Faculty and student experiences with clickers: a qualitative exploration of engaging students in higher-level thinking

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Faculty and student experiences with clickers: A qualitative exploration of engaging students in higher-level thinking

by

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A dissertation submitted to the graduate faculty in partial fulfillment of the requirements for the degree of

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ABSTRACT

Research has shown that personal response systems, or clickers, are motivating and engaging for students in higher education. This phenomenological, qualitative study focuses on the exploration of the experiences of faculty and students using personal response systems in the college classroom. An understanding of instructor and student experiences with clickers is provided. In addition, the manner in which this sample of instructors is implementing clickers in their classrooms is compared to Bloom’s taxonomy of cognitive domains. Instructors view the clicker as an evolving strategy that improves their teaching, increases student engagement and attendance, and makes classroom teaching more fun. Students, while showing some ambivalence in their feelings toward the use of clickers, cite benefits to classroom attendance, classroom participation, and academic learning provided by this technology being used in the classroom. Recommendations for instructor pedagogy relating to clickers and future research directions are provided.
CHAPTER 1. INTRODUCTION

Background

University classrooms are filled with students from varying cultures with varying life experiences. Students tend to come to the university setting with a desire to learn and a desire to explore the interests of their choice. Most of these students are in the period of their life from 18 to 25 years of age. This transition period from adolescence to adulthood is coined as emerging adulthood (Arnett, 2004). Experimentation and exploration are common characteristics of emerging adulthood (Santrock, 2006) and the majority of these students are in the post-formal operations stage of cognitive development, a stage in which they learn to handle their complex social worlds through the emergence of dialectical thinking processes (Santrock). Complex, frequently conflicting, and ambiguous demands of life produce a higher-level of reasoning capability in early adulthood. While the non-traditional student is the exception to this developmental level, it is within this dialectical (Riegel, 1976) and problem-finding (Arlin, 1975) stage of development that most university students present themselves to us as learners.

Higher education has been urged into reform with regard to undergraduate education. The undergraduate students whom we serve in higher education are in precisely the developmental period of growth that this study will focus on. The Boyer Commission on Educating Undergraduates in the Research University (1998) suggested that research universities are all but ignoring undergraduate education and specifically called for reform beginning in the freshman year of college. The commission stated, “The freshman experience needs to be an intellectually integrated one, so that the student will not learn to think of the academic program as a set of disparate and unconnected experiences” (p.19). More recently,
the National Survey of Student Engagement (NSSE) has been developed and implemented to identify aspects of the undergraduate experience that can be improved through changes in policies and practices both inside and outside the classroom (NSSE, 2007). The NSSE is used to empirically assess student participation in best practices (Chickering & Gamson, 1987) provided by institutions for student learning and personal development. According to the NSSE website, NSSE provides “an estimate of how undergraduates spend their time and what they gain from attending college.” About 1,200 colleges and universities have participated in NSSE, including the university where this study was conducted (NSSE, 2007). The NSSE results fall into five key clusters associated with higher-levels of student learning. These clusters are level of academic challenge, active and collaborative learning, student faculty interactions, enriching educational opportunities, and supportive campus environment.

New technologies are emerging that align with the goals of active and collaborative learning, student-faculty interactions, and enriching educational opportunities. This study looked at how instructors use a particular technological tool, personal response systems, to improve higher-level learning within these three specific clusters.

Small, hand-held gadgets called “clickers” that mimic those used by the audience on the popular television show “Who Wants to be a Millionaire” are appearing in classrooms across the United States and abroad. The technology generates individual student responses to questions posed by their instructor and seamlessly integrates with projection technology to project the student results for all students in the classroom to see. While literature on the technology can be dated to the 1960’s (Judson & Sawada, 2002), the effectiveness of this technology on enhancing learning, especially as it relates to the adolescent and emerging
adulthood student population, is still unfolding. The technology is becoming less expensive and more reliable and therefore it is also becoming more popular across college campuses. Personal response systems are one tool faculty are implementing as a means of potentially improving classroom learning environments. The clickers, cited as favorable by many students who use them (Trees & Jackson, 2007), show promising implications for tapping into the cognitive thinking of the emerging adult population. It is the intent of this researcher to explore what it is instructors who use clickers actually do that might be responsible for guiding this dialectical and problem solving phase of development in their students. In addition, it is my intent to explore instructor and student perceptions of their experiences in using clickers as a tool for enhancing active and collaborative learning, increasing student-faculty interactions, and providing enriching educational opportunities.

**Rationale**

With the onset of the use of personal response systems in higher education, formative, quantitative data indicate that students say clickers enhance their learning (Trees & Jackson, 2007), are fun to use (Weiman & Perkins, 2005), and increase their attention and motivation (Trees & Jackson). An overwhelming majority of 1500 students surveyed report that clickers helped them learn (Trees & Jackson). However, little qualitative research has been conducted, especially in regard to the instructor and student experience of using clickers and their perceptions as to why clickers are beneficial to the heightened learning of this sub-group of emerging adult learners. This study extends what is known about the use of clickers as a tool to actively engage students. Much of what is written about clicker technologies is focused on student outcomes such as academic learning gains, motivation, attendance, and retention. Less is known about the experiences of the instructor, the experiences of the
student, and the technology in relation to students’ cognitive development during the emerging adulthood developmental stage.

**Purpose of the Study**

The purpose of this study was to explore the experiences and perceptions of instructors and students who have used personal response systems in university classrooms. The goal was to provide a thick description (Geertz, 1973) of the experiences instructors and students have with personal response systems with regard to higher-level cognitive learning. In addition, this study explored instructors’ understanding of their university level students’ cognitive development as it relates to the use of clicker technologies. Finally, this study also sought to align instructors’ current practices with clicker technologies to the cognitive domains of Bloom’s taxonomy (Anderson & Krathwohl, 2001) and to clusters related to student learning as outlined by the NSSE.

**Research Questions**

Three main research questions guided this study:

1. In what ways do instructors describe their experience of incorporating personal response systems into their university level classes?
   a. What outcomes do they identify from the use of personal response systems?
   b. What advantages/disadvantages of personal response systems do they identify?

2. Are instructors who incorporate personal response systems aware of the cognitive developmental level of their students?
According to Bloom’s taxonomy, what level of higher order functioning is represented in the activities instructors use to implement personal response systems?

How do instructors decide which activities they will use when implementing clicker technologies?

Do instructors feel personal response systems are a tool to support the higher-level cognitive development of their students?

In what ways do students describe their experience of using personal response systems in their university level classes?

What outcomes do they identify from their use of personal response systems?

What advantages/disadvantages of personal response systems do they identify?

What clicker-related activities do students cite as most beneficial to their learning?

Do students believe personal response systems are a tool for enhancing higher-level cognitive thinking?

**Theoretical Framework**

The theoretical framework guiding this research is three-fold. First with regard to the cognitive processing in students, the theory on post-formal thought is at the forefront of this study. Piaget’s portrayal of the nature of cognitive growth as terminal in adolescence is being challenged by life-span researchers, suggesting instead that cognition continues to change beyond the teen years. It is now believed that formal reasoning is qualitatively changed by a more pragmatic and less rigid form of cognition referred to as post-formal reasoning.
(Commons, Sinnott, Richards, & Arnott, 2007). The current study examined whether instructors were using clickers in a way that enhanced this post-formal or higher-level cognitive thinking in their students. The primary theory to which this study was grounded is based on the belief that cognition continues to develop beyond adolescence, and that this advancing cognition may be enhanced by the use of clicker technologies in the stage of emerging adulthood.

Secondary to this cognitive theory is the constructivist theory. The constructivist theory, introduced by Bruner (1960), posits that learning is an active process whereby knowledge is constructed by individuals based on their current and past experiences. According to the constructivist line of thought, an instructor should encourage students to discover principles by themselves, should engage in active dialog with the students, and should organize curriculum in a spiral manner that builds upon previously learned knowledge (Bruner, 1966). Does the experience with clicker technologies foster this constructivist approach to higher-level thinking and knowledge in students? Do clicker technologies serve as a tool for instructors to embark on the suggested constructivist instructional strategies?

Finally, a qualitative, phenomenological approach brings in the post-positivist theory of research methodology. A post-positive approach (Lincoln & Guba, 2000) assumes there is not just one reality but that there is more than one meaning which can be assigned to phenomena. Post-positivists believe that human knowledge is not based on unchallengeable, rock-solid foundations but rather that reality is formed by providing meaning to the world around us (Lincoln & Guba). I conducted this study from a post-positivist stance.
Significance of the Study

This study provided a unique look at the use of clicker technologies in university classrooms. The perspectives and lived experiences of both instructors and students were captured through rich, thick descriptions (Geertz, 1973). In addition, the actual activities used by instructors were compared to Bloom’s taxonomy levels (Anderson & Krathwohl, 2001) to provide an entirely new component to our understanding of the impact of personal response systems. Because this study included students and instructors from a variety of disciplines, the results are of interest across various academic areas. Although the study was emergent based on its qualitative nature, the results may impact the manner in which instructors choose to implement personal response systems into their classroom methodologies.
CHAPTER 2. REVIEW OF LITERATURE

Emerging Adulthood

In western society, going to college is often viewed as a marker of adulthood. Several researchers (Kitchener & King, 1989; Perry, 1970) have noted that attending college can serve as a catalyst for intellectual and personal growth. Approximately 65% of high school graduates attend college (Smith, 2001). Recent thought in the field of human development argues that the college age years between 18 and 25 reflect a distinct stage of life (Kail & Cavanaugh, 2007). Students of this age are classified as between adolescence and adulthood. Emerging adulthood has been used to describe this transition period (Arnett, 2004). Another term applied to this stage of development is “thresholders” (Apter, 2001). The individual has not yet entered full adulthood according to Western societal standards and yet is no longer seen as an adolescent. Experimentation and exploration are common characteristics of this stage (Santrock, 2006) and the transition from high school to college can be a time of change and stress. The top-dog phenomenon can occur, whereby a student transfers from being in the oldest and most powerful or knowledgeable group of students in high school (senior class) to now being in the youngest, and often most unknowledgeable group of students in college (freshman class). The transition can also include the move to a more impersonal school setting (Santrock).

Cognitively, it is believed that young adults think in ways that are different from adolescents (King & Kitchener, 2004). Adolescents reason in mainly a deductive manner; they draw from the information given to them to come to a single solution (Kail & Cavanaugh, 2007). However, Kail and Cavanaugh state:
Post-formal thought is characterized by the recognition that truth (the correct answer) may vary from situation to situation, that solutions must be realistic and reasonable, that ambiguity and contradiction are the rule rather than the exception, and that emotion and subjective factors usually play a role in thinking. (p. 397)

This post-formal thought would more adequately describe the cognition that develops in emerging adulthood.

Research has recently shown that the brain is a very plastic organ, much more plastic than once thought, and capable of forming synaptic connections during the later stages of individual development. It is now believed that important structural changes are taking place in the brain well into adolescence and beyond (Weinberger, Elvevag, & Giedd, 2005). In June, 2005, The National Campaign to Prevent Teen Pregnancy released a report, The Adolescent Brain: A Work in Progress, that stated, “MRI studies show that the level of gray matter in the frontal lobes of the brain do not stabilize until well into the third decade of life” (Weinberger et al., p. 11). This is precisely the developmental period to which most university students are progressing as they sit before us in classroom environments.

Perry (1970) studied undergraduate college students and found that first-year 18-year-old college students tie their thinking tightly to logic. They also rely heavily on authority figures to confirm the rightness or wrongness of their thoughts. A characteristic of this thinking is to “view the world in terms of polarities—right/wrong, we/they, good/bad” (Santrock, 2006). However, Perry also found that changes take place as these 18 year-old students emerge into adulthood. Reflective, realistic thinking begins to overshadow the absolute, dualistic thinking of adolescence. As students age chronologically, their perceptions change and they begin to examine different sides of an issue while recognizing that they are their own source of authority (Kail & Cavanaugh, 2007). In addition they begin to realize
that they may have differing positions than their peers although their peers may be equally committed to the different view. This kind of thinking, whereby one is able to recognize varying views on a topic, take a stand, and yet acknowledge the differing views of others, emerges in the college years (Perry) and represents a level of cognitive thinking which is qualitatively different (King & Kitchener, 1994, 2004; Kitchener & King, 1989; Sinnott, 1998) than that described by Piaget in his formal operations stage.

