide ample ‘opportunities for applied learning in large courses’ (Mollborn & Hoekstra, 2010, p. 19). These opportunities can be well explored only by using the right type of questions to gauge student response. The professor highlighted the importance of using the right questions in her interview by saying, “if you can be attentive to or savvy about how you write the questions” a wide variety of responses from all students present in the large lecture can be gathered. She also elucidated the thought she put into designing questions for her lectures.
“How else could I develop this that would actually make my lectures that much more interactive, more robust, make the students think that, even look harder. How would I change the questions...”

The question types predominantly used in the lecture included:

i. Opinion based multiple choice/multiple response questions

ii. Opinion based Yes/No questions

iii. Open-ended text entry questions

According to Mollborn and Hoekstra (2010) opinion questions “solicit student’s perceptions of sociological ideas and findings to initiate discussion in a manner that encourages critical thinking of course concepts” (p.21). The professor in the large lecture also used opinion questions to gather student perceptions and initiate discussion. The professor during her interview registered her comments on the question types used in lecture as follows:

“...the ones that I found the most valuable was either the opinion kind of yes or no or... the multiple choice in terms of what I was trying to highlight is the spectrum of thought. So for the purposes of my course, those provided the most value and I was surprised about the textual responses and I kept on going back to the textual responses, and I was trying to work through it seeing if there was a better way in which I could pull the ideas out.”

The teaching assistant felt that open-ended “text questions have certain value” over yes or no and multiple choice questions”. However he added, “any question can be formulated in a way that it informs the instructor, informs the students about thoughts and ideas about the course subject matter, so any question, can be valuable.” The student felt opinion based multiple choice questions helped her “see different ideas” and also allowed students to express themselves. The student felt opinion based multiple
choice questions helped her “see different ideas” and also allowed students to express themselves. An analysis of two survey items based on the most commonly used question types indicate that 63% of the student survey respondents “strongly agreed/agreed” that answering open-ended questions using the clickers was an effective way to advance their learning. When it came to opinion based multiple choice questions, 58% of the student survey respondents felt that answering multiple-choice questions using the clickers was an effective way to advance their learning. Figure 4.6 depicts the comparison to student response to survey items on text entry and multiple choice question types.

**Figure 4.6 Comparison of Student Response to Text Entry and Multiple Choice Question Types**

Though a majority of participants agreed that textual responses were of great value, there were three different opinions when it came to the question of textual responses Vs. open class discussions. When questioned if thought open-ended textual entry clicker question was comparable to an open class discussion each participant had a
different view. The student said she felt that open-ended clicker questions were better than an open class discussion because “..in an open class discussion, you are more limited. You are more likely to have the same people talk. So I think.. open-ended questions are better.” The professor on the other hand, thought that open class discussion was better than an open-ended text entry clicker question. She explained her stance as follows:

“.. I think I got more robust answers, when I just went back to the open discussion. That said, we had more people engaging in the open discussion. So... the quality is poor but the quantity was better.. you need to balance that out... for those people who are quiet or reluctant, to have an open discussion, it forces them [to respond], I had a breath of answers but I think that... they were not superficial, but...skimmed the issues. So if I want people to become engaged at one level, then I think that it provided that. If I wanted more in depth and more development of those ideas, then I think open discussion was better than a clicker.”

The teaching assistant adopted a more neutral tone by saying that both methods of interaction had their pros and cons. When it comes to open-ended text entry questions and classroom discussions, he added:

“Open class discussion the positives are everyone can express their points and you can have debates in the classroom. It creates... more feeling, talking; expressing yourself verbally there is more feeling more emotion, passion so this .... gets students really into the subject matter. Putting responses through a clicker, perhaps doesn’t engender the type of passion because you are typing in responses.”

Question types used in the lecture include opinion based multiple choice, multiple response, yes/no and open-ended questions. Of these, the most discussed types seem to be the traditional multiple choice, multiple response question and open-ended text entry
question. The open-ended text entry question format was made possible by the QWERTY keypad in the SMART Response™ XE clickers. With this new clicker question type it does appear that there is some debate if they can compare to an open class discussion. While instructors feel open-ended text entry clicker questions, garnered different opinions from a large number of participants, more quality can only be expected in an open class discussions. These type of responses, they feel should ideally be followed up with open discussions to help students develop a deeper understanding. However from the point of view of a shy/reluctant participant it appears the opportunity of expressing views though the clicker system knowing that your opinion will be registered regardless of what others have to say, sways the balance towards open-ended text entry clicker questions over an open class discussion.

**Pedagogy**

Clickers bring a promising new technology to the large lecture. However, clickers are only as valuable as the pedagogy that surrounds the use of this technology. Instructors who use clickers must think carefully about the pedagogical strategies for the clicker classroom (Mollborn & Hoekstra, 2010, p. 19). The first step is developing strong and useful questions that enable the instructor and students to address key learning goals in the course. The professor of the large lecture “*wanted to see to what extent it [clickers] would enhance or detract*” classroom interaction because she always tries “*to create a very interactive environment*” in large lectures. The focus for her was to see if she could expand the ways in which she could interact with students using clickers. She also admitted that incorporating clicker technology within the pedagogy of the large lecture was a challenge. Her comments during the interview were recorded as follows:
“It did challenge my pedagogy. I know that I have certain strengths as a lecturer. And any time when you bring in a new strategy, it creates a reflective process and structure to say how valuable was it, maybe I need to be thinking what other aspects of my teaching, so it creates for a moment of pause in teaching more broadly speaking in terms of what is the point in this, what is the purpose of this lecture, and how am I articulating, in what ways am I articulating it. Am I favoring or am I creating certain biases towards students. Can I reduce that? What are the implications when I use a clicker? Can I use a clicker more effectively and draw the shy students … it just raises all these other questions in terms of just [how] you are teaching more broadly conceived.”

An analysis of student survey results about clickers indicates that majority of the students (86%) “strongly agreed/agreed” that the instructor clearly communicated lecture topics.

**Figure 4.7 Student Response to Survey item on Instructor Communicating lecture topics**
It is also interesting to note that this survey item represented in Figure 4.7 had the highest level of agreement among the 26 item student survey. Table 4.4 compiles student survey responses about instructional strategies with clickers. Among the five instructional strategy with clickers survey items, three items had the highest levels of agreement when compared to the 57.5% median value for the “strongly agree/agree” percentages of survey responses:

1) The instructor clearly communicated important lecture topics (86%).

2) The audience response system was used at appropriate times to advance my understanding and learning (70%), and

3) The instructor used the variety of questions to kindle my learning and advance my understanding (66%).

For two other survey items, more than half of the students “strongly agreed/agreed” to the statements about instructional strategy or pedagogy used with clickers:

1) Answering open-ended questions using the clickers was an effective way to advance my learning (66%), and

2) Answering multiple-choice questions using the clickers was an effective way to advance my learning (58%).