Adults tend to use a process which may differ from the formal-operational thinking that Piaget proposed. Adult thinking will often involve the consideration of situational circumstances and constraints, the understanding that feelings matter in solutions, and the realization that reality sometimes plays a role in constraining solution generation (Kail & Cavanaugh, 2007). Kail and Cavanaugh offer a description of the thinking in adulthood as reflective judgment or “a way in which adults reason through dilemmas involving current affairs, religion, science, personal relationships, and the like” (p. 397). Within this reflective judgment model, an individual moves from the thinking that there is only one right answer to a more constructivist approach of thinking that involves holding very firm convictions on an issue, reached only after the consideration of several points of view. The person with reflective judgment also realizes that continual reevaluation must take place in light of new evidence or situations that affect the issue (Kail & Cavanaugh). In addition, adult thinking reflects a process of making a decision on pragmatic and emotional grounds and includes the integration of emotion with logic. Some researchers argue that adolescents are not capable of processing emotions with logic, while adult cognition allows for such integration. In a classic study, Blanchard-Fields (1986) showed clear developmental trends in reasoning level among adolescents, young adults, and middle adults. The thought processes of university students
must fall somewhere between the formal-operational stage of thinking in adolescence and the more ambiguous, situational thinking of middle to late adulthood.

**Student Engagement in Higher Education**

Given this developmental shift that occurs in college age students from concrete, dualistic thinking at age 18 to ambiguous, situational thinking in adulthood, the question must then follow: What, if anything, can we as instructors do to support this developmental shift? Much research has been conducted supporting the involvement of teachers in the active engagement of their students. Bloom’s taxonomy (Bloom, 1956) outlines cognitive, affective, and psychomotor domains of cognitive development and provides specific instructional strategies to support a hierarchy of cognitive functioning in student learning. The National Survey of Student Engagement (NSSE, 2007) describes five clusters which those in higher education should focus on to best support college student learning. Summarizing Perry’s (1970) work, Nelson (1999) discussed key methods by which teachers can assist students in emerging adulthood in the transition from dualistic thinking to higher-level, critical thinking and commitment. Nelson argued that critical thinking is acquired incrementally and also that the development of critical thinking can be challenging for students. He emphasized strategies such as review of content questions and material, fostering student voice in the classroom, and teaching in a manner in which the student and teacher are connected. The question of the current study is whether personal response system technologies provide a tool to instructors for fostering this higher-level of cognitive functioning by providing a method of review, student voice, and teacher-student connection. Are instructors using the clicker technologies in ways that align with Bloom’s higher order functioning and the five clusters of
best practice outlined by NSSE? Is the use of clickers one method for assisting students in the development of critical thinking?

**History of Personal Response Systems**

Personal response systems have been used on university campuses since the 1990’s especially in large lecture science courses (Judson & Sawada, 2002). The use of personal response systems in college classrooms grew out of the military’s use of filmed instruction material in the 1950’s (Sawada, 2002, Boardman, 1969; Froehlich, 1963). During this time, the U.S. government had begun producing instructional training films and using computers in education and training. Instructional technology emphasized the systematic development of teaching and learning procedures and programmed instruction (Treat, Wang, Chadha, & Dixon, 2006). Much of this focus was based in behavioral psychology (Ely, 2000) and the work of B.F. Skinner (1974) and Albert Bandura (1977) in stimulus response and operant conditioning helped guide this progression in programmed instruction (Treat et al., 2006).

During the early use of personal response systems, college instructors could use either tagged or anonymous systems to gather data from their students (Sawada, 2002). The tagged system recorded answers from every seat in the classroom, while the anonymous system provided a count of the responses for each available answer. The instructor could also choose to generate a print-out of the student responses on paper tape through computers and typewriters (Chu, 1972).

The Litton Student Response System, which was also introduced in the 1960’s, provided a vibrating responder dial at each student seat if the correct answer was given by the student (Judson & Sawada, 2002). This new system provided feedback to the instructor as to the number of correct responses but also provided feedback to the student as to the
correctness of his/her answer. College classrooms with this type of system allowed instructors to modify instruction based on student responses to content questions (Brown, 1972; Casanova, 1971; Garg, 1975) and thus, indirectly, for students to have a voice in the content selected for presentation. The focus of the personal response systems in the 1960’s and the 1970’s was on student privacy (Chu, 1972; Garg) and the tally counting of student responses, with little focus on generating student discussion. However, Garg alluded to the system as a potential source of fostering creative teaching and Littauer (1972) wrote of spontaneous discussion that emerged by giving students a print-out of the questions and answer choices that were to be asked in the class via personal response systems. Despite shortcomings on connecting the use of personal response systems to academic learning gains, student endorsement was none-the-less supported (Bapst, 1971; Brown; Casanova; Garg; Littauer). Positive attitudes toward the class, usefulness and acceptance of the system, and a feeling of increased understanding were all highly supported in early student survey data (Sawada, 2002).

**Personal Response Systems Today**

The clickers of today are somewhat similar to the clickers used in the 1960’s and 1970’s (Judson & Sawada, 2002). Although structural technological differences exist, most personal response systems are similar to each other in design and function, with three basic components including the software, a receiver, and the actual personal response system device (Kaleta & Joosten, 2007). The main purpose of the system is to create interactivity between the audience and the presenter. Slides are developed through the response system software which seamlessly integrates to presentation software. A slide is projected that displays a question, generally in a multiple choice format. The audience then participates by
selecting an answer on their individual wireless clicker keypad. A receiver attached to the presenter’s computer collects the results and the aggregate data are then displayed in graphic form for all to see. Data can be collected anonymously or traced to individual clicker keypads. Reports ranging from attendance to moment by moment detail of individual clicker keypads can be generated within the instructor’s personal response system software.

Wireless hardware has become the standard for audience response systems. Radio frequency and infrared frequency are the two primary technologies that exist to transmit the data from the keypad to the receiver. Browser-based software is also available and routes data via an internet protocol address. The wireless receiver can collect up to 1000 responses in seven seconds, allowing the presenter to collect immediate feedback from the audience or students.

Decision Tree Consulting (Gilbert, 2005) researched the audience response market over a four-year period and reported that over 7 million handsets had been sold from 2003-2006, including a 48% increase in the number of voting handsets sold from 2005 to 2006, with 3.2 million sold in 2006. The voting systems market is estimated to be valued at almost $400 million by 2009 and it is forecast that over 8.4 million handsets will be sold in 2009. Schools and universities, most in the United States, bought nearly a million clickers in 2005, almost double from the previous year, according to market research firm DTC Worldwide (Gilbert). DTC, which tracks the global market for educational technology, expects that 8 million clickers, worth $350 million, will be sold annually by 2008 (Gilbert). E-instruction, a developer of audience response systems, claims that more than 700 universities are using its devices (Gilbert). Turning Technologies, another audience response system distributor, says more than 250 universities have purchased their version. Partnerships between publishers and
clicker distributors to bundle technologies and textbooks are emerging. In addition, companies are beginning to utilize cellular text messaging networks and plug-ins to take an all-software approach to audience response systems, eliminating the need for specialized hardware.
CHAPTER 3. METHODOLOGY

Qualitative research seeks to understand phenomena in context-specific settings through naturalistic approaches and has been broadly defined as “any kind of research that produces findings not arrived at by means of statistical procedures or other means of quantification” (Strauss & Corbin, 1990, p. 17). Qualitative researchers do not generally attempt to change the phenomena, but rather seek to explore and explain the phenomena in question. Not only numbers, but words, impressions, gestures, images, and tones can represent data and reality. Qualitative research provides depth that aligns with the broad understanding gained in quantitative studies. Qualitative methodology was employed in this study to provide a thick, rich description (Geertz, 1973) and understanding of the experiences of faculty and students using personal response systems.

Research Site

Prior to beginning the study, permission to conduct the study was requested and obtained from the university’s Institutional Review Board (see Appendix A). This study was conducted at a research intensive, land grant university (hereafter referred to as the University) in the Midwest with total undergraduate, professional, and graduate enrollment of 25,462 students. According to the Center for Excellence in Learning and Teaching at the University, as of fall 2007 approximately 3,000 students were participating in courses where clicker technologies were being implemented. According to the campus bookstore list (see Appendix B) of instructors requesting that students purchase clickers for their courses, over 6000 students were enrolled in courses where clickers were being used during spring 2008 semester.
The Turning Point technologies audience response system was recently adopted as the recommended personal response system at the University. Turning Point personal response system technology seamlessly integrates with Power Point and WebCT Gold connecting the personal response systems via student ID and a receiver inserted into the instructor’s laptop. Student response data compiled during lecture can be uploaded into the WebCT grade book for instructor manipulation and student viewing. The current research was conducted in classrooms with students and instructors who are currently using clicker technologies based on the list received from the campus bookstore.

Participants

I interviewed eight faculty members (hereafter labeled as “instructors”) of various academic rank, including tenured, tenure-track, or non-tenure eligible faculty, who were currently using clicker technologies in their teaching. I selected instructors who represented a broad range of (a) disciplines, (b) experience with personal response systems, and (c) academic rank. Patton (1990) described the usefulness of purposive sampling saying, “The logic and power of purposeful sampling lie in selecting information rich cases for study in depth” (p. 230). He also described maximum variation and its purpose of attempting to capture and describe overarching themes within a heterogeneous small sample. Using purposeful sampling with the incorporation of maximum variation provided for variety in my sample. From the list obtained at the campus bookstore, my major professor and I chose eight instructors who represented a variety of disciplines, experience with personal response systems, and academic ranks.

After choosing the instructors, an email was sent to each of the instructors (see Appendix C) outlining the study details and requesting their participation in the study. Of the
first eight instructors emailed, all but three agreed to participate in the study. One indicated that she was not currently teaching a class using clickers but noted a colleague who was teaching that course with clickers. When I contacted the colleague s/he agreed to participate. Another instructor did not respond to my email request for participation in the study or telephone request until after the study was completed, and thus another instructor from the list with a similar academic rank, discipline, and clicker experience was contacted and did agree to participate. One instructor who agreed to participate recommended also including a colleague with several years of experience with clickers. Through this snowball effect, that instructor was contacted and agreed to participate. In qualitative research, it has been said that “there are no rules for sample size” (Patton, 2002, p. 244). The sample size of instructors for this study was based on gathering a representation of a variety of instructors currently using clicker technologies. Patton recognized that “minimal samples” are adequate based on “reasonable coverage of the phenomenon given the purpose of the study” (p. 246). In addition, I considered the recommendations of Lincoln and Guba (1985) to use a sample selection whereby the point of redundancy or the lack of new information is obtained. As a qualitative researcher I am also “obligated to discuss how the sample size affects the findings” of the study (Patton, p. 246).

Once the eight instructors were selected and agreed to participate in the study, I attempted to recruit 3-4 students from each instructor’s class in which s/he is using the clicker technologies. The students were recruited via a class announcement on WebCT and an in-class announcement by the instructor or the researcher (see Appendix D). Students were asked to participate in a group interview relating to their experience with the use of
personal response systems in that particular classroom. Rather than purposeful sampling, students self-selected themselves into the study by responding to the recruitment solicitation.

Procedure

Four sources of data collection were used in this study:

1. Observations of classroom use of clicker technologies

2. Semi-structured individual interviews of instructors

3. Review of clicker technology slides used by instructors

4. Semi-structured interviews of students

An email request was sent to those instructors chosen from the list of instructors currently using clicker technologies. Upon agreeing to participate in the study, the instructor participants signed an informed consent document and were asked to supply a class period in which I could observe them using the clicker technologies. This was purely a descriptive and exploratory observation during which field notes were taken; I served as a non-participatory observer in the class. Following the classroom observation, a mutually agreed upon date was set to conduct the semi-structured faculty interview, which was audio-taped and transcribed (see Appendix E for instructor interview protocol). These interviews varied from 21 to 45 minutes, for an average of 32 minutes. To ensure confidentiality all instructor participants were provided a pseudonym to be used in narrative and document artifact analysis.

In addition, I asked each instructor to provide three sets of classroom slides showing their range of use of clicker technologies. The slides were considered document artifacts and analyzed for levels of cognitive process according to the revised Bloom’s taxonomy (Anderson & Krathwohl, 2001) (see Appendix F).
Once instructors agreed to participate, I asked them to post an announcement on their WebCT course page to recruit student volunteers for participation. In addition, the instructors were asked to make an in-class announcement to the students, alerting them of a posting on their WebCT course page concerning volunteering for participation. Interested students were directed to contact the researcher via email for participation and assured that their participation not only would be voluntary, but would be anonymous to all parties except the researcher (including the classroom instructor). Upon being contacted by the students, I worked with them to establish the date/time for the student interview. When students arrived at the interview, they were asked to sign an informed consent document. The interview was audio-taped and transcribed using the student interview question protocol (see Appendix G). Students were provided a boxed lunch upon arrival at the interview which they ate following the interview. Student interviews consisted of either a group of 2-3 students or an individual student. Interviews lasted between 16 and 45 minutes for an average of 38 minutes.

**Data Analysis**

The phenomenological approach, based on the belief that people construe meaning of the world in different and unique ways, was used in this study. The basis of phenomenology is an interpretive paradigm that investigates the qualitatively different ways in which people experience or think about something (Marton, 1986). Phenomenology, initially described by Edmund Husserl (1931), begins with an exploration of phenomena, in this case the phenomena of using or experiencing clicker technologies in a college classroom. Following a traditional qualitative analysis approach, data collection and analysis occurred concurrently in this study. As Merriam (2002) pointed out, “Simultaneous data collection and analysis
allows the researcher to make adjustments along the way” (p. 14). Identifying recurring themes and patterns was the primary focus of my data analysis.

The contextual experiences of instructors and students are the units of analysis for this study. In addition, I reviewed the clicker slides used by the instructors for cross-comparative analysis. This analysis of interview data from instructors and students, document artifacts, and observational data allows for triangulation by data source and method, thereby increasing the credibility and dependability of the study. I transcribed and reviewed the interview narratives for emerging themes relating to the use of clicker technologies to engage students in higher-level cognitive thinking. I also reviewed the clicker technology slides and coded their contents according to a taxonomy table looking for emerging themes and patterns. A quantitative summary of the slide analysis was also formulated. Finally, the observation field notes were compared to the student and instructor interview narratives and documents supplied by the instructors. Careful attention was paid to the experience level of the teacher, experience level of use of clicker technologies, and the disciplines represented by the participants.

Creswell (1998) provided an outline of analysis for a phenomenological study (p. 148). I followed his design which includes a focus on data management, reading and writing memos, description, classification, interpretation, and representation or visualization. Data management included recording audio tapes and taking field notes. Reading through texts, making notes in the margin, and the formation of initial codes followed. A constant-comparative method of analysis as described by Glaser and Strauss (1967) was employed. Each statement had equal worth and statements were grouped into meaningful units or categories. Finally, a rich, thick description (Geertz, 1973) of the data was formulated, with
the overall goal to develop a description of what students and instructors experience and perceive with regard to the use of clicker technologies for fostering higher-level cognitive thinking. The use of tables, graphs, and visual depictions as well as textual narrative was used to provide readers with an accurate description of the informants’ perceptions and experiences.

Because the qualitative paradigm is founded on the notion of emergence and flexibility in the study process, I kept these concepts at the forefront of my thought during this study. I was open to transverse down new pathways that emerged from the participants, the process, or the analysis of the data.

**Trustworthiness and Rigor**

To ensure rigor and credibility of this study, several verification methods were employed. Creswell (1998) provided eight procedures for ensuring the trustworthiness of a study: triangulation, prolonged engagement, negative case analysis, clarifying researcher bias, member checks, peer review, thick descriptions, and external audits. Creswell recommended that “researchers engage in at least two of these in any given study” (p. 203). In this study, I used the following strategies as outlined by Creswell: triangulation, prolonged engagement, peer review or peer debriefing, member checks, thick descriptions, and clarification of researcher bias.

*Triangulation* involves looking at something from more than one perspective or angle and can be employed either by data source (person, places, time), by method (observation, interviews, artifacts), by researcher, or by theory (Denzin, 1978, 1989a). It was my intent to look at the experiences of students and instructors with clicker technologies from both the perspective of the student and the instructor (triangulation by source). I also compared the
instructor interview narratives to the student interview narratives and to the classroom observations and document artifacts (triangulation by method). Employing triangulation enhances the credibility (internal validity) of the findings (Lincoln & Guba, 1985; Merriam, 2002).

According to Creswell (1998) prolonged engagement involves building trust with the informants in the study, understanding their culture, and conducting a check for distortions in the study. Having spent time as a university teacher using clicker technologies, I have a prolonged engagement in the subject of the study. I am also superficially familiar with several of the instructors currently using clicker technologies and with the methods employed in higher education. I understand the culture of university classrooms, the culture of clicker technologies, and the culture of teaching and learning on the university campus. It was my intent to dive deeper into the field of clicker technologies and how they affect students’ higher-level cognitive learning in classrooms. Prolonged engagement through observations, student and instructor interviews, artifact analysis, and personal experiences with clicker technologies also enhanced the rigor and trustworthiness of this study.

The primary objective of peer review or peer debriefing was to provide an external audit of the findings of this study (Lincoln & Guba, 1985). Peer review mirrors the idea of inter-rater reliability in studies of the quantitative nature (Creswell, 1998). I discussed my research with another graduate student in my graduate program who is not familiar with clicker technologies. Having her read my transcripts, judge my categories, and review my findings provided an external audit to the study. The process and findings that emerged from the study were affirmed through peer debriefing with the graduate student and members of
my dissertation committee, but they also added new insight and perspective with regard to the eventual detail and nuance that I added as I wrote the final product.

*Member checks* are the process of asking for feedback from the participants in a study (Guba, 1981; Guba & Lincoln, 1981). Instructors and students were provided written transcription via email correspondence of their interviews so they could verify the accuracy of the transcription. Member checks are critical in establishing validity of the research findings (Lincoln & Guba, 1985), to support my interpretation of the informants’ perspectives and experiences. Each of the instructor participants and the student participants agreed to the credibility of the transcriptions and supported the credibility of my findings.

Detailed descriptions, including direct quotes of the students and instructors, are used to gather rich, *thick descriptions* (Geertz, 1973). These thick descriptions guide reader understanding of the data and transferability of the results of the study. By audio-taping, transcribing, and taking field notes, thick descriptions were made possible. I provided as detailed an explanation of the data as possible to allow for a deep understanding of the lived experiences of the instructors and students relative to the research topic.

Finally, my biases as a researcher were clarified throughout the process. Denzin (1989b) saw the role of *researcher bias* as the beginning and ending of qualitative research methodology: "Interpretive research begins and ends with the biography and self of the researcher" (p. 12). My own personal use of clicker technologies and general acceptance of the technology as an effective tool for teaching were written as a formal statement in my research. In this way, the deliberate educational and professional choices that I have made throughout my career were noted as an influence in my selection of a research topic (Mehra, 2001).
In addition, any biases reflected from my demographic status or teaching experience were described and presented for readers of the research. Who I am plays a central role in what I want to study and was outlined for readers.

Role of the Researcher

In qualitative inquiry, the researcher is one of the primary instruments of learning in the study (Lincoln & Guba, 1985). The reasoning process used in qualitative research involves putting pieces of a puzzle together to form a whole picture. Meaning is produced as one embarks on the qualitative research paradigm process. However, because each individual may hold a different perception, many different meanings are possible and therefore the role of the researcher becomes an important component in qualitative inquiry.

As the primary researcher in this study, my demographic background, as well as my experiences in teaching, learning, and clicker technologies, impacted the design, analysis, and results of this study. I am a 37 year-old Caucasian female who has taught in varying capacities for the past 12 years. I hold a B.A. in finance and a M.Ed. in special education; I am currently a Ph.D. candidate in Human Development and Family Studies. Teaching and learning have comprised a great part of my childhood and adult life. I have taught preschool-age children through adult education classes and most recently have spent time teaching a large introductory lecture course for my graduate department. For ten years, I taught continuing education courses for teachers from various areas in the United States in traditional and online learning environments. My work as a teaching assistant in human development and family studies and for the Center for Excellence in Learning and Teaching introduced me to the world of clicker technologies. I spent two years as a graduate teaching
assistant where clicker technologies were implemented in a large introductory lecture course. I then implemented the same clicker technologies when I taught the same large course and found it effective. Since that time, I have begun a quantitative study of over 400 university students about their perceptions of and experiences with clicker technologies and have presented to local faculty and at national conferences on the use of clicker technologies to actively engage students. Through my own experiences and research, I have had a positive experience with using clicker technologies in higher education. My background and experience in both teaching and clicker technologies have shaped and affected the design, process, and results of this study.
CHAPTER 4. RESULTS AND DISCUSSION

I have divided the results on this study into four separate, but overlapping categories:

1. Results of the observation of instructors
2. Results of the interviews with instructors
3. Results of the analysis of slides provided by instructors
4. Results of interviews with students

I will first describe the instructor sample and then follow up with the results of the observations, interviews, and document artifacts provided by the instructors. Following these results, I will describe the student sample and present the results of the interviews conducted with the students.

**Description of the Instructor Sample**

My final sample of eight instructors included one university professor, one professor, four associate professors, one assistant professor, and one adjunct assistant professor. The gender distribution was split with four females and four males. University and college teaching experience ranged from 12 to 47 years and experience using clicker technologies ranged from less than two months to over six years. The six academic disciplines represented were chemistry, geology, horticulture, human development and family studies, natural resource ecology management, and veterinary medicine. There were two instructors with less than two months of clicker experience and both indicated at the time of their interview that they had used clickers in their teaching less than six times. The demographic information of the instructor sample is outlined in Table 1 below.
Table 1: Description of Instructor Sample

<table>
<thead>
<tr>
<th>Pseudonym</th>
<th>Gender</th>
<th>Academic Rank</th>
<th>Teaching Experience</th>
<th>Clicker Experience</th>
<th>Class Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bob</td>
<td>Male</td>
<td>University Professor</td>
<td>47 years</td>
<td>Less than 2 months</td>
<td>100+ students</td>
</tr>
<tr>
<td>Sam</td>
<td>Male</td>
<td>Professor</td>
<td>35 years</td>
<td>1 year</td>
<td>26-50 students</td>
</tr>
<tr>
<td>Jocelyn</td>
<td>Female</td>
<td>Associate Professor</td>
<td>28 years</td>
<td>Less than 2 months</td>
<td>26-50 students</td>
</tr>
<tr>
<td>Mary</td>
<td>Female</td>
<td>Associate Professor</td>
<td>12 years</td>
<td>1 year</td>
<td>26-50 students</td>
</tr>
<tr>
<td>Dennis</td>
<td>Male</td>
<td>Associate Professor</td>
<td>31 years</td>
<td>6 years</td>
<td>100+ students</td>
</tr>
<tr>
<td>Tamara</td>
<td>Female</td>
<td>Associate Professor</td>
<td>28 years</td>
<td>4 years</td>
<td>100+ students</td>
</tr>
<tr>
<td>David</td>
<td>Male</td>
<td>Adjunct Assistant</td>
<td>14 years</td>
<td>1 year</td>
<td>100+ students</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Professor</td>
<td></td>
<td></td>
<td>26-50 students</td>
</tr>
<tr>
<td>Elizabeth</td>
<td>Female</td>
<td>Assistant Professor</td>
<td>12 years</td>
<td>1.5 years</td>
<td>26-50 students</td>
</tr>
</tbody>
</table>

Observation Results

As a part of this study I conducted an observation of each of the eight instructor participants to view how they were using clickers in the classroom. I served as a non-participatory observer, generally sat in the rear or middle of the classroom, and transcribed field notes as to the happenings in the classroom. The observation was conducted prior to my interview of the instructor or students in seven of eight cases. This was done in a purposeful manner so as not to alert the instructors to the goals of the study and so the instructor could be observed prior to our discussion about the use of clickers. Due to a scheduling conflict one interview was completed prior to the instructor observation. The observation was structured in such a manner so that the instructor did not change his/her normal teaching and use of clickers based on participation in the study.

From the observation field notes, I conducted a cross-comparative analysis, looking for emerging themes with regard to the observations of instructors. Several themes emerged from the observation field notes.
Theme 1: Full classroom discussion is initiated following clicker questions.

The first theme that emerged was the use of clicker questions to initiate discussion of content in the classroom. Each and every instructor followed the majority of the clicker questions with a verbal initiation for discussion.

“For those who said no, not to amend, why did you say so?”
~Mary, a horticulture instructor, after posing a clicker question and seeing a split of yes/no responses relating to amending clay soil prior to planting a tree.