Table 4.4 Survey Responses to “Instructional Strategies with Clickers” Items (n=83)

<table>
<thead>
<tr>
<th>Item</th>
<th>Question</th>
<th>Percentage</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Agree/Strongly Agree</td>
<td>Neutral</td>
<td>Disagree/Strongly Disagree</td>
</tr>
<tr>
<td>1</td>
<td>The instructor clearly communicated important lecture topics.</td>
<td>86%</td>
<td>10%</td>
<td>4%</td>
</tr>
<tr>
<td>2</td>
<td>The audience response system</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Item</td>
<td>Question</td>
<td>Percentage</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>------</td>
<td>--------------------------------------------------------------------------</td>
<td>------------------</td>
<td>------</td>
<td>-----</td>
</tr>
<tr>
<td>1</td>
<td>was used at appropriate times to advance my understanding and learning.</td>
<td>Agree/Strongly</td>
<td>70%</td>
<td>3.81</td>
</tr>
<tr>
<td></td>
<td>Strongly Agree</td>
<td>Neutral</td>
<td>19%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Disagree/Strongly Disagree</td>
<td></td>
<td>4%</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>The instructor used the variety of questions to kindle my learning and advance my understanding.</td>
<td>Agree/Strongly</td>
<td>66%</td>
<td>3.79</td>
</tr>
<tr>
<td></td>
<td>Strongly Agree</td>
<td>Neutral</td>
<td>26%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Disagree/Strongly Disagree</td>
<td></td>
<td>6%</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Answering <strong>open-ended questions</strong> using the clickers was an effective way to advance my learning.</td>
<td>Agree/Strongly</td>
<td>63%</td>
<td>3.68</td>
</tr>
<tr>
<td></td>
<td>Strongly Agree</td>
<td>Neutral</td>
<td>23%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Disagree/Strongly Disagree</td>
<td></td>
<td>12%</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Answering <strong>multiple-choice questions</strong> using the clickers was an effective way to advance my learning.</td>
<td>Agree/Strongly</td>
<td>58%</td>
<td>3.44</td>
</tr>
<tr>
<td></td>
<td>Strongly Agree</td>
<td>Neutral</td>
<td>17%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Disagree/Strongly Disagree</td>
<td></td>
<td>24%</td>
<td></td>
</tr>
</tbody>
</table>

The teaching assistant for the large lecture observed that the professor used clicker question responses “as a starting point for a discussion.” In the discussion that follows often “students are quite vocal about” their views. Using a clicker gives students the chance to express their views through the clicker response as well as share their views in the discussion that follows. This opportunity, he felt was “more balanced” because “it’s not like ok you are just typing in responses and not actually saying anything. they get a chance to do both.” In addition, he felt that clickers offered a glimpse into the minds of students and help instructors readjust their pedagogy to better suit student learning needs.

He recorded his thoughts in the interview as follows:

“I think that it gives us the opportunity to find out what students are thinking and to be able to make adjustments to our syllabus or to our activities based on our greater
The professor, felt that the clickers provided her feedback about how students develop and refine their positions when it comes to important issues in education. This knowledge she said also helped shape her teaching and pedagogy. Clicker questions, she revealed “highlighted startling results” and made her “need to spend a bit more time here and talk about the issue more” because this particular issue was far “more contested” than she expected or if the viewpoint revealed in the clicker responses wasn’t the dominant view she expected to see. Thus, it appears that the professor gets to know the students ideas on a topic and this viewpoint can form the “professor’s practice in future courses and future lectures.” In addition, she said opinion poll results “often changed the nature of the emphasis that I was going to make.” The professor saw the most value in this unique pedagogical tool because it brings about “a different pedagogic strategy that will appeal to” most students from a “visual or auditory or kinesthetic perspective.”

Conclusion

This chapter presented an analysis of the data for this study in three different themes: student engagement, student participation and active learning. The first section for the theme titled impact on student engagement summarized and presented data for student attention, interaction and reflection. An analysis of data was presented for the digital learner, student-teacher, student-student interaction and assessment. The second section on the theme of student participation compiles data for shy/reluctant learner participation and user experience. The analysis of shy/reluctant learner participation also included data on providing opinions anonymously. The user experience section also
discussed the technology benefits of the clicker system. The third theme of active learning reported data on social learning, question types and pedagogy.

Chapter Five summarizes the key findings in the context of the research questions at the core of this study. Based on the study findings key recommendations are also made for practice and future research. Limitations of the study are also discussed followed by a summary and a conclusion.
CHAPTER 5 RESULTS AND DISCUSSION

Many studies have researched the effectiveness of audience response systems in large lectures. Fields of study for audience response system research include accounting, computer information systems, science, nursing, and physiology. The present study seeks to add to the limited amount of research on engagement and clicker use with students in education faculties and teacher preparation programs. The current exploratory case study contributes to the existing literature on clicker use in large lectures by employing mixed methods for data collection and analysis to address three research questions. The study records student and instructor perspectives on student engagement, shy/reluctant learner participation in lecture, and instructional strategies used in conjunction with the clicker questions. Study findings are compiled in three sections in this chapter, each section containing data pertinent to one of the three research questions. The presentation of key findings is followed by a discussion of the limitations of the study, and concludes with recommendations for future practice and research.

Discussion of Major Findings

The current study is framed around three fundamental questions about the use of Audience Response Systems in large education lectures. The questions at the core of this case study are:

1. How do audience response systems impact student engagement in large education lectures?
2. How do audience response systems empower and engage reluctant participants?
3. Which instructional strategies for audience response system questions work best to advance student learning in large education lectures?
The following sections compile study data as a response to the three research questions.

**Impact on Student Engagement**

The first research question of this study is – How do clickers impact student engagement in large education lectures? To answer this question, the researcher included survey items that garnered study participant opinions on student engagement in the primary data instruments – student survey, instructor interviews and student focus groups. In addition field observations also recorded instances of student engagement in the classroom.

Interaction and engagement are “fundamental to student learning in large lectures” (Sharma et al., 2005, p. 137). Opportunities for interaction in a traditional large lecture are limited because of large space, class size, and inaccessibility of the instructor (Gleason, 1986). Several past studies have studied the concept of student engagement in the context of clickers (Marcum, 2009; Vibert & Shields, 2003). A broad definition of student engagement that emerged from these studies is - engagement is a construct of activities require “psychological investment” and effort towards learning (Vibert & Shields, 2003, p. 224). This study found that student interaction and engagement in a large lecture can be increased by using an audience response system like the SMART Response™ XE clicker system as part of the learning environment. The current case study draws upon and expands on the findings of many research studies that explored the influence of clickers on student engagement in large lectures (Cotner et al., 2008; M. Freeman & Blayney, 2005; Gauci et al., 2009; Martyn, 2007; Russell et al., 2011). When it comes to student engagement in lecture, data from the participants indicate that the implementation of the response system appeared to increase student engagement in the
lectures to varying degrees. An analysis of survey data indicates high levels of agreement with items on student engagement (45%-62%). Similar to the findings in the Cotner et al. (2008) study, the SMART Response™ XE system appeared to help students to pay attention, to stay focused in lecture, and keep them thinking about ideas and discussions associated with clicker questions beyond the classroom. The increased engagement can likely be attributed to the ease of use of the system, coupled with the anonymous mode usage that tends to encourage students to participate, and well-timed questions that require students to focus in class discussions. Student engagement cannot be separated from associated social, cultural and political contexts (Vibert & Shields, 2003). To explore the social contexts around student engagement, it is important to understand learner attention, interaction and reflection.

Attention

Student attention in the large lecture should move beyond sustained concentration and simple retention of information to help develop a deeper understanding and use information in different ways (Glenn, 2010). From the data collected and analyzed in this case study, it appears that the SMART XE clickers, helped:

- Capture and retain student attention to receive instruction and to respond to concepts and ideas during lecture
- Students to interact with peers and the instructor in the classroom
- Students to build an understanding of concepts being discussed in lecture.

During the course of the lecture, changes in levels of student attention were noticeable to the instructors and to the researcher who was collecting field observations. One of the desirable effects of the response system was that it provided a way to gain the attention of
distracted digital learners and bring their attention back to the concepts being discussed in lecture. Since it is very impractical to address distractions with stringent usage rules alone, in this digital age (Glenn, 2010), clickers offer a novel way to use technology to enhance learning in the large lecture. The findings of this case study are consistent with the results of Russell et al. (2011)’s study of clicker usage in an introductory course for an accelerated nursing program, which indicated that the use of clickers made the class more engaging and helped students to concentrate better in class.

Interaction

In a traditional large lecture classroom, interaction can rarely feel like personal communication because the instructor is so far away. Tight rows can make group discussion difficult (Gleason, 1986). Use of the SMART Response™ XE system appeared to increase the personal connections in the large lecture by facilitating greater person-to-person interaction. The use of the audience response system thus appears to have:

- Promoted greater student-instructor and student-student interaction.
- Increased sense of belonging in the course for students
- Increased time for students to interact with peers and to develop and express their own understanding of the ideas discussed in lecture.
- Increased opportunities for social learning facilitated by clicker questions, the display of results and peer discussion.
- More teaching and learning moments for the instructor to tailor instruction in the direction of the class discussion.
These findings closely mirror the study results in the Stowell and Nelson (2007)’s study with psychology students that focused on better understanding student participation, learning and emotion.

**Reflection**

Reflection is an important learning strategy for students because it is closely related to critical thinking and decision making (Koufogiannakis, 2010). The use of the SMART Response™ XE response systems allows students to develop and express their own understanding of course concepts by reflecting on course content in real time and via peer/class discussions that allow students to play an active role in their own learning process (Ayu et al., 2009, p. 711). It appears that issues and ideas raised by the instructor using clicker questions and the resulting discussions about results, kept students thinking and reflecting on these issues even after the lecture. The display of results, that compiled response trends, also seems to have played an important role in the student’s reflective process. This comparison of a student’s own responses to the group response trends also seems to help students to better understand their own perspectives and views. These findings are very similar to the results of Bashforth and Parmar (2010)’s pilot study for the use of electronic voting systems (EVS) in large lectures at the University of Bath.

**Empower and Engage Reluctant Participants**

The term reluctant participants can be used to describe students who may not be used to responding spontaneously during class and often fear “losing face” by providing an incorrect response in class (Beekes, 2006, p. 28). The current study aimed to better understand whether the SMART Response™ XE systems had any influence on the
participation of shy/reluctant students in class. The data from this case study indicates that clickers:

- Provided an opportunity for all students to voice and share their views with the whole class.
- Created a level playing field for all students to be able to share their views.
- Provided a safeguard for students to express themselves in the large lecture without making them feel vulnerable.
- Increased student confidence to using the response system in class with the anonymous feature to kindle class discussions.
- Created an unspoken ‘solidarity’ on an issue and helped students speak more confidently about their views.
- Allowed students to be more authentic and provide honest opinions though the response system.

The findings of this case study are similar to the results of Cain and Robinson (2008) and Graham et al. (2007) study that investigated the relationship between Audience Response System use and shy/reluctant learner participation. It was a widely shared view among the participants that the SMART Response™ XE system was easy to use. An overwhelming majority of the study participants indicated that they were felt comfortable interacting and participating in lecture discussions using clickers.

**Conceptual Framework Revisited**

Graham et al. (2007)’s study forms part of the conceptual framework for this study. Five survey questions from their study have been used in the current case study to explore responses from shy/reluctant participators:
1) I am interested to know the opinions of other students in class (Graham et al. 2007).

2) I am reluctant to share my opinions in class.

3) I am hesitant to ask questions when I don’t understand the lecture material or the nature of course work.

4) I prefer classes where I am not required to participate.

5) I prefer classes where I have opportunities for participation and interaction.

Student responses to these questions were analyzed as per the Graham et al. (2007)’s criteria to identify shy and reluctant learners. Shy/reluctant learners can be understood as a group in these ways:

1) Students who may be classified as shy/reluctant learners want to know peers’ opinions but may be reluctant to share their own opinions. This may include respondents in this study who answered “strongly agree/agree” to survey items: ‘I am interested to know the opinions of other students in class’ and ‘I am reluctant to share my opinions in class’.

2) Students who may be classified as shy/reluctant learners are hesitant to ask a question in class when they don’t understand the material. This includes respondents in this study who answered “strongly agreed/agreed” to survey items: ‘I am hesitant to ask questions when I don’t understand the lecture material or the nature of course work’.

3) Students who may be classified as shy/reluctant learners prefer classes where they are not required to participate. Respondents in this study who answered “strongly disagree/disagree” to: ‘I prefer classes where I have opportunities for
participation and interaction.’ and answered “strongly agree/agree” to: ‘I prefer classes where I am not required to participate may be the shy/reluctant learners.

While Graham et al. (2007) identified three sub-groups of reluctant participators in large lectures (students reluctant to share opinions; Hesitant to ask questions; students preferring courses that do not require them to participate), the researcher in this current study did not attempt to separate the shy/reluctant learner survey respondents from the entire sample for analysis because of the small sample size and insufficient interview data to triangulate on the question of shy and reluctant participants. Thus, a descriptive analysis was conducted with these items to explore the concept of shy and reluctant participants.

Descriptive analysis of survey data reveal that about 40-45% of the surveyed sample appears to fit into the category of shy/reluctant learners. No further analysis such as correlational analysis between engagement and participation, t-test was performed considering the convenient sampling technique and the relatively small sample size.

To understand the reasons why learners may be shy or reluctant, qualitative data was collected and analyzed. Only one student participated in the student interview and indicated how her shy nature was always a challenge to active participation in a large classroom. Additional student interviews may have contributed greater understanding from shy and reluctant participant perspectives. Due to the limited qualitative data available for analysis, it is difficult to ascertain the various reasons why students may be shy/reluctant in the classroom.

However, with the available quantitative and qualitative data, the existence of shy/reluctant participants in the large classroom has been explored using Graham et al.’s
(2007) survey items. Clickers appear to have helped these students share their views to the larger class without feeling vulnerable and also may have helped to empower them by providing all students the same opportunity to put forth an opinion to the larger classroom and enhance peer, social learning opportunities in the large lecture.

User Experience

From the researcher’s experience with implementing and using the SMART Response™ XE in the large lecture, it can be said that the system worked seamlessly without any crashes during lecture. Students also found the system easy to use. In the first introductory where the system was introduced, usage instructions for students were presented in the class. No student after the first session required help in using the clickers in the classroom. However a more comprehensive understanding of the usability of the SMART Response™ XE clicker system can be obtained by applying Quesenbery (2004)’s five dimensions of usability to the SMART Response™ XE system. Table 5.1 compares the usability of the SMART Response™ XE system to Quesenbery (2004)’s usability criteria.

Table 5.1 Usability of SMART XE in Comparison to Quesenbery (2004)’s Criteria

<table>
<thead>
<tr>
<th>Quesenbery (2004)’s 5E’s of Usability</th>
<th>Definition of Quesenbery (2004)’s Usability Criteria</th>
<th>SMART Response XE Usability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effective</td>
<td>How completely and accurately the work or experience is completed or goals reached</td>
<td>Responses submitted were accurately received by the response system without any loss of data even for open-ended text entry questions. No crashes experienced when using the system in the classroom.</td>
</tr>
<tr>
<td>Quesenbery (2004)’s 5E’s of Usability</td>
<td>Definition of Quesenbery (2004)’s Usability Criteria</td>
<td>SMART Response XE Usability</td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>-----------------------------------------------------</td>
<td>----------------------------</td>
</tr>
<tr>
<td>Efficient</td>
<td>How quickly this work can be completed</td>
<td>Little or no time delay between when responses are submitted and received by the SMART Response system.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Instantaneous display of compiled results once the response reception is turned off for the clicker system.</td>
</tr>
<tr>
<td>Engaging</td>
<td>How well the interface draws the user into the interaction and how pleasant and satisfying it is to use</td>
<td>Interface with minimal but clear instructions when a question is open to receive responses.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Feedback to clicker device from the response system once the response system receives and records a response from a clicker.</td>
</tr>
<tr>
<td>Error Tolerant</td>
<td>How well the product prevents errors and can help the user recover from mistakes that do occur</td>
<td>Over all low error tolerance.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Students must connect to the correct receiver (Clicker classroom) to be able to receive or submit responses.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Responses not submitted unless students click the submit button. There is no automatic submission following a time delay in chosen response submission.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lack of auto save function to immediately preserve received response data as they are received on the instructor system.</td>
</tr>
<tr>
<td>Easy to Learn</td>
<td>How well the product supports both the initial orientation and continued</td>
<td>Simple and easy to use device for users.</td>
</tr>
</tbody>
</table>
This comparison yields a concise picture of usability of the SMART Response™ XE system. From this comparison with Quesenbery (2004)’s usability criteria, it is clear that the SMART Response™ XE system lends itself as a simple, effective, efficient, engaging and easy to learn interface for all users.