“So, what should we do in the event of an emergency in this classroom?”
~Jocelyn, a human development and family studies instructor after clicker polling shows 96% of her students disagree or strongly disagree with the statement that they know what to do in an emergency in the classroom.

“Ok, let’s start at the opposite end. Who put 20? Why did you put that?”
~Sam, a forestry instructor after seeing 23% of his students listed 20 as the correct answer to a question about the maturity of trees. (20 was the incorrect answer to the question).

“Anyone who wants to defend their answer?”
~Sam, a forestry instructor to students after clicker question polling shows 62%-24%-14% split on answer selection to the question posed.

Instructors also often asked verbal questions of students and received very limited or no response from the students. However following the clicker questions and showing the results, the discussions seemed to be effortless as seen in the transcript from the following observation field notes:

2:15 p.m. Instructor asks, “Cohort- who wants to define that? This was covered in your readings.” No answer from students. Silence. Instructor gives answer to students and explains with an example.

2:18 p.m. Clicker question #1 “We are doing this to clear up misconceptions today.”
#1. How old are mature trees that are cut each cycle?
   a. 20
   b. At least 60
   c. 90
   d. Over 100

Responses indicate that all 30 of the students present have entered a response. 70% have indicated the correct answer as their choice. Instructor follows up by saying, “Ok, let’s start at the opposite end— who put 20? Why did you put it?” Immediately hands shoot up and two students respond with answers and examples from their life.

The instructor continues the discussion and eliminates the misperceptions of students which he says are common mistakes in this content.

The instructor continues down the list of possible responses, “Ok— how do we come up with at least 60?” Again, a student provides a verbal response and the instructor continues to teach on this topic.

Finally he says, “Anyone who put 90— want to explain that?” Again a student gives a response with an example from his life and the instructor clarifies his misperception.

The discussion and student-teacher interaction are completely different when posed as clicker questions compared to the verbal posing of a question to students. Following the analysis of the observation field notes, this student-instructor interaction after clicker questions was evident in seven of the eight observations conducted. The instructor where I did not view the interaction and discussion following clicker questions noted that he was having an off-day the day I observed. He noted that he normally does initiate discussion following clicker questions, but timing and clerical issues prevented him from doing that on the day I observed.
Theme 2: Peer discussion is encouraged.

The observations also revealed that almost every instructor encouraged students to hold a peer discussion relating to the majority of clicker questions posed. This peer discussion was fostered either prior to answering the clicker question or after students answer the clicker question but prior to showing the polling results. It was exciting to witness the “explosion” of student discussion given this opportunity. As an observer, it seemed the students were on target with their discussions and these discussions took only a very limited time to complete in the overall time in the classroom. For example, in a one classroom, the instructor posed a clicker question at 2:20 p.m. He then asked the students to discuss the question and to enter a response. He showed the polling results at 2:21 p.m. and then fostered another discussion with students which lasted for another two minutes.

Theme 3: A variety of technological tools are used in the classroom.

Finally a third theme that emerged from the observations of the instructors was that the instructors using the clickers also use a variety of other technological tools in the classroom. PowerPoint, which is a necessity to the Turning Point technology, was being used by every instructor. Instructors also used the Elmo, graphics, WebCT, the World Wide Web, video clips, and CD software in their courses. While instructors sometimes fumbled with the technology, a variety of technological tools was evident none-the-less in each classroom. Of the eight instructors I observed, I witnessed all eight using Power Point and WebCt. Four of the eight instructors used Elmo, graphics or the World Wide Web. One instructor used a video clip during the observation and another instructor used a CD software program during the observation.
Theme 4: A majority of students had their clickers and were participating

As the observer I attempted to conduct a head count of the number of students present in the classrooms. I compared this manual count to the number of responses registering in the Turning Point technology. In every observation instance it appeared most of the students present were participating in the clicker questioning by clicking a response. Technical issues occurred during only one of the observations. The instructor was a new clicker user. The students were patient and even offered assistance and humor as the instructor tried to resolve the issue.

I did not observe any abuse of clickers in the form of students having more than one clicker, although students do report this is occurring on campus. I also noticed a majority of students did participate in focused peer discussion when prompted to do so by their instructor. Some classroom incivility in the form of cell phone text messaging, laptop use, and peer conversation was observed but when prompted by a clicker question the students seemed to become focused and this incivility seemed to subside at least for a time when clickers were in use.

As I will describe later, the themes from the observations substantiate the interview results and also provide a measure of credibility in conjunction with the interviews of the instructors. One of the main purposes of the observations was to triangulate the source of information. Based on the themes that emerged and their overlap with the themes that emerged in the instructor and student interviews, I feel this triangulation by source was achieved.
Instructor Interview Results

Semi-structured interviews based on the interview question protocol were conducted with each of the eight instructors. Interviews lasted between 21 and 45 minutes, were audio-taped and transcribed. Transcriptions of the interview were provided to each instructor participant via email as a member check for validity of the transcription. All eight participants confirmed the validity of their interview. The purpose of the interview and question protocol was to explore the instructors’ methods of using clickers in the classroom and to investigate their experiences with using clickers in the classroom. Several themes emerged from the eight instructor interviews.

1. There are a variety of uses of clicker technologies per instructor and across the instructor sample.

2. There is variety in the incorporation of points associated with clicker participation by students.

3. Instructors view clicker technologies as a tool that enhances classroom learning and teaching

4. Instructors believe clicker technologies have a positive impact on student engagement and attendance.

5. Instructors feel the benefits to using clicker technologies outweigh the limitations.

Theme 1: There are a variety of uses of clicker technologies per instructor and across the instructor sample

Seven of the eight instructors interviewed were using clicker technologies in a variety of ways within their classrooms. I was able to identify 18 varied uses of the clickers implemented by these instructors as follows.

1. Student attendance check

2. Insertion of graphics with a conceptual, practical application problem
3. Preview question prior to the viewing of a video clip

4. Post question after the viewing of a video clip

5. Course content comprehension questions where peers collaborate before answering, but answer individually with or without points assigned

6. Course content comprehension questions where peers collaborate before answering, but answer as a team or group with one clicker with or without points assigned

7. Questions relating to sensitive issues

8. Questions relating to high interest or current event topics

9. Questions for formative assessment of the class relating to classroom procedures

10. Problem solving questions

11. Case study questions

12. Debatable, opinion-based questions from a post-modern perspective without a single correct answer

13. Conditional branching of questions whereby new content or questions are generated based on polling results

14. Questions for instructor data collection & IRB approved research purposes

15. Questions included in upcoming exams

16. General knowledge questions

17. Individual questions relating to course content that is about to be covered with or without points

18. Individual questions as a review of course content previously covered with or without points

All eight of the instructors noted daily use of the technology and noted the importance of making adequate and relevant use to substantiate the monetary purchases of the clickers by
the students. This variety of use was substantiated through the slide analysis, instructor interview, and student interview results.

**Theme 2: There is variety in the incorporation of points associated with clicker participation by students.**

There appeared to be variety in the percentage of points assigned and manner in which points were assigned to students for clicker participation. There were differences in how points were assigned with the maximum percentage of the final grade accounted for by clicker questions as ten percent and the minimum as less than one percent. The instructor with the highest representation of clicker points noted that her students actually participate in a democratic negotiation for the level of points assigned by clickers, so this was based on student choice. All of the instructors included clicker responses into the grading of their course; however the points associated for the clicker responses were generally very minimal in relation to the maximum points available for the course. Every instructor interviewed also provided a description of how they are flexible with the points assigned for clicker participation. In other words, instructors either dropped a percentage of the points, allowed for in class hand writing of the clicker questions, or simply were flexible in the scoring of the clicker questions to account for technical glitches or forgotten clickers by their students. Several instructors actually have a stated policy written into their syllabus, while other instructors have a much less structured, evolving, and flexible policy. Examples of how instructors included clicker points into their syllabus include the inclusion under a professionalism category, inclusion under an attendance/participation category, or inclusion in the in-class activities or quizzes categories of the syllabus. Jocelyn, a human development
and family studies instructor, described a technology statement that she includes in her syllabus.

“I have learned in my 28 years of teaching. I now put a technology requirement piece on the syllabus. And because it seems to me, even with emails, I want to make sure students understand that there is a responsibility that comes with the class and that this is a required piece of the class. So, yeah there is a technology statement and it reads, ‘Turning point clickers: students will be required to purchase and bring a TP clicker to class each session.’ And I have a section on WebCT and email too. Any more explicit than that, I would say no, because I knew I wanted to try it but wasn’t sure how it would work. I am actually going to revise the syllabus, and I will think about that [adding a stated points policy] then.”

The instructors did however note the importance that even the minimal points played in student engagement and motivation. Sam, a natural resource ecology management instructor, noted

“They are very eager to get the points, so they seem to show up to get the points.”

**Theme 3: Instructors view clicker technologies as a tool that enhances classroom learning and teaching**

A sub-theme within this idea of clicker technologies as a tool to teaching was how clicker technologies is a tool to pace and modify their current teaching practice. Instructors mentioned that they have become much more thoughtful in the design of their lecture presentations. Instructors mentioned how the clicker slides provide for better pacing of the lecture presentation and allow for a reminder of what it is they want to discuss that day in lecture. Tamara, a veterinary medicine instructor, said,

“They are nice memory trippers for me because I kind of get everything all set up ahead of time and then I don’t have to remember everything to do because it sort of prompts me, ‘Oh yea, I wanted to ask about that.”
David, a geology instructor, added,

“It has helped me. I like Power Point but it gets boring after awhile and so it [Turning Point] definitely provides a diversion from just clicking through slides and to actually stop and ask the students and then to discuss that.”

Another sub-theme that emerged is that Turning Point technologies has provided a tool for the instructor to really think about what questions they want to ask their students during the course of their lectures. Mary, a horticulture instructor, said,

“This has forced me to ask them questions to see what they are thinking.”

David, natural resource ecology management instructor, added,

“You know it has changed my teaching. Well I needed to invest time in learning how to do this. Thinking of the question is challenging and in a way helpful as a teacher to think of what I am trying to get across; setting up the goals for the major concepts for today’s 50 minutes—that’s a help to me, and it’s made me perhaps a little more thoughtful about lecture.”

Another sub-theme is the impact the clicker technology has had on student engagement in the classroom and therefore impacted their teaching of the content. Instructors noted active engagement with the content, a decrease in student incivility, and in some cases, an increase in student attendance. When asked if she felt clickers affected participation in her class, Jocelyn, an instructor in human development and family studies, responded with,

“Oh yes! It appears the students are more engaged with the activities. I have done this activity a number of times [without clickers] and the debriefing part has always been really difficult because we always had to write on the board and by the time you went through say the fourth person to write their answers, they were uncomfortable. So it [clickers] has kept down some of the angst of the students in being wrong.”

David, in natural resource ecology management, said,
“Students seem more engaged. To my mind as I lectured, they seemed more engaged and I am even asking more questions, rhetorical questions, you know in addition to the clicker questions.”

Mary, in horticulture, also noted the impact on student engagement

“Yes, it has improved participation. One of the things I noticed this year is in the past I didn’t necessarily always get questions during lecture. But this year there is more diversity, not always that same one or two students asking. It is different students asking questions, either during or after class.”

Instructors felt the clicker questions generate discussion because students can see immediate feedback as to the responses of the entire class. Students know immediately that they are not the only person who got the answer correct or who feels a certain way about a topic. Instructors also described using the responses as a means for generating further discussion and for modifying their presentation of the content on the spot. Dennis, a geology instructor said,

“I just like the fact you can get feedback right now, right away and use the teaching moment.”

When asked about the benefits of clickers, this idea of immediate feedback for both the student and instructor continued to emerge. Dennis continued,

“Just knowing where students are, what they are thinking, how I can be most useful as an instructor. To be able to target specific areas or say, ‘Oh good, you know this already, let’s fly through this section.’”

Jocelyn, an instructor in human development and family studies, also spoke of the immediate feedback for students,

“In the class we have always done some in-class exercises and they have written out their answers on a sheet and handed it in. We have changed the exercises some so that we can get them that immediate feedback with the clickers and to me that is a huge advantage right away. To let them see what they did compared to everyone else and to let them know right away and to discuss the reasons for the differences. I keep liking the feedback I get. It has helped me to
understand a lot better, where they may be getting a wrong answer, because if they are giving a wrong answer, I am thinking why are they saying that? And now, in the present [with clickers], it is a lot easier to make connections as to why it is not going down the right path and why there are wrong answers."