**Instructional Strategies for Response System Questions**

The traditional approach to lecturing has been to create a learning environment where lecturers talk and students listen (Ayu et al., 2009). Large lectures in higher education often rely on a passive learning pedagogy where knowledge is transferred from an authoritative source to ready and naïve recipients (Schwartz & Fischer, 2003, p. 23). There is also evidence in literature that lecturing is a “relatively ineffective pedagogical tool” to promote conceptual understanding (Knight & Wood, 2005, p. 298). It is also known that students learn better when they are active in the classroom (Freeman et al. 2007, p.133). The SMART Response™ XE response system was used in the lecture to increase interaction and facilitate discussion on course topics during lecture. The instructor applied an active learning pedagogy facilitated by the audience response
system in the classroom. The goal for the instructor was to direct students to question their existing knowledge and beliefs and to actively engage with the content that was shared in the lecture. The data from this case study reveals that the usage of clicker questions in the lecture appeared to actively foster learning by challenging student perspectives and inviting reflection and response. Similar to the findings in the Broussard (2012) study, clickers provided instant access into student’s minds and thought processes and student’s views on course content came to the forefront when results were displayed to the class.

In the present case study, it was observed that the group results display allowed students to instantly compare opinions across a broad spectrum of participants. The group results display and instructor facilitation also allowed a deeper discussion to occur that increased understanding and consolidation of critical information. The use of clickers, instructor created questions and group display of results also brought about an awareness of peer opinions and social learning facilitated by peer discussion. The display of results also created teachable moments for the instructor by allowing her to tailor instructor in the direction of the class responses and resultant discussion. The use of clickers also provided the instructor feedback about how students develop and refine their positions when it comes to important issues in education. This knowledge helped the instructor to shape teaching and pedagogy for the present and subsequent lectures. As will be discussed in the next section, a great deal of emphasis needs to be in the question design and types of questions used during the lecture.
Question Types

The instructor believed that it is important to be savvy in using the right clicker question types for lecture. The question types predominantly used in the lecture included:

i. Opinion based multiple choice/multiple response questions

ii. Opinion based Yes/No questions

iii. Open-ended text entry questions

Similar to the findings of the Mollborn and Hoekstra (2010) study, the use of opinion questions helped gather student’s perceptions about lecture topics and initiated discussion in a manner that encourages critical thinking of course concepts. The most discussed among the study participants was the use of open-ended text entry questions in the lecture. A majority of study participants felt that open-ended textual entry clicker questions were of great value because they allowed the respondents to type in the responses. A comparison of this question type with an open class discussion reveals different opinions:

i. Textual entry responses were better than the open class discussion because it provided all students with equal opportunity to provide opinions in their own words.

ii. Open class discussions were better that text entry questions as they allowed in-depth development of critical ideas developed by social interaction.

iii. Both measures of interactions have their merits and can be used alternatively to encourage student discussion and critical thinking.

Though multiple opinions were expressed by study participants when it came to the effectiveness of an open-ended textual entry question in a large lecture, it is clear that
this new question type made possible by the full QWERTY keypad of the SMART Response™ XE clicker does add value to the large lecture format education classroom.

Instructional strategies used for the clicker classroom must closely mirror the desired outcome for technology mediated classroom. In the large lecture that served as the primary research site for this study, the SMART Response™ XE clicker system was used to increase interaction and facilitate discussion on course topics during lecture. The primary pedagogy used was the active learning pedagogy mediated by the use of response systems during lecture. Data collected for the study also seemed to indicate that the use of clicker system in lecture challenged student’s perspectives and kindled reflection and introspection. The primary method supporting the active learning pedagogy involved the use of various clicker question types during lecture. Question types included opinion based multiple choice, multiple response, Yes/No questions and open-ended text entry questions. Of these the most discussed was the text entry question since it allowed students to text in their responses with a 140 character limit. Data collected indicated that this question was instrumental in gathering multiple perspectives not restricted by a defined number of options.

Limitations

The current study gathered empirical data in an attempt to answer the research questions that framed this study. However, there are limitations that need to be discussed in the broader terms of applying these findings. The first limitation is the sampling method and size. A convenience sampling method was employed to gather participants for this study. The researcher chose this sampling method over random sampling because the current study relies on social learning within a structured environment such as a large
lecture, and because of the type of student sought: undergraduate education students.

Since the study results have been generated from a convenience sample within theFaculty of Education, study findings cannot be over-generalized to every large lecture that employs interactive classroom technology such as the clickers. The researcher sought out participants for student focus groups and survey by seeking informed consent. However, the number of participants for the survey was limited to 83 from a possible 160. The goal of interviewing several student participants was not met. Only one student participated in the focus groups out of a possible seven who provided consent for focus group participation. Though multiple attempts were made to contact and remind participants via email to schedule an available time and seek more participants for the student focus groups within the convenient sample, the recruitment did not materialize into more participants for the student focus group. Hence this study is limited in the amount and variety of the qualitative data obtained from students in the convenient sample. During an analysis of data pertaining to the participation of shy/reluctant learners in the large lecture, the study adopted (Graham et al., 2007) to identify these participants from the rest of the sample data. However, it is difficult to state with conviction that the percentage of participants who appear to have been shy/reluctant based on responses to the survey actually were shy/reluctant because: 1) there is limited interview data from students to support the notion that the clickers increased the participation of shy/reluctant learners in the large lecture, 2) There is a percentage of participants who chose to be neutral in the Likert scale responses for survey items pertaining to shy/reluctant learner participation survey items and these participants might be shy/reluctant learners or not, and 3) the percentage of people who did admit to being shy and reluctant could have been
hesitant to participate in class for a number of reasons including cultural and social barriers. None of these reasons could be obtained through the survey alone. Though the lone student focus group participant did admit to being shy because she was always shy to participate in class discussions, future research is needed to examine whether students who answered “strongly agree/agree” on the Likert scale for survey items pertaining to shy/reluctant learner participation, are actually shy/reluctant to participate in the lecture. A limitation to the interpretation of survey data is that the respondents had the option of neutral in the Likert scale. Hence, there is no way of knowing whether respondents who chose neutral in response to the questions may have been leaning towards either the agree or the disagree response, or if neutral meant something else altogether. Thus, having the neutral option in the Likert response scale makes it challenging to interpret these responses in the survey data. In a future study, a four-point Likert scale is recommended.

Though clicker questions generated a lot of peer discussion as students entered responses though the clickers, the discussion was limited to smaller groups of students sitting in close proximity to one another in the large lecture. In a future study, strategies might be sought to support small group peer discussion beyond the peers that are in close proximity.

This section aims to consolidate any known limitations to this study. The researcher also needs to acknowledge that by collecting multiple sources of data in the current study, including classroom student focus groups, instructor and teaching assistant interviews, and student survey data, a robust data set was triangulated in order to address the research questions. The study has produced some findings that lead to confidence in
making recommendations. The next section compiles recommendations for practice and research using Audience Response Systems.

**Recommendations**

The experiences of the researcher and lessons learned while conducting the study have been summarized as recommendations for teaching practice and ongoing research on the use of audience response systems in large lectures.

**Recommendations for Practice**

This section summarizes the recommendations for practice for instructors considering using Audience Response Systems in a large lecture classroom. These recommendations have been compiled from the researcher’s data and experience while helping implement the SMART Response™ XE system in the large lecture.

Instructors must first consider “the impact of technology use on their own conformed beliefs of how best to teach” (Gibson, 2001, p. 39). It is best to consider Knapp and Glenn (1996)’s questions to consider when planning to implement any new technology in a classroom. These include:

- How will students react to technology?
- How will technology affect our concept of knowledge?
- How will technology change the location for teaching and learning?
- What type of new skills will students need to learn?
- How will the technology change my classroom and my relationship with my students?
- How will technology impact upon the accountability for achievement in my classroom?
• How does this technology work?

• How much time is needed to get ready to use the technology in the classroom?

• How will the technology change my teaching style?

• What kind of classroom management problems may occur if I use technology?

The most advanced technological tools must always be considered to be “in service of the pedagogy” (Johnston & Stoll, 2011, “It's the Pedagogy, Stupid,” Para. 2). Hence it is important to carefully consider the type of pedagogy to be used in the lecture with the clicker technology. This includes using the response system at appropriate intervals to set the pace of the lecture and help enhance the overall learning experience of the classroom. The present study found that clickers can be used effectively to promote in-class discussion and after class reflection on course content.

It is also imperative to decide if the response system will be used anonymously or with identifying information only. This decision must closely mirror the pedagogy and the learning goals for the classroom. Buckley et al. (2004) observe that students in a passive learning environment play a latent role in the classroom where they remain anonymous, bored and disengaged from the lecture. However, it is true that using an audience response system anonymously can help the instructor understand the true opinions of the class while providing respondents the “security of being anonymous” (Cain & Robinson, 2008, p. 5). In the current study the anonymity of using clickers was found to support students in expressing honest opinions, to offer a wide range of viewpoints, and over time, to express and own opinions in large lecture that were related to non-dominant views.
The efficacy of an audience response system, is primarily dependent on the quality of the clicker questions (Beatty et al., 2006), and the pedagogy surrounding use. Good questioning strategies include removing non-essentials, and using approaches that invite students to make comparisons and interpret information. Using Sullivan (2009)’s guidelines including relate to content presented in lecture, and ensuring that the directions in the question stem are clear, will help simulate the “higher order thinking” of students as in the Bloom’s taxonomy of cognitive levels. It is also ideal to include a few questions spontaneously based on the direction that the class takes to avoid looking too prepared and lacking spontaneity in pedagogy. For example, in this study, it was observed that instructor created clicker questions spontaneously on three different occasions based on the direction of class discussion and it was effective for sponsoring discussion and debate. Spontaneous questions can help students to understand that instruction is being tailored in accordance to their needs without following the one instruction fits all approach.

It is also good to use a few different types of clicker questions instead of using a few select question types. In a large classroom time is always of the essence. While the open-ended text entry question types seem to take longer than multiple-choice/response or true/false, yes/no questions, this question type to be preferred by instructors and students in the present study. To reduce the time spent on just answering text entry questions, instructors can use a countdown timer device after which no responses will be accepted into the system.

While using Audience Response System files in the classroom to administer clicker questions, care must be taken to save response files in a different file name from
the original file to avoid overwriting the original files. The original clicker question file can also be reused in the future. The saved response files can be reviewed by the instructor away from the classroom to understand student perspectives.

Finally, it is important for instructors to have appropriate professional development before they can implement an audience response system and to use the appropriate pedagogy to direct the use of this technology in the classroom. A robust technological support is also required during the clicker use in the classroom to ensure seamless operation of the Audience Response System in the classroom.

In summary, it is important to understand the impact of implementing new technologies in the large classroom, decide the direction of the pedagogy, the mode of using the clicker system – anonymous or non-anonymous, and create good clicker questions to elicit appropriate responses from participating students in the large lecture to enhance their learning experience in the classroom.

**Recommendations for Research**

This section compiles recommendation for research that may be helpful to other investigators who may want to conduct research using audience research using Audience Response systems. These recommendations stemmed from the researchers experiences while conducting this case study. As the case study was carried out, new questions arose that could be the starting point for future research. For example, what was the impact of using a response system in overall student participation in lecture? This question delves into the issue of student participation in lecture. While analyzing the data pertaining to shy/reluctant participation, the researcher felt that there could be many reasons for not participating in a large lecture other than being shy or reluctant. Hence it remains to be
seen if audience response systems can directly impact student participation in a large lecture. Other questions include:

- Can clickers mediate discussion beyond the lecture and translate into more effective collaboration among students?
- How do open source smartphone based clicker systems fare against standalone clicker systems in terms of usability and ease of use?
- What are the advantages of using clickers in the non-anonymous mode over an anonymous mode?

Several data collection methods worked very well. Several ways in which the data collection methods can be improved include using incentives to increase participation, preparing for scheduling conflicts from consented participants and the medium to administer surveys.

From the researcher’s experience it is clear that the best instrument to administer study survey is the response system under study. Though this approach might take time away from the lecturing period, it can instantaneously gather a large number of responses. Also, it is predicted that more participants will come forward if the survey is done in the classroom rather than on paper or using an online survey tool. When gathering study participants for a focus group or interview, it may be helpful to offer a reward or incentive such as a gift card or prize draw to gain higher rates of participation in the interviews. Plan for the incentive while preparing to obtain ethics board approval for this study to avoid any violations or submitting modifications for ethics review. This incentive method can also be applied for any other data gathering instrument. Remember that participation for a research study garners a commitment of time from the participants
and scheduling conflicts occur and the participant may not be able to make it in time for the study. So prepare a backup plan and be flexible to reschedule to collect data if possible.

During this study the survey was conducted all at once using the response systems. For the benefit of participants who arrived late for the survey, questions remained open in the response system from the start to finish of the entire survey. This option allowed answers for any question to be submitted at any time during the duration of the survey in the classroom. Second, participants who arrived after the commencement of the survey were provided with a sheet with the full list of survey questions so that they could still submit answers to all survey questions from start to finish.

To solve the problem of consent form availability, one can provide electronic copies of consent forms or any other such research material so that participants may benefit from having access to study information away from the research site.

To avoid losing any critical study data, it is vital to create multiple backups of important research files and documents. System crashes or hardware malfunctions though rare do occur. Backing up all files to an external hard drive or to a cloud drive for easy anywhere access is recommended, and one needs to secure the laptop computer and backup files with passwords to comply with ethics protocols. The researcher did experience a system hard drive crash on her personal laptop computer and no data could be retrieved from the drive. However the back-ups files restored all the data in the new drive and though this caused a minor delay of a day restoring the backup files, the researcher did not lose any data or important files that could jeopardize the investigation.
These recommendations for practice and research can help enhance the teaching, research practices and the learning environment in a large lecture classroom.

**Conclusion**

The purpose of the current investigation was to explore the influence of SMART Response™ XE Interactive Response System on student engagement in large education lectures. The study also examined shy/reluctant learner participation and instructional strategies for questions to be used in conjunction with response systems in the classroom. Various data collection instruments such as surveys, interviews, focus groups and field observations were used to gather data for this study. Analysis of the collected data reveals enough evidence to address the research questions at the core of this study. The interactivity facilitated by the clickers and supported by an active learning pedagogy in the large lecture engaged learners and allowed all learners, including any shy/reluctant learners, to participate and present their opinions to peers and instructors the classroom.