Traversing along this path of student-instructor connections and immediate feedback, another sub-theme was how clickers have transformed instructors’ assumptions of the knowledge their students bring to the classroom and how clickers can be used to formally assess student knowledge prior to exams. Dennis, a geology instructor, stated,

“In the old days, when all we had was chalk on the board and really about the only evaluation you had was the exam, you had some slides and a chalkboard and then you get the exams and you realize that for a very high percentage of the class it didn’t sink in. No clue. You wouldn’t know that until the exams and you would get very frustrated. Now, I think, just as I said, it helps them keep up and it helps me keep up. It is the fact that we are closer to being on the same page before the assessment.”

Mary, a horticulture instructor, explained how she uncovered a misconception in her students’ thinking because of the clickers:

“One of the biggest discussions we had last semester was on organic gardening and the amount of nutrients in the vegetables. Does gardening organically change the nutritive value of a fruit or vegetable? That was one they all got wrong [on the clicker question] and that was a huge myth right there and we had a huge discussion about it.”

When asked how the clicker technologies affected this discussion, Mary replied,

“Well, I’m not sure that if I didn’t have clickers I would not have known to even go there, would not have known to even ask, may be would not have even had the discussion. Someone had asked a question, then I put it in there [clickers] thinking that everyone will get this one correct, but they almost all got it wrong! Clickers allowed me to see that!”
**Theme 4: Instructors believe clicker technologies have a positive impact on student engagement and attendance**

Student engagement and increased attendance were commonly mentioned by the instructors interviewed as a benefit of the clicker technologies. And while none of the instructors interviewed used the clicker technologies as a large portion of their course points or for solely tracking attendance, they saw the benefit that associating points to the questions has on student engagement, attendance, and possibly even academic performance. Sam, an instructor in natural resource ecology management with 35 years of teaching experience, said,

“I am pretty sure it has increased participation. But the big thing we noticed right away is that the test scores went up. We draw our questions from a test bank, so we expect sort of similar performance across the years and last semester was the best semester we’ve had for a long, long time in scores for the class. I think the best part is that we think it [clickers] has cleared up questions prior to the exam.”

David, a natural resource ecology management instructor, who is in his first year of clicker use said:

“Last semester was the first semester we used clickers and we noticed we had less of a problem with people sitting in the back of the room reading their newspaper. Students seemed more engaged. This is the central promise of clickers: the central thing, the central hope is that the students will become more engaged with the ideas in class, and it can be, it might even be for the wrong reasons. For the little button to push, the gizmo on the screen, just that might bring them in. I am not sure on attendance but they are eager to get points, so they seem to show up to get the points.”

Interviews with students later quantified this assumption of their instructors. Students reported that clickers do bring them to class and also formulated the connection between class attendance and learning.
Theme 5: The benefits of using clicker technologies outweigh the limitations

Instructors noted technical issues and limitations they encounter with the clicker technology, but almost all cited personal error as the main reason for technical glitches they encounter. Instructors also cited frustration on the part of students and disappointment when technical errors occur during the classroom session. Mary, a horticulture instructor explained,

“When the technology doesn’t work, when I have something wrong on my computer, and I have everything planned and they have to just raise their hands, there is not as good a response from the students and they will wait and see what everyone else says before raising their own hand. It just is not as effective as the clickers.”

Bob, a first year clicker user with 47 years of teaching experience in chemistry, added,

“I had one day where I just couldn’t get the technology to work. The students were moaning and asking if I could include the questions as clicker questions next session.”

Several instructors also noted a learning curve that coincides with implementing the technology. When asked if she would recommend the use of clickers to other instructors, Tamara, a veterinary medicine instructor with four years of clicker use, replied,

“Sure. I would. I think it takes some planning and a little bit of a learning curve, although not a steep one. It takes some preparation time, and I have helped a few other people get started so far and they have been really happy with them.”

David, an adjunct assistant professor with one year of clicker use, described the learning curve,

“I was very suspicious because I thought there would be a big learning curve, and it has been, there have been quite a few hours. I have no idea how many of preparation and learning the system, goofing with all of the little technologies. I mean yeah, it takes some time.”
Several of the instructors in this sample mentioned the word “evolving” when asked about how they use clickers in their classrooms and the learning curve involved. Jocelyn, a human development family studies instructor who had used clickers less than two months, said,

“It is evolving. Just learning to figure out different ways to use them.”

Overall, the instructors felt the benefits of the technology outweigh the limitations and the instructors portray an overall positive impact of the clicker technologies on themselves and their students. Sam, a professor with one year of clicker experience and 35 years of teaching experience, noted,

“That is sometimes a challenge to have a question that is meaningful and to have different answers that aren’t trite. It gives me a little bit of a thought challenge and so it helps me stay enthusiastic I guess.”

Bob, who has been teaching 47 years at the university level and is in his first semester of using clickers said,

“It has been a positive experience for me on the whole. I would use them again in a freshman course I’d say!”

David, a natural resource ecology management instructor, said,

“Maybe I’m just on a roll you know, having a good semester. But you know, ‘It’s clicking!’ I will say I am enjoying teaching much more than last semester and this semester because they seem like they are actually paying attention.”

And he continued later in the interview,

“I don’t know maybe it was a lucky semester, maybe I am on a roll. But I think it very well could be the clickers. We’re not sure yet, but it seems that if I can look around for the moment we are going to blame the clickers. I will, and I will think it has improved this classroom in some subtle ways that tend to make it more fun and interesting. I guess I will be more fun and interesting if the students feel more fun and interested.”
This concept of fun in the classroom as a result of the clickers continues throughout the interviews of the instructors. Mary, a horticulture instructor, said,

“Overall, I have had a lot of fun with them. I have hoped that they have improved my teaching, overall they have helped improve my accessibility to the students because they ask more questions at the end of class. They are hard to get out of the room at the end of class. I think it is because they know I am interested in their responses, opinion questions, ‘would you do this?’ They know I am interested.”

The faculty interviews were filled with thick descriptions of the impact clicker technologies have had on the instructors, their teaching, and ultimately the classroom learning environment. It was interesting to note that none of the instructors felt they had reached the pinnacle of clicker understanding and use. Each one mentioned the process as evolving and thought they could do more with the technology to enhance student learning. However, another subtle theme that emerged through the overall interview process was the student-centered approach each of these instructors held. While I was not able to distinguish whether that approach was held prior to the use of clickers or at their onset of using clickers, the instructors seemed to grasp a central idea of wanting to improve the large lecture and overall classroom environment. They seemed to feel that the clickers allowed for this improvement to learning, not only by engaging students and soliciting student feedback, but also by changing the way they designed and implemented the lecture itself. Instructors went into their class sessions open to hearing what students knew and thought about content, open to the discussions that might be generated based on clicker questions, and open to modifying previously held ways of teaching in an attempt to improve the classroom environment for the students they teach. And in the process, the instructors realized this was not only beneficial but also fun!
Slide Analysis Results

As a part of their participation in this study, instructors were asked to supply several sessions of their Turning Point slides to be compared to Bloom’s taxonomy of cognitive domains. The slide sessions they submitted were at the discretion of the instructors. Several instructors asked if I wanted to see a range of their use of clickers, and I responded that it was at their discretion as to which slide sessions they shared with me for analysis. Instructors were told that I would be analyzing the slides to see how clickers are incorporated into their lectures, how often they are incorporated, and how the slides compare to Bloom’s taxonomy of learning. Instructors provided the slides either as an email attachment or downloaded the slides directly to my flash drive following our interview.

The purpose of the slide analysis portion of the study was multi-dimensional. It served as a method of triangulation to support the observation and interview results as to how often, and in what manner, clickers were being used in the classroom. It also allowed for an analysis of the cognitive level of use of clickers in relation to Bloom’s taxonomy. My intent was to simply explore the methods of use by various instructors represented in this sample. This exploration was both within disciplines where more than one instructor was represented, and across disciplines. I also aimed to explore the construction of the slide questions, and the frequency of use of clicker questions within classroom sessions. It was my goal to place each of the slides within one of Bloom’s cognitive domain categories, but going into the exploration I did not even know if that would be possible. I believe it was achieved, although do feel this is an art more than a science, with consistency as the key.

Five of the eight instructors in the study produced slides for analysis. Each of the five who produced slides provided at least two sessions of slides to be reviewed, with most
providing three sessions. Upon receiving the slides, I printed the slides, counted the number of times a clicker question was asked per session, and calculated the total number of slides presented in that session. Overall, I analyzed 15 sessions of slides, including 161 clicker questions slides and 692 total slides, providing a somewhat quantitative aspect to the study.

The six levels of Bloom’s taxonomy, from the least complex (lower) to the most complex (highest) of thinking, include: knowledge, comprehension, application, analysis, synthesis, and evaluation. I placed each slide within one of the six levels of Bloom’s taxonomy of cognitive domains. When a question was difficult to place, I placed it in the lower of the possible levels rather than in a higher-level. As mentioned earlier, consistency was a key to analyzing the slides. I looked for common formats based on the six cognitive domain characteristics.

Examples of slides and their subsequent Bloom’s taxonomy rankings are located in Appendix I. My ranking of the slides into the cognitive domains was peer checked by two members of my program of study committee who are familiar with the taxonomy table as well as by a peer who is less familiar with the taxonomy table. Consensus among the four of us was met as to the ranking and analysis of the slides. Table 2 outlines the slide analysis results.

What became evident in the analysis of the slides is the variety of use by instructors both within and across the disciplines represented. Recognizing this variety of use by instructors provided triangulation with the results from the observation and interviews, substantiating the idea that these instructors pose clicker questions in a variety of ways in the classroom.
### Table 2: Turning Point Clicker Use Classroom Session Slide Analysis

<table>
<thead>
<tr>
<th>Discipline</th>
<th>Classroom Session (with length in minutes)</th>
<th>Number of Clicker Slides</th>
<th>Total Number of Slides</th>
<th>Bloom’s Taxonomy of Cognitive Domain</th>
<th>Number of Slides Related to Bloom’s Taxonomy</th>
<th>Level of Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horticulture</td>
<td>1 (50 minute sessions)</td>
<td>11</td>
<td>45</td>
<td>Knowledge</td>
<td>2</td>
<td>Mid-Level</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Comprehension</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Application</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>6</td>
<td>21</td>
<td>Knowledge</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Comprehension</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Application</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Geology</td>
<td>1 (1 hour, 15 minute sessions)</td>
<td>10</td>
<td>52</td>
<td>Knowledge</td>
<td>3</td>
<td>Introductory</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Comprehension</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Application</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>4</td>
<td>31</td>
<td>Knowledge</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Veterinary Medicine</td>
<td>1 (1 hour, 15 minute sessions)</td>
<td>8</td>
<td>96</td>
<td>Application</td>
<td>7</td>
<td>Upper Level-Post Baccalaureate</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Evaluation</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>47</td>
<td>71</td>
<td>Knowledge</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Comprehension</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td>Application</td>
<td>43</td>
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<td>Evaluation</td>
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<td>5</td>
<td>16</td>
<td>Application</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Natural Resource Ecology Management</td>
<td>1 (50 minute sessions)</td>
<td>4</td>
<td>51</td>
<td>Comprehension</td>
<td>2</td>
<td>Introductory</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td>Synthesis</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>5</td>
<td>46</td>
<td>Knowledge</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Comprehension</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>6</td>
<td>47</td>
<td>Knowledge</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Human Development and Family Studies</td>
<td>1 (50 minute sessions)</td>
<td>5</td>
<td>25</td>
<td>Application</td>
<td>5</td>
<td>Mid-Level</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>18</td>
<td>46</td>
<td>Knowledge</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Comprehension</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>10</td>
<td>41</td>
<td>Knowledge</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Evaluation</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>6</td>
<td>36</td>
<td>Knowledge</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Application</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td><strong>TOTALS</strong></td>
<td><strong>15</strong></td>
<td><strong>161</strong></td>
<td><strong>692</strong></td>
<td>Knowledge</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td>Comprehension</td>
<td>12</td>
<td></td>
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<tr>
<td></td>
<td></td>
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<td>Application</td>
<td>78</td>
<td></td>
</tr>
<tr>
<td></td>
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<td></td>
<td>Analysis</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Synthesis</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Evaluation</td>
<td>11</td>
<td></td>
</tr>
</tbody>
</table>
It is interesting to note the large number of slides used in several of the classroom sessions. As mentioned later in this document, these instructors tend to use an abundance of technology. The classroom session slides that I analyzed did include a large number of slides, some of which had only one minor difference from the slide prior to or after it. Instructors might also have used a single slide to include a graphic or a website link. It may also be that these instructors included an abundance of slides they may never actually get through in the designated class period and then carry over to the following class period.