Study findings indicate that use of interactive classroom technology such as an Audience Response System, can help to capture the attention of distracted learners and focus their attention on the course topics. As a result of using clickers to respond to questions, students actively engaged in discussions with the course instructors and peers which seemed to foster a sense of belonging to the larger group of students in the lecture. The disconnect between being at the lecture and being a part the lecture is reduced by the use of new question types with clickers such as open-ended text entry questions. The open-ended questions seem to promote a sense of belonging to the course by allowing students to type a precise response to the question akin to being part of a large discussion in the lecture.
Based on the study findings, it can be stated with conviction that this study achieved its purpose by finding enough evidence to address the research questions and also adds to the growing body of knowledge on the use of Audience Response Systems in large undergraduate education lectures. The current case study also offers a glimpse into the technical and pedagogical challenges involved in the implementation of an Audience Response system in a large lecture classroom. The recommendations for practice compiled at the end of the study, would be helpful to any instructor considering the use of interactive classroom technologies to support and enhance learning in the large lecture format classroom. The study also offers a glimpse into other learning and behaviour patterns that can serve as a starting point for other research studies that investigate the use of technology to support and enhance the learning of digital learners in the 21st century classroom.
REFERENCES


http://www.cmu.edu/teaching/technology/whitepapers/ClassroomResponse_Nov07.pdf


APPENDIX A CERTIFICATION OF INSTITUTIONAL ETHICS REVIEW

Granted: Certificate on File.
APPENDIX B STUDENT CONSENT FORM

Research Project Title: Effects Of Audience Response Systems On Student Engagement In Large Education Lectures
Investigator: Aarthi Rajasekaran, Master of Science Student, Educational Technology
Co-investigator: Dr. Michele Jacobsen, Supervisor
Research Approval: The University of Calgary Conjoint Faculties Research Ethics Board has approved this research study.

To Faculty of Education Undergraduate Student:

As an education student in Dr. Brent Davis’ plenary lecture, you are being invited to participate in a research study related to the use of an audience response system (ARS), “clickers”, for learning in a large lecture format. This consent form, a copy of which has been given to you, is only part of the process of informed consent.

My name is Aarthi Rajasekaran. I am a Master of Science graduate student specializing in Educational Technology in the Faculty of Education. If you want more details about something mentioned here, or information not included here, you should feel free to ask Aarthi Rajasekaran, arajasek@ucalgary.ca, or my thesis supervisor, Dr. Michele Jacobsen [dmjacobs@ucalgary.ca].

Please take the time to read this consent form carefully and to understand any accompanying information.

Purpose of the Research

The purpose of this investigation is to better understand the use of SMART Technology’s XE and Notebook Software Audience Response System (i.e., clickers) to actively engage student teachers in a large-group, learning environment.

The goals of the research are to document:

- The impact of clicker technologies on instructional design, teaching and learning in a large lecture environment.
- Identify and document the best instructional strategies for large lecture using audience response systems.
- The ways that teachers and students utilize ARS technology to increase interaction and engagement in course topics and educational issues.
- Student impressions of clicker technology and the context of use experiences from both the perspective of learners and the perspective of prospective teachers.
- The use of clicker technology to increase student participation in large education lectures.

What Will You Be Asked To Do?

Students will be informed when data is being collected during lecture (i.e., lecture questions, survey questions, and classroom observations). Students will be invited to contribute to a focus group outside of lecture time. For the research, you will be asked to complete content-related questions during lectures anonymously, to complete an anonymous online survey, and to participate in a focus group. During
classroom observations, you will not be interrupted or approached by the researcher, or identified in any way.

1. **Survey Data & Lecture Question information collected via Audience Response System:** Participation using the audience response system is completely anonymous. No identifying information is collected at any time. Individuals login using the number on the XE Clicker device; the devices are randomly distributed and collected by students at the beginning and end of each lecture. Survey data will be reported in aggregate. Lecture question data will be reported in aggregate.

2. **Student Focus Group data:** Care will be taken to ensure anonymity and confidentiality of participants by having the researcher collect the informed consent forms and gather the data. One-hour, focus group interviews will be scheduled and will occur on campus with 4 – 8 participants at a time. Participants will be made aware that anonymity cannot be guaranteed in a focus group interview; however, the researcher will request that participants in the focus groups keep comments confidential and refrain from using names while providing feedback and observations.

3. **Classroom Observations:** The researcher will observe audience response patterns during lecture (i.e., question type, number of respondents, time to respond), types of peer and instructor interaction associated with questions, and the utilization of the clickers.

### Use of Data & Dissemination of Findings

This research is carried out as part of a Master’s degree program. Research findings will be presented to University and Faculty administrators, faculty members and staff. The final report may be published online or in print journals and may be presented at local, provincial, national or international academic conferences for the purposes of furthering an understanding of the use of audience response technology in large-lecture, learning environments. The final research thesis will be presented to the University of Calgary as part of the requirements of the educational technology graduate program.

### What Type of Personal Information Will Be Collected?

Data collected from you may include:

- **Whole group, classroom observations** by the researcher using a classroom observation protocol; no individual student actions or behaviors are documented. No identifying information is collected.
- Group response data to **content-related questions** during lecture - anonymous
- A formal, **online survey** – anonymous, completed using the SMART XE clickers
- An **audio-taped focus group** - confidential

There are several options for you to consider if you decide to take part in this research. You can choose all, some or none of them. Please put a check mark on the corresponding lines that outline your wishes for consent.

<table>
<thead>
<tr>
<th>I give informed consent to participate in the anonymous formal online survey (administered near the end of the course, during regularly scheduled lecture time)</th>
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<td>Yes: _____ No: _____</td>
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<tr>
<th>I give informed consent for researcher to use data I provide anonymously during the informal, content related questions posed anonymously via the SMART Response XE response system during lecture, and for observations of instructor-student interactions.</th>
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<td>Yes: _____ No: _____</td>
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I give informed consent to participate in a **focus group**. As part of my consent, I have given the researcher my email address to contact me about scheduling participation in a **focus group** (i.e., no identifying information is collected during the focus group, nor are names used). I understand that the researcher will contact only those students whose names are randomly chosen from all those who have given consent to participate in a focus group and that my name may not be chosen.

Yes:_____, and here is my email address: __________________________________________ No Thanks: _____

**What Happens to the Information I Provide?**

Your participation is completely voluntary. Research participation, non-participation or withdrawal will have no effect on student grades, and the course instructor will not know of any specific individual’s participation, even after course grades are posted. The course instructor has agreed to be identified in the reporting of data; there is a small chance that this may impact the confidentiality of student participants.

You will always be informed when data is being collected for the study – you have the opportunity to decline participation, to withdraw fully from participation after consenting, and to choose not to participate in any particular data collection event by choosing not to enter data using the clicker. You are free to discontinue your participation at any time during the study. If you chose to withdraw from the study, data collected from you, up to the point of withdrawal, will be used in the analysis. If the professor chooses to withdraw from the study, all scheduled focus groups will proceed as scheduled. All data collected from you and the professor during lectures, up to the point of withdrawal, will be used in the analysis.

Care will be taken to protect the confidentiality of student participants in a focus group. In a focus group, participants may know each other; thus, anonymity cannot be guaranteed. However, the researcher will request that participants in the focus groups keep comments confidential and refrain from using names.

To keep the information that you provide confidential, NO identifying information is collected. In all reports and analyses, individual students will not be identified. Instead, every attempt will be made to keep individual contributions confidential by identifying "student teacher" as the sole identifiers for this group of individuals. All survey data and content questions data collected during a lecture will be reported as an aggregate. Findings will be available only within contexts outlined in this proposal.

To ensure confidentiality of focus group study data, both audio-tapes and dated transcript data will be stored in a locked cabinet and only the primary investigator will have the key. Anonymous, undated transcripts will be used by both researchers for analysis after lectures are complete and grades are submitted. Any local electronic data will be stored on secured computers where only the investigator can gain access to the data. All data will be held until December 2016 and will be subsequently destroyed. Paper data will be shredded. Electronic data will be deleted and the hard drive erased.

**Potential Benefits / Risks**

**Benefits** – Hands on, active experience using an audience response system for learning, and reflecting upon and discussing the use, will benefit student teachers as learners and as beginning teachers who are developing a pedagogical stance and practice. The information gathered from classroom observations, surveys and interviews will help to articulate opportunities and benefits of extending learning opportunities to all student teachers. To assist in highlighting specific ways and examples in order to describe post-secondary, large lecture learning environments that utilize audience response systems. Faculty and university administrators, instructors, undergraduate students and information technology personnel will benefit from context-specific data about successes, impacts and also challenges that can iteratively inform campus decision-making and instructional / learning improvements. To outline factors that will assist in developing a richer understanding of the types of student engagement and knowledge building environments being called for in the current research literature.

**Risks** – The risks associated with this research are similar to those encountered by the participants in everyday life.
Signatures – Written Consent

Your signature on this form indicates that you 1) understand to your satisfaction the information provided to you about your participation in this research project, and 2) agree to participate as a research subject.

In no way does this waive your legal rights nor release the investigators, sponsors, or involved institutions from their legal and professional responsibilities. You are free to withdraw from this research project at any time. You should feel free to ask for clarification or for information throughout your participation.

Participant’s Name: (please print) ________________________________

Participant’s Signature: ____________________________ Date: ____________

Researcher’s Name: (please print) ________________________________

Researcher’s Signature: ________________________________ Date: ____________

Questions/Concerns

If you have any further questions or want clarification regarding this research and/or your participation, please contact the primary researcher:

Aarthi Rajasekaran
403.926.0808
arajasek@ucalgary.ca

Dr. Michele Jacobsen, Supervisor
dmjacobs@ucalgary.ca

If you have any questions or issues concerning this project that are not related to the specifics of the research, you may also contact the Research Services Office, University of Calgary at (403) 220-3782; email rburrows@ucalgary.ca

A copy of this consent form is available online for you to access for your records and reference.
APPENDIX C FACULTY CONSENT FORM

Research Project Title: Effects Of Audience Response Systems On Student Engagement In Large Education Lectures

Investigators: Aarthi Rajasekaran, Master of Science Student, Educational Technology
Co-investigator: Dr. Michele Jacobsen, Supervisor

Research Approval: The University of Calgary Conjoint Faculties Research Ethics Board has approved this research study.

To Faculty of Education Professor:

As an Education professor who is teaching a large lecture and using clickers, you are being invited to participate in a research study related to the use of an audience response system (ARS), for learning in a large lecture format. This consent form, a copy of which has been given to you, is only part of the process of informed consent. If you want more details about something mentioned here, or information not included here, you should feel free to ask Aarthi Rajasekaran, arajasek@ucalgary.ca or Dr. Michele Jacobsen, dmjacobs@ucalgary.ca. Please take the time to read this carefully and to understand any accompanying information.

Purpose of the Research

The purpose of this investigation is to better understand the use of SMART Technology’s XE and Notebook Software Audience Response System (i.e., clickers) to actively engage student teachers in a large-group, learning environment.

The goals of the research are to document:
- The impact of clicker technologies on instructional design, teaching and learning in a large lecture environment.
- Identify and document the best instructional strategies for large lecture using audience response systems.
- The ways that teachers and students utilize ARS technology to increase interaction and engagement in course topics and educational issues.
- Student impressions of clicker technology and the context of use experiences from both the perspective of learners and the perspective of prospective teachers.
- The use of clicker technology to increase student participation in large education lectures.

What Will You Be Asked To Do?

For the research, you will be asked to participate in a one-hour interview to provide feedback on the use of clickers in your classroom. Participation, non-participation or withdrawal will have no effect on your employment with the University of Calgary. Supervisors will not be informed about participation, non-participation or withdrawal.

- Faculty Interview data: A One-hour, individual interview will be scheduled and will occur on campus at a location of your choosing. Questions will be provided beforehand.
- Classroom observations:
Dissemination of Findings

This research is carried out as part of a Master’s degree program. Research findings will be presented to University and Faculty administrators, faculty members and staff. The final report may be published online or in print journals and may be presented at local, provincial, national or international academic conferences for the purposes of furthering an understanding of the use of audience response technology in large-lecture, learning environments. The final research thesis will be presented to the University of Calgary as part of the requirements of the educational technology graduate program.

What Type of Personal Information Will Be Collected?

Data collected from you will include: An audio-taped interview and classroom observations.

Classroom observation: I give informed consent for researcher to use data that students provide anonymously during the informal, content related questions I pose via the SMART Response XE response system during lecture, and for observations of instructor-student interactions.

<table>
<thead>
<tr>
<th>Yes:</th>
<th>No:</th>
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<tbody>
<tr>
<td>• I give informed consent to participate in an interview. As part of my consent, I have you my email address to contact me about scheduling participation in an interview at a location of my choosing.</td>
<td></td>
</tr>
<tr>
<td>Yes: _____, and here is my email address:</td>
<td>No Thanks: _____</td>
</tr>
<tr>
<td>• As the course instructor, you are publicly associated with this course, so maintaining confidentiality or anonymity will be difficult. Therefore, as the course instructor, do you agreed to be public and cited in the research?</td>
<td></td>
</tr>
<tr>
<td>Yes, I agree to be public and cited in the research: _____ No Thanks: _____</td>
<td></td>
</tr>
</tbody>
</table>

What Happens to the Information I Provide?

Your participation is completely voluntary. You have the opportunity to decline participation, to withdraw fully from participation after consenting, and to choose not to participate. You are free to discontinue your participation at any time during the study. If you chose to withdraw from the study, data collected from you and from students during lecture, up to the point of withdrawal, will be used in the analysis; all scheduled focus groups with students will proceed as scheduled.

To ensure confidentiality of study data, anonymous, undated transcripts will be used for analysis after lectures are complete and grades are submitted. Any local electronic data will be stored on secured computers where only the investigator can gain access to the data. All data will be held until December 2016 and will be subsequently destroyed. Paper data will be shredded. Electronic data will be deleted and the hard drive erased.

Potential Benefits / Risks

Benefits - To assist in highlighting specific ways and examples to describe post-secondary, large lecture learning environments that utilize audience response systems. Faculty and university administrators, instructors and undergraduate students will benefit from context-specific data
about successes, impacts of audience response systems. The documentation of factors that influence student engagement, participation and learning in large classrooms, can provide insights for instructors to use the best instructional strategies to advance student learning.

Risks – The risks associated with this research are similar to those encountered by the participants in everyday life.

Signatures – Written Consent

Your signature on this form indicates that you 1) understand to your satisfaction the information provided to you about your participation in this research project, and 2) agree to participate as a research subject.

In no way does this waive your legal rights nor release the investigators, sponsors, or involved institutions from their legal and professional responsibilities. You are free to withdraw from this research project at any time. You should feel free to ask for clarification or for information throughout your participation.

Participant’s Name: (please print) ___________________________________

Participant’s Signature: ____________________________ Date: ____________

Researcher’s Name: (please print) ____________________________________________

Researcher’s Signature: ________________________________ Date: _______________

Questions/Concerns

If you have any further questions or want clarification regarding this research and/or your participation, please contact the primary researcher:

Aarthi Rajasekaran
403.926.0808
arajasek@ucalgary.ca

Dr. Michele Jacobsen, Supervisor
dmjacobs@ucalgary.ca

If you have any questions or issues concerning this project that are not related to the specifics of the research, you may also contact the Research Services Office, University of Calgary at (403) 220-3782; email rburrows@ucalgary.ca

A copy of this consent form is available online for you to access for your records and reference.
APPENDIX D INSTRUCTOR INTERVIEW PROTOCOL

1. What do you think of using audience response systems in the classroom?
2. How do audience response systems affect student teacher interaction in large lectures?

Learning and Assessment of Learning

3. Do you think audience response systems impacted student engagement in your classroom? Can you provide any examples of this impact in your classroom?
4. Do you feel that ARS technology use has provided opportunities for reluctant learners to participate in the classroom?
5. Have you seen any changes in the way students participated in class using audience response systems?
6. What are the major benefits of ARS technology use for students in your lecture? Are there any drawbacks that should be documented?
7. Would you describe this initiative to be a successful learning experience for the participants? Why?
8. Has the ARS initiative influenced how you assess student learning? Grading and reporting?
9. Do you think audience response systems can be used for formative and summative assessments?