I have shown a graphical representation of the total number of slides per domain below. It is evident that most of the clicker slides analyzed fell into the application domain with the second most being knowledge level slides.

Figure 1: Bloom’s Taxonomy of Slide Analysis

Bloom's Taxonomy of Slide Analysis

It is difficult to create higher-level thinking within multiple choice questions; however it appears with the thoughtfulness involved in asking clicker questions, these instructors have begun to foster higher-level thinking. I believe this critical thinking is being
fostered not only in the manner in which the instructors pose the questions, but also in the discussion the instructors initiate after the question is posed. In addition, the mere act of using clickers and having to commit to an answer increases the level of learning. Dennis, an instructor in geology spoke of this decision making process,

“\text{You can ask them [students] if they know the content and they will say yes almost always. But it is not until you test them that you see. It's that response. One thing I like about clickers is it makes them make a decision and they can't just sit there. I know it is still more passive than an active similar type of class, but with that many students getting people to respond is tough and they will just sit there and not make a comment. They won't make any decision until they see what the right answer is and then convince themselves that that is the answer they are going to chose. I make them come up with an answer first. They have to commit to something and by committing to it then that puts them on one side or another and then they see either they are right or wrong or they have to somehow defend their position which I see as useful. That is another way I use it: to ask provocative questions which don't have an answer, or don't necessarily have a right answer.}”

The idea that instructors then ask students to defend their answers coincides with this continuum of critical thinking through the use of clickers. Here are a few examples from the review of the slides and the interview and observation data in this sample:

\textbf{Clicker question: I have discussed my own funeral/ceremony with another person.}
\begin{itemize}
  \item[1.] Yes
  \item[2.] No
\end{itemize}

This question, when reviewed in isolation, was analyzed and marked as a knowledge level question within Bloom’s taxonomy of cognitive domains. I felt it was simple recall of personal knowledge when posed as is. However, if the teacher fosters discussion following the posing of this question, the student must now defend or describe his/her decision to discuss end-of-life issues with others. This discussion may now bringing the level of this
question to an evaluation level on Bloom’s taxonomy as the student is now required to give reasons, to justify, or tell why s/he answered the way s/he did.

Another example of how a clicker question in isolation may be rated at the knowledge level of Bloom’s taxonomy follows:

**Clicker Question: The second number on a fertilizer bag tells you the amount of:**
1. nitrogen
2. potassium
3. phosphorus
4. carbon

Again, if analyzed in isolation, this is a knowledge level question requiring recall of content and was ranked as such in my analysis. If the instructor follows this question by asking students to describe why they put the answer they put, the instructor has now moved to a higher-level of cognitive thinking as the student again is required to justify his/her choice.

Some questions seemed to be immediately posed in a manner that fostered higher-level thinking even within the multiple choice format. For example, a veterinary medicine instructor provided an animal case study in which she included medical information about the sick animal. She then posed this clicker question. The abbreviations in the question represent medical terms within the course content.

**Clicker Question: Your patient is bleeding. There is thrombocytopenia, prolonged ACT, APTT, PT and TT (TCT), increased FDP’s, Decreased ATIII. Where is the problem?**
1. primary hemostasis
2. intrinsic systems
3. extrinsic system
4. common system
5. more than one answer
This question, as it was posed, required students to synthesize course content learned previously in the class and hypothesize to a new situation. This question was ranked at the synthesis level in Bloom’s taxonomy based on the synthesis of old and new information and the hypothesis requirement. This instructor allowed students to work in teams to answer the question and then followed by asking each team of students why they answered the way they answered, thus bringing the students into the evaluation domain of Bloom’s taxonomy because they are now required to justify their answer and critique the answer of other teams.

Another example is a human development and family studies instructor who posed an application question whereby students must consider how they might respond if they are told they had a serious illness.

After a routine check-up your doctor expresses concerns. She discussed possible scenarios involving serious illness. What would you do that evening?

- a. Not think about it
- b. Call someone I love
- c. Look up info on the internet
- d. Figure out what this may mean

Students were asked to apply the course content to a real life situation. She then followed with additional real life application questions asking whether the students talk openly about difficult topics with their families, whether they would want to know everything about their hypothetical illness, and whether those opinions would change if it were a significant other with the illness. This type of application question fosters student thinking as to the real life application of course content.

It does seem, whether instructors realize it or not, that they are actually fostering a high level of cognitive thinking in their classroom by using clickers in conjunction with classroom discussions and activities. There is a good spread of the levels of cognitive
domains represented within this sample of classroom sessions. While knowledge, comprehension, and application type questions were the majority of the slides presented via clicker technologies, the level of cognition required increased as instructors forced students to make a decision, to stick to that decision, and to discuss that decision with peers. While this process of ranking questions with regard to Bloom’s cognitive domain levels is more of an art than a science, it is important to note the diversity in the format of questions being asked through clicker technologies. It appears that the instructors also consider the content in the discipline they teach when deciding how to incorporate clickers into their teaching and classroom learning environment, with case studies prevalent in the medical slides I analyzed, and practical application, opinion-type questions more prevalent in the field of human development.

**Description of the Student Sample**

Another aspect of this study was to interview students in the instructors’ classes as to their perceptions of the use of clickers. These interviews provided triangulation by source and also student opinions about the use of clickers. It was my intent to secure 3-5 students from each instructor’s class to interview as to their perceptions of the use of clicker technologies within that course and across campus. I was able to secure a total of eleven student interviews, representing five of the eight instructors. Two of the students had been enrolled in classes representing two different instructors in my study. These two students only had one of the instructors at the time of this study. For example, student A may have previously had instructor A and currently had instructor B, both of whom are in my clicker study as instructor participants. Therefore I actually reached students from seven of the eight instructor participants.
While the information obtained from the students neared a saturation point, I am not sure I can say with confidence that I was able to completely reach a saturation point in the interviews of students for several reasons. The students represented various academic learning levels, from freshman to senior level, with one student who was actually a non-traditional student at 26 years of age. Student perceptions and feelings about clickers may vary based on their year in school. Having only one semester left prior to graduation and being required to purchase a clicker during that semester might play a role in the student’s perception of the use of clickers. However, my hunch was not fully realized due to the limited sample size of students I interviewed. In addition, students may voice varying opinions based on the number or courses and experiences they have had with clickers. For example, if a student has had a number of experiences, he or she may have a different perception of the use of clickers than one who has had a very limited experience or only a single, either positive or negative clicker experience. As well, interviewing students in even a small group of two may affect their responses. I was not able to interview each student individually due to student scheduling and time constraints and this might have impacted the results. This in no way diminishes the perception of the students, but does make it difficult to achieve a saturation point in a non-funded qualitative dissertation study.

However, the eleven students I was able to interview provided some valuable information relating to their perceptions and feelings about the use of clickers in the classroom. Thus, despite a lack of saturation of data I have provided the results from the students’ perspectives and some recommendations for future research when it might be possible to reach a saturation point.
Several of the students interviewed were enrolled in a single course with the same instructor. Three students interviewed were enrolled in an introductory, large lecture chemistry course. Two were female, one was male. The interviews were designed to be held as a small group interview; however because of students not showing up, the male in this course was interviewed alone and the females were interviewed together. Three additional female students were enrolled in a medium size human development and family studies course; two were interviewed together and one was interviewed individually. There were also two female students enrolled in another medium size human development and family studies course and they were interviewed separately. Finally, I interviewed two female students in a natural resource ecology management course and a female student enrolled in a veterinary medicine course. There was a heavy population of students representing the human development and family studies field, possibly resulting from my connection to that discipline. While this may be viewed as a limitation in the research, this also opens the door for future discipline specific research within my field of study from this sub-sample.

Three of the students interviewed had been previously enrolled in a course in which I taught and used clickers. As a researcher, I was not aware of this until after they arrived for the interview. Because this interview was focused on their experience with clickers in their current class, I decided to proceed with the interview but made a statement to the students that I valued their honest feedback and that the content of this interview would be in relation to their current use of clickers. However, this may be a limitation to the study.

The student sample included two freshman, two sophomores, two juniors, four seniors, and one post-baccalaureate student. All students appeared to be Caucasian although
they were never asked to identify their ethnicity. The student sample is summarized in Table 3 below.

Table 3: Description of Student Sample

<table>
<thead>
<tr>
<th>Pseudonym</th>
<th>Gender</th>
<th>Student Status</th>
<th>Course Discipline</th>
<th>Interview</th>
</tr>
</thead>
<tbody>
<tr>
<td>Megan</td>
<td>Female</td>
<td>Freshman</td>
<td>Chemistry</td>
<td>Group</td>
</tr>
<tr>
<td>Lauren</td>
<td>Female</td>
<td>Freshman</td>
<td>Natural Resource Ecology Management</td>
<td>Individual</td>
</tr>
<tr>
<td>Jan</td>
<td>Female</td>
<td>Sophomore</td>
<td>Human Development &amp; Family Studies</td>
<td>Group</td>
</tr>
<tr>
<td>Tammi</td>
<td>Female</td>
<td>Sophomore</td>
<td>Human Development &amp; Family Studies</td>
<td>Individual</td>
</tr>
<tr>
<td>Callen</td>
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<td>Junior</td>
<td>Human Development &amp; Family Studies</td>
<td>Individual</td>
</tr>
<tr>
<td>Tanya</td>
<td>Female</td>
<td>Junior</td>
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<td>Individual</td>
</tr>
<tr>
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<td>Senior</td>
<td>Human Development &amp; Family Studies</td>
<td>Group</td>
</tr>
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<td>Senior</td>
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<td>Individual</td>
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<td>Mallery</td>
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<td>Chemistry</td>
<td>Group</td>
</tr>
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<td>Senior</td>
<td>Chemistry</td>
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<tr>
<td>Kendra</td>
<td>Female</td>
<td>Post-Baccalaureate</td>
<td>Veterinary Medicine</td>
<td>Individual</td>
</tr>
</tbody>
</table>

Interviews lasted between 16 and 45 minutes with an average interview time of 38 minutes. Student interviews followed the previously mentioned student interview protocol while also allowing for free-flowing discussion as to the student perceptions and thoughts. The purpose of the student interview was two fold: to provide a voice to the students as to their perceptions on the use of clickers in the classroom and to provide triangulation related to the method and frequency of use of clickers in the classrooms represented. Both were partially accomplished through the student interviews.

**Student Interview Results**

The students in this sample had varying levels of experiences with clickers, from one to four classes. Their opinions were thought-provoking, encouraging, and concerning.

Several themes emerged from the student interviews:

1. Students’ general perceptions of clickers vary in this sample

2. Students have mixed feelings on the impact on attendance with regard to the use of clickers
3. Students are able to identify benefits to their learning relating to the use of clickers in the classroom.

4. Students value technical competence in the instructors who use clickers.

5. Students would like to see more instructors use clickers.

6. Students would like information on the use of clickers.

**Theme 1: Students’ general perceptions of clickers vary in this sample**

Some students expressed a dislike for the use of clickers while other students voiced a strong like for their use. In this sample, two senior students expressed dislike for clickers, while two seniors and the other student participants liked the clickers. Jay, a senior in chemistry who used clickers only in his last semester at the university with a first time clicker instructor, was relatively positive about the use of clickers and the impact they can have on student learning; he said,

“Yeah, I still don’t like them though. It is just real annoying mostly because of the technical problems and the [instructor] user error.”

He continued later in the interview,

“Yeah, it is like getting a vaccination. You don’t like it but you see it’s benefit. I think it is probably beneficial, but I just don’t really care for them. But, I don’t eat healthy foods either, same reasons!”

These two seniors also expressed concern about the price of clickers. Jay, continued,

“If they could find a way to improve. If I didn’t have to pay for it, I would be ok with it.”

And Mallery, a graduating senior in the same chemistry class added,

“They are $40 and the problem is they are only used in classes that people have to take, whether they want to or not so you are going to get a lot of people who do not want to be there, so they just see it as another thing they have to deal with in this class that they don’t want to be in. I think maybe if it was used in larger classes that the people
chose to be in, then people might think better of the clickers. But the fact that I have to be in this class sets the tone already. So you are already kind of annoyed that you have to take it and I don’t like it and now I have to get this clicker. I mean I have never heard anyone say they love clickers.”

However, Beth, a graduating senior in human development and family studies, says, “I don’t mind them at all. I think they are good. I think the only problem I have heard or had people complain about is that you have to buy them.”

Most students noted that the price has declined over the past few semesters and that the price is still less than what they spend on textbooks. Students are also happy the university has standardized to the use of one specific clicker.

Students in this sample noted that they hope the university does not continue to change what is the currently standardized clicker, but rather remain firm on the use of one clicker across campus. They felt it is unclear as to how often they will need to use clickers over the course of their academic time at the university and recommend a posting stating which courses will require clickers. Beth, a graduating senior who has used clickers in two courses says, “The one thing that bothered me was after my first course with clickers, I checked my course layout for the next semester and none of the teachers called for clickers so I returned it, and of course I had to re-buy it at the bookstore price again, so that was kind of upsetting. So it is kind of like returning the exact same book that you just used. But it is also nice that they take them back.”

Most of the students I interviewed were positive as to the use of clickers and desired greater use of clickers. Jan, a sophomore in human development and family studies who has used clickers in three classes, said, “Now that I have started to use them, I like the classes better when they do use them.”
Carla, a senior in human development and family studies who has had two classes with clickers, said,

“I love clickers! I really enjoy the clickers.”

Callen, a sophomore student majoring in graphic design but taking a course in human development and family studies, said,

“I actually like clickers a lot. I wish more teachers would use them.”

It is important for me to note that on this campus the campus newspaper and others in the campus community have publicly stated that students do not like clickers. I must say despite my own personal experiences with clickers as an instructor and my personal like for clickers, I went into this study attempting to be very open and emergent with the design and with my analysis of the results. I was honestly expecting a much more negative perspective of clickers to be portrayed by the students I interviewed based on this assumption of student dislike across campus. Several students spoke to this assumption of dislike across campus. Jan, a sophomore in human development and family studies provided her opinion on this,

“I don’t think people know that much about them [clickers] so they get frustrated with them really easily. And now that I have used them a couple times and I see how much they really can help, I really like them [clickers]. So I think that if more teachers got into using them and just kept on pushing and were like, ‘ok, we are going to do this’ [more students would like the clickers]. I like them a lot more every time I use them. So I think that if other people used them [clickers] they wouldn’t be as apprehensive about them.”

Carla, a senior in human development and family studies added,

“I was talking to some friends about clickers before coming to this interview and most of my friends were saying how they just love clickers. But one friend was saying he didn’t like them at all. He thought they were a waste of money. We were like, ‘no way, are you kidding?’ Well then as we talked more we found out he hadn’t even used clickers in a class before. I think that is where the supposed
dislike comes from. People who haven’t even used them, so they don’t see the benefits. Seriously, I like love clickers. I wish more classes would use them.”

**Theme 2: Students had mixed feelings on the impact on attendance with regard to the use of clickers**

Students who said they might not otherwise attend class felt that clickers did improve their attendance in class because they had to come to receive the clicker points. Some students said they attend class because of the points associated with the clicker questions, even if those points are minimal. Mallery, a senior majoring in geology but using clickers in a chemistry class, and who did not like using clickers, said,

“Yeah, though I suppose it does give me a little, ‘Well I should go just so I can get my clicker points.’ You know I don’t mind them when it is just worth a few points, you know it is kind of like an extra credit, participation type deal. Um, I enjoy that. And I think that you will find that kids who attend class generally do better in class and so if that is any motivation, then first off you just earned a couple points and you are probably able to learn the material better.”

Beth, a graduating senior in adult and family services, who spoke positively of the use of clickers, said,

“Yeah, clickers definitely affected my attendance in this class. I am finding myself mentally done with school as a graduating senior. I am only taking two classes. I am not on campus much at all and the other class does not use a clicker. I find myself going to this class [that uses clickers] a lot more. I know that is a bad reason, but it brings me there.”

Other students felt clickers did not affect their attendance. Tammi, a human development and family studies student, said,

“No, I would probably go to class either way.”

Jan, also in the same class as Tammi, followed with,
“Yeah, I am the same way. I would go to class either way but I think for some people if we knew there were going to be points attached to it [clicker questions], they would want to come more.”

Kendra, a post-baccalaureate student in veterinary medicine said,

“Yeah, you know having those points attached does help get me to class. I mean I have only missed one class. I don’t want to miss the points. And like at this point in our education we are supposed to be responsible and motivated, but the clickers with the points definitely help.”

Jay, a graduating senior, had a mixed feeling on clickers affecting attendance,

“No, I don’t think it affected my attendance. It’s an afternoon class so it is pretty easy to get to. Yeah, though I suppose it does give me a little, ‘well, I should go to class just so I can get my clicker points’.”

He continued,

“You know I don’t mind them when it is just worth a few points, you know it is kind of like extra credit, participation type deal. Um, I enjoy that. And I think you will find that kids who attend class generally do better in class and so if that is any motivation, then first off you just earned a couple of points and you are probably going to be able to learn the material better just being in class. Let’s say a student had the option of either going or not going, which they all do. If he was motivated to go, just so he gets that clicker point, he is going to have the material taught to him. I think that is probably true. People who attend class do better, regardless of why they are there. If the clickers bring them there then great.”

Theme 3: Students are able to identify benefits to their learning relating to the use of clickers in the classroom

As a part of the interviews, students were probed as to the methods used by their instructors, the benefits and limitations of clickers, and the impact of clickers on learning. All students, whether they expressed a like or a dislike for clickers, were able to generate benefits from the use of clickers. Students liked the classroom and individual feedback that clickers provided. They liked being able to see potential exam questions prior to the exam as
well as being able to know immediately if they were correct in their answer. Jan, a sophomore student in human development and family studies, said

“I think just getting extra questions that might be on the test or help you study for the test because like I said I make sure I write them all down or type them in because most of the time there are like at least a couple of them that end up on the test.”

Mallery, a senior, said,

“Yeah, that is the one thing I do like, being able to see what everyone put except for when you are the only person in the low percentage. You are like, yeah it must be really obvious to everyone but me, most of the time you are like, oh you read the question wrong, but it is kind of nice to be like, if it is like 30-40-30, then you kind of feel like ok, I am not the only one confused. But sometimes you look at it and like 30% are wrong and like 70% are right so we will just go on, but ok, out of 200 people, that 30% is kind of a lot of people who are confused.”

Tanya, a junior majoring in dietetics taking and natural resource ecology management course, added,

“Our instructor uses them [clickers] to see what we know before introducing the next topic. I like seeing that. What I knew or didn’t know about the topic and then seeing where the rest of the class was.”

Megan, a freshman student added,

“I liked that immediate feedback of the professor being able to see what the response is. So he can help teach what we are thinking is wrong.”

A sub-theme within the benefits to learning was that students also liked the interaction with other students that their instructors encouraged with regard to clicker questions. Tammi, a sophomore explained,

“It makes it like everybody can share and you put your answers in so you can see the results and then sometimes we discuss the results so that helps and encourages participation.”
Jan, a sophomore whose instructor poses clicker questions following a classroom video clip added,

“If we know we have to put our answer up on the board we are going to be sure we are watching the videos. We are going to be paying attention a lot more than if it was just a video type thing, so I think it does help.”

Carla, a senior in human development and family studies who has used clickers in both large and small classes, said,

“I liked talking with others in the class about the clicker answers. That is the best way to use them. To foster that discussion.”

Another sub-theme with regard to the benefits was the anonymity provided by clickers, in both large and small classrooms. Beth, a senior mentioned,

“I like the fact that you can see other people’s points of views or what the rest of the class is thinking without personally raising your hand. Some subjects we talk about in the death class are personal you know so you don’t have to raise your hand and say what you think. And you can still get what everyone else in the class thinks and how they answered it.”

Jan, a sophomore, spoke about the use of clickers in a large introductory course with regard to this idea of anonymity,

“It makes it feel like the classes aren’t as big. Like the intro. class was huge and that was one of the very first classes I took, but with the clickers it made it seem like it wasn’t quite as big and intimidating, because you could still put your information out there but you didn’t have to put your information out there with everyone knowing it was you. And it also made it more fun and interesting.”

Tanya, a senior in dietetics, mentioned,

“Our instructor also uses it for some ethics questions. It is good to be able to answer it without having to raise your hand.”

Carla, also a senior, added,
“You can be intimate in a classroom, large or small, without having to give away your whole self.”

And Tammi, a sophomore, agreed by saying,

“People wouldn’t participate as much if we had to say it out loud.”

Finally, some students also felt that the clickers enhanced their learning and added to the level of cognitive thinking required in the classroom. When asked if she felt clickers were beneficial to her learning, Carla, a senior in human development and family studies, said,

“Absolutely clickers help support my learning. They help drive it [the content] home. Especially when instructors foster discussion after the questions and you can internalize the content.”

Tanya, a senior in dietetics agreed,

“Well, it gets you thinking about the content. I mean sometimes, without clickers you just sit there and don’t really connect the content to your own personal feelings and opinions. But clickers make me connect it [the content] and apply it to my own thinking. That takes more thought.”

When asked if clickers supported her learning at all, Beth, a senior in human development and family studies, said,

“Well, yes. The information our teacher uses is probably information we would not have gotten without the clickers.”

Jan, a sophomore whose instructor was using the clickers for content review, added,

“It makes you realize that what they say in class also goes with the book. So it just checks your understanding along the way so you don’t realize at the very end, I didn’t get this. And if you have a question, or you don’t understand why that is the answer, you know teachers are usually pretty good at explaining it. And so it just makes sure you understand what is going on.”

She continued,

“I think a lot of it is it makes you think and sometimes when you sit there in class, you take the notes and that’s about it. And this just
pushes you like up and beyond and I think that is really nice because I think a lot of college classes make it so it is like you get the notes down and that is basically it. Then it is your own responsibility to go back later [and check the notes]. I think that this just kind of makes you sit there and actually pay attention to what is being said, which I don’t think other classes [without clickers] promote as much. So I think that really helps.”

Tammi, another sophomore in the same class, agreed,

“Um hum, it definitely holds you accountable for the readings.”

**Theme 4: Students value technical competence in the instructors who use clickers.**

Three students, all from one class where the instructor is a new clicker user, were frustrated with the level of technological competence exhibited by their instructor. Technical errors on the part of their instructor frustrated students, especially when the instructor used class time to try to resolve the errors. Mallery, a senior, recommended that instructors be required to take a clicker class to learn how to use the technology prior to implementing them in the classroom,

“I think that teachers should have to go through some serious training to use them because I mean the first couple of days we were there he had someone in there to help him, but since she hasn’t been there it has been consistently not working. It is just frustrating. I think he is a nice guy, but it just is really frustrating to sit there and then it makes you hate clickers more because you are like this is why we shouldn’t have these because for the amount we use them.”

Jay added to this picture of frustration of instructor competence,

“The limitations are easily the technology problems.”

Other students were more forgiving with regard to instructor error with the technology. Jan, a sophomore student, offered her thoughts as to why teachers do not use the technology,
“I think some teachers are afraid to use them. And so in the classes where they haven’t used them I think it is just that they don’t want to take the time to set it up and they don’t want to take the time to troubleshoot when things do go wrong. So they would rather do other things than class discussion. I think teachers need to push through that because it is going to be hard when you first start using them because you know everyone is starting new. And in this class, she is just starting to use them and she doesn’t really know how. She is learning. And so I don’t think teachers should give up on it [clickers].”

She continues later in the interview by saying,

“So I just kind of wish that teachers would realize that technology isn’t going to hurt you. If anything it is going to help you. I mean it might be frustrating at first but, that is even true with just general technology, not just clickers.”

Students also desired a method for knowing that their clicker was registering their answers and believed instructors should provide some sort of flexibility in grading clicker questions based on technological complications that might occur. Jan, a sophomore, spoke of the benefits of the response grid, which is a feature of the software that allows students to see if their clicker has registered their response. She spoke of how this feature helps to ease student anxiety over their clicker question responses being recorded,

“You don’t know if they are going to work all the time. And that’s why I was saying I really like the little numbers on the bottom and it was a little bit hard to figure out what your number was but we got it figured out and then now that we have I think that is going to really help. Because before I was always like afraid that something was going wrong with my clicker and then with technical difficulties.”

Carla supported this by saying,

“I really like the response grid at the bottom where you can see if your answer registered.”

Jay continued by explaining how his instructor is flexible with regard to technological issues faced by students,
“People have issues with their clickers. One of them was this girl. Her clicker hadn’t been working for awhile and the instructor said to just give him the dates and she would still get credit.”

Tanya, a senior student, also spoke of the flexibility on the part of the instructors when technological complications arise,

“If you have a problem you just write your answers on a sheet of paper. That is good.”

**Theme 5: Students would like to see more instructors use clickers**

Students in this sample expressed a desire for more use of clickers across campus and within their individual courses. This desire seemed to be expressed by both those students who felt their instructor was using clickers adequately, in that they would like other instructors to use the clickers, and also by those students who felt their instructor was not using the clicker technology enough in their specific course to justify the cost. Carla, a senior student said,

“I wish more instructors would use the clickers. They are so beneficial!”

Jan, a sophomore spoke about the frequency of use by her instructor. This instructor is currently using about five to ten questions per class session at least one time per week.

“I think we could use them a little bit more just because it does actually help me.”

Jan continued later in the interview,

“I want to use it [the clicker], so like money-wise I wish more instructors used them but also because it helps so much. Use them [clickers] every day and not just now and then.”

Tammi, a sophomore student added to this saying,

“I would definitely like to see more widespread use of clickers. I think our technology class would be a great place to use clickers. I was
surprised they didn’t. I mean they introduced them to us, but we didn’t actually use them. I was just really expecting to use them in that class.”

Callen, a junior in another major, but taking a human development course, agreed,

“I like clickers. I think more teachers should use them.”

Jay, a graduating senior, added

“It is not beneficial when you pay for one and you use it for one class, or don’t use it much in class. Basically you don’t get your money’s worth out of it. I think if they standardize it and maybe require it for some major class so you know everybody pretty much gets one and has it.”

And finally when asked for any recommendations she might have relating to the use of clickers, Bobbi, a graduating senior said,

“I would suggest more instructors using them. I think it is a great use of technology. It saves paper. I am sure it is convenient for the teachers.”

**Theme 6: Students would like information on the use of clickers**

Another theme that emerged in the student interviews was the desire for information relating to the use of the clickers on campus. For example, students mentioned the need for the campus or individual departments to list which courses are currently using clickers or are most likely to be using clickers in the future to allow students to know if they should keep their clickers or sell them. One faculty member interviewed also brought this idea to the forefront. In addition, students noted that simply having an instructor tell them to keep their clicker for the remainder of their time on campus would be a benefit since they might need to use it in another class.
Students also mentioned wanting to know what content their clicker quizzes would cover in the event points are associated with correct and incorrect answers. As Jay, a senior in chemistry put it,

“I can’t study for a clicker quiz if I don’t know what content it will cover. I am sure it is beneficial, you know to make your head start thinking really quick, but it is generally unannounced so you don’t know what the question is going to be and you have like a minute or two to figure this out. I don’t think anybody likes that quick anxiety you get you know.”

Students seemed open to the technology and to using funds to purchase the technology as long as they are made aware of how the clickers will be used, what the expectations of use are, that they will be used enough to justify their purchase, and how they will benefit from the use of the clickers.

“I think it would be better if she was more clear about it. Because like I accidentally forgot my clicker last time because I switched my bag and I forgot about bringing it and that is like the one day we actually needed it kind of thing. And so if she kind of told us since we don’t use it everyday. It would be kind of nice to just have like a warning. And then also just kind of tell us when we are going to be getting points and when we aren’t, because that sort of gets confusing. I mean not that I am not going to try as hard on the ones that don’t get points, but it would just be nice to know.”

Along this same line, students also wanted to know what was expected of them regarding their use of clickers and what will be considered academic dishonesty as it relates to the use of clickers. Students mentioned abuse by students who are giving their clicker to another student to click in for them during class. When asked if they felt this was academic dishonesty, the majority of students mentioned that it would depend on whether the instructor had stated it as such in the beginning of the semester or in the syllabus. Tammi, a sophomore said,
“I don’t think people [students] are realizing that these can be used for quizzes. So I don’t think people [students], since they haven’t used them [clickers] like that, they don’t view them [clickers] as a big deal. I could see students being like, ‘well, it is not like I was actually cheating’ but at the same time it is academic dishonesty.”

It was my perception that the students had never even considered the clicking in for other students to be academically dishonest. However, upon our further discussion of the topic, students realized the use of another student’s clicker would in fact be academic dishonesty. The students felt it would be of importance by instructors to alert the class of such. Mallery, a senior, and Megan, a freshman had this discussion about academic dishonesty and clickers during my interview with them. Mallery said,

“I guess I never really thought of it as academic dishonesty. I would say if it is a graded quiz, then it would probably be cheating, but I think for participation, I wouldn’t call that academic dishonesty.”

Megan replied,

“Well in one course they did say it was academic dishonesty because we are getting points for being there, for attendance. If you don’t come you don’t get the points.”

Mallery responded,

“I guess I would be pretty mad if I got in trouble for like getting someone to click me in, but I guess as you [instructors] are up front about the rules, then it is our choice. I think that should be stated by the instructors because if someone did that [clicked in for another person] and they got in trouble, I don’t think that is fair because you don’t know you are breaking an actual school policy.”

Students felt that if instructors specifically alert students to what is considered academically dishonest with the use of clickers, then it would be fair to prosecute such abuses relating to clickers. It is important to note that the University does have an academic
dishonesty policy and the abuse of clickers would fall under that policy whether students are made aware of it by their instructors or not.

After interviewing the students, in some sense I see their perceptions of clickers much like the purchase of textbooks. Some students do not mind purchasing textbooks while others do not always want to. Some students do not immediately see the benefit of the textbook; however, if instructors take the time to explain why they value the textbook, if the instructors are familiar with the textbook, and if instructors regularly cite and use the textbook, students begin to see the benefits. It seems the same with clickers.
CHAPTER 5. CONCLUSIONS

Summary

The qualitative nature of this inquiry has led to the emergence of an in-depth understanding of the use of clickers on campus. I set out on this journey to answer three questions.

1. **In what ways do instructors describe their experience of incorporating personal response systems into their university level classes?**

   It would seem from this sample of eight instructors that incorporating personal response systems into their university level classrooms is both beneficial and for the most part enjoyable. Learning the clicker technology and deciding on ways to incorporate the technology has challenged the instructors to think about their lectures as a whole with respect to pacing, student interaction, and classroom engagement. Instructor perceived outcomes of the use of personal response systems include increased student participation, increased student attendance, improved instructor-student interaction, active and collaborative learning activities, and an enriching educational environment. Santrock (1996) described the transition to college as one where students move to a more impersonal school setting. Could it be that clickers are bringing a more personal feeling to the classrooms in our universities? Students are no longer anonymous to their instructor as instructors can track individual student responses. Students are given a “voice” by being able to click in with an answer to every clicker question posed. Instructors are using the clickers to foster discussion, therefore forming discussion among peers and supporting a more personal-feeling classroom learning environment.
Faculty also reported a decline in student incivility that comes along with the active participation and overall student involvement and interaction. James, an instructor in natural resource ecology management said,

“Last semester we were wondering if the clickers affected participation in the class. It was the first semester and we noticed that we had less of a problem with people sitting in the back of the room reading the newspaper. Students seemed more engaged. To my mind, as I lectured, they seemed more engaged.”

I would describe this almost within the concept of reciprocity. It seems that as the instructors became more student-centered in their approach to designing and implementing clickers and their students became more engaged in the content and therefore more involved in the class as a whole.

Instructors also note that incorporating clickers involves a learning curve with regard to the technology. Many describe the process as evolving, whereby each semester brings more insight as to how they might better implement the clicker technologies. Instructors in this sample exude a student-centered approach as to the use of the technology and while claiming various reasons for the use, they generally land on the improvement of student learning through increased participation and discussion as the central core to their use of clickers. Instructors describe their use of clickers as providing immediate feedback to them as the instructor. It allows them to know what their students are thinking, and then to encourage students to discuss their answers. Perry (1970) noted that students at this age rely heavily on authority figures to confirm the rightness or wrongness of their thoughts. Students may hold a different position than their peers, but learn to take a stand while also acknowledging these different views. It would seem the instructors in this sample are using clickers to support this shift to a reflective judgment (Kail & Cavanagau, 2007) model of thinking. They pose a
question, ask students to take a stand, and yet allow students to see the variety in opinions and views among their peers.

Subtle benefits to clickers also emerged and included a decrease in the amount of time spent grading and writing down answers, greater understanding behind the indication of wrong answers, an increase in student generated verbal questions, and a new thoughtfulness behind the preparation of class sessions.

Instructors in this sample also noted a new level of enthusiasm in their teaching and noted that teaching seems to be more fun since including using clickers. Some comments from the instructors in this sample were,

“Overall, I have had a lot of fun with them [clickers]. I have hoped they have improved my teaching. Overall they have helped improve my accessibility to students because they ask more questions at the end, they are hard to get out of the room at the end of class. I think it is because I am interested in their responses. They know I am interested.”
~Mary, horticulture instructor

“I resisted clickers at first and was dreading it, but now that we have gotten going, I like it and I am glad we did it. We are getting better at it. You know, ‘It’s clicking!’ I will say this, I am enjoying teaching much more last semester and this semester [since using clickers] because they seem like they are actually paying attention. It’s made my job actually more enjoyable!”
~David, natural resource ecology management

“It gives me a little bit of a thought challenge and so it helps me stay enthusiastic I guess.”
~Sam, natural resource ecology management

“Yeah, I think clickers have changed how I teach. I think it would be positively.”
~Elizabeth, human development family studies

“Overall it has been a positive experience for me. I would use them again.”
~Bob, chemistry
“When I go back to this is a generation of students who use technology. There is an easy connection. To me this was a harmless first step for me. It was kind of intriguing. I had the desire to try to figure it out and it seems to be a nice resource to have in the class.”

~Jocelyn, human development family studies

Some limitations emerged with regard to instructor experiences with clickers although they tended to centralize around the common theme of competence with the technology. Instructors who had a greater level of experience with the clickers also noted some limitations to the technology itself, such as the lack of format for developing open ended questioning and the number of steps involved in some of the technological features.

Clickers are a tool for teachers and yet they are in no way a cure to all of the issues faced in university classrooms. The incorporation of clickers, without careful thought and preparation or without additional teaching considerations, will not be beneficial to student learning. The ultimate goal of clickers must lie in an increase in student learning. Achieving this will need to include a student-centered approach, student-teacher interaction, and a focus on active engagement. Clickers are a tool that seems to help foster this.

2. Are instructors who incorporate personal response systems aware of the cognitive developmental levels of their students?

While instructors generally answered by saying that they did not consider the cognitive level of the their students when designing the clicker questions, the actual slides representing clicker questions and the interview and observation results represent a mix of cognitive learning domains according to Bloom’s taxonomy. Many questions posed through the use of clickers are simply knowledge level questions:

- Do you have a living will?
- Why has the growth rate of the world population fallen?
• What does the second number on a fertilizer bag represent?

However, higher-level, synthesis and evaluation questions were represented and students were also asked to predict medical levels, analyze a case scenario, and formulate requirements:

• Predict PP/Fibrinogen Dehydrated + inflammation levels

• In a case scenario of a patient bleeding: what is the problem?

• The formation of an artesian system requires?

It is also evident that a higher-level of thinking can occur as an instructor fosters discussion along with the use of the clicker questions. A question is posed, students are required to make a decision, they have to choose an answer, and the instructor then encourages the students to talk among themselves, generating peer discussion or peer-learning. The student now either has support for the answer s/he chose or must defend the answer to a peer. Further discussion as a large group might also be generated. As the instructor guides the students through the process of describing why they chose the response they chose and why that response is right, wrong, or indifferent, this higher-level thinking can emerge.

In addition, students become more likely to ask questions when they are able to see that they are not alone in their thinking and when they feel the instructor cares about their opinions and learning. Instructors can clear up misconceptions and generate class discussions about course content immediately upon seeing student responses.

In line with the three clusters from the NSSE proposed at the onset of this study, this scenario replicates and generates the much valued student-faculty interactions, active and collaborative learning, and enriching educational opportunities. In addition this scenario ties
in nicely with the suggested constructivist strategies proposed by Bruner (1964) of students discovering principles and teachers using active dialog