Teaching Strategies

10. What do you think is the most important benefit of using audience response systems in large classrooms?
11. What types of pedagogical changes has the ARS initiative required?
12. Which type of questions do you think best advance student learning using audience response systems?
13. Do you think that capturing open-ended responses using audience response systems in large classrooms is comparable to an open class discussion?
14. Do you think audience response systems capture the attention of the digital learner in a large classroom?

Advice and Recommendations

15. Would you prefer to use audience response systems in smaller or larger classrooms?
16. Have you identified any additional strategies that you would recommend for use with audience response systems in large classrooms?
17. Do you have any additional comments that you would like to make?
APPENDIX E STUDENT INTERVIEW PROTOCOL

Own Learning and Participation in Class

1. Overall, what is your opinion of using ARS technology in large lectures?
2. Overall, do you think ARS technology has made an impact on how you learn and engaged in the lectures?
3. How would you describe your participation in class? Extension: you could come up with a descriptive metaphor.
4. From what you have seen, has having access to ARS changed the way that you or other student teachers interact and communicate with others during lecture?
5. Do you feel that ARS technology use has provided opportunities for you to participate more in a large class?
6. What are the major benefits of ARS technology use for students in the lecture?
7. Are there any drawbacks to using the ARS that we should document?
8. Did the use of the ARS require changes in how you participated in lecture? In how you prepared for lectures?
9. What type of questions used with audience response systems did you think best advanced your learning?
10. Would you describe this initiative to be a successful learning experience for the participants? Why?

Learning As a Prospective Teacher

11. Can you think of any instructional strategy that you would want to implement in your own classroom using audience response systems?
12. Have you thought about ways that you might use ARS technology for learning, communication and engagement in your own classroom?
13. As a prospective teacher, would you like to use audience response systems in smaller or larger classrooms?
14. Would you use audience response systems as assessment tools in your own classrooms?
15. Which types of assessment do you think is best supplemented by using audience response systems as assessment tools?
16. Do you think you can use audience response systems to engage and hold attention of the digital learner?
17. Are there things that you were able to do with the ARS that would have been very difficult or even impossible to do without one? How do you think this has influenced your learning?
APPENDIX F STUDENT SURVEY

5 point Likert-type scale

1 = strongly agree, 2 = agree, 3 = neutral, 4 = disagree, 5 = strongly disagree

Teaching Presence

Design & Organization

1. The instructor clearly communicated important lecture topics.
2. The audience response system was used at appropriate times to advance my understanding and learning.

Facilitation

3. Using clickers in the lecture helped me pay attention and stay focused during the lecture.
4. By using clicker questions, the instructor encouraged me to explore new concepts in this course.
5. I am hesitant to ask questions when I don’t understand the lecture material or the nature of course work. (Graham et al 2007)

Direct Instruction

6. The immediate feedback and results from clicker questions helped me understand my strengths and weaknesses better.
7. The instructor used the variety of questions to kindle my learning and advance my understanding.
8. Answering multiple-choice questions using the clickers was an effective way to advance my learning.
9. Answering open-ended questions using the clickers was an effective way to advance my learning.

Social Presence

Affective expression

10. I prefer classes where I have opportunities for participation and interaction. (Graham et al 2007)
11. I prefer classes where I am not required to participate. (Graham et al 2007)
12. I felt comfortable interacting and participating in lecture discussions using clickers.
13. I am interested to know the opinions of other students in class. (Graham et al 2007)
14. Getting to know other course participants’ views via peer discussion about clicker questions gave me a sense of belonging in the course.
15. I am reluctant to share my opinions in class. (Graham et al 2007)

**Group Cohesion**

16. The clickers were instrumental in helping me provide my thoughts and opinions in a large classroom.
17. The anonymity of using the clickers helped me provide honest opinions and responses to clicker questions.
18. Audience response questions and discussions help me to develop a sense of collaboration.
19. Using a clicker in a large lecture format helped me communicate with the instructor.

**Cognitive Presence**

**Triggering event**

20. Course activities using the clickers piqued my curiosity.
21. The clicker questions inspired me to go back my textbook or other course materials to advance my learning.

**Integration**

22. Using clicker questions to reflect on course content helped me understand fundamental concepts in this class.

**User Experience with Clickers**

23. Comparing my response to the group’s response trends helped me to better understand my own perspectives and views.
24. Ideas and issues raised during discussion associated with clicker questions kept me thinking about these ideas and issues after lecture.
25. I would you like to see clickers used more widely as a learning tool in the teacher education program.
26. I would like to use clickers as a learning tool in my own classroom.
APPENDIX G CLASSROOM OBSERVATION PROTOCOL

Date:

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<tr>
<th>Question # / Type (i.e., multiple choice, text input, number input, true/false)</th>
<th>Instructional Intent (i.e., elicit opinions, assess understanding, gauge awareness, etc.)</th>
<th>Impact on Learners (i.e., follow up questions from audience, instructor elaboration, level of engagement, etc.)</th>
<th>Student Numbers</th>
<th>Number of Responses</th>
<th>Time To Respond (5 and 10 sec. interval)</th>
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**Type and Level of Student Interaction**
- a. With peers
- b. With professor

**Distribution & Collection of Clickers**

**Technical Questions / Challenges**

**Other Comments/Observations**
APPENDIX H RECRUITMENT SCRIPT

Script to be read in lecture:
At the end of a regularly scheduled lecture time, the professor and teaching assistants will exit the lecture theatre; Graduate Researcher (Aarthi Rajasekaran) will present the following verbal invitation to students to invite them to participate in the research.

“Thank you for using the Audience Response System (clickers) as part of the learning environment during the Fall 2011 Lectures. As mentioned at the start of this semester, Dr. Davis and I are interested in investigating the use of this audience response system to engage learners in large lecture style settings. As the instructor, Dr. Davis will not be involved in data collection, nor will he have access to the consent forms. Dr. Davis will not know who has given consent to participate in the research during or after the study.

I am a Master of Science student in Educational Technology. My supervisor is Dr. Michele Jacobsen. I am the primary investigator and will collect all of the data. I do not have any influence on student grades in this course. After the semester, when grades have been submitted, I will analyze the data collected from the research. No identifying information will be included with the data that will be analyzed.

As part of the research, I would like to conduct a survey using the ARS and also carry out some focus groups to gather information about user experience with the clickers, impacts of clicker use on your own learning, and on your opinions of ARS as a prospective teacher. I will conduct observations during lectures. As data is collected anonymously by the clickers, and using confidentiality during focus groups, and in aggregate during classroom observations, there will be no way to connect your identity with the data you produce.

You will always be informed if and when data is being collected during lecture (i.e., responses to lecture questions, formal survey questions, classroom observations). If you do not consent to your data from the clickers being used, you have the choice to refrain from using the clickers during that data collection event by electing to not enter responses. Students will be invited to contribute to a focus group outside of lecture time. For the research, you are invited to give consent to complete an anonymous online survey during lecture, and to participate in a focus group scheduled outside of lecture time. During classroom observations, you will not be interrupted or approached by me in any way. No identifying information is collected during classroom observations.

A consent form will be distributed shortly that invites you to take part in this study of the clicker initiative in the Faculty of Education. You do not have to take part in any part of the study. Even if you consent to participate, you can withdraw from the study at any time. Participation, non-participation or withdrawal will have no impact on your course grade.

Please take the time to read the consent form to learn exactly what you are being asked to do. If you do not wish to participate, then please leave the form blank. If you do agree to participate in the study, please indicate the nature of your consent, and sign the form. The only reason that I may contact you is to set up a time for a focus group. I will pick up the forms from the end of each row in the lecture theatre. A copy of this consent form is available on my website for your review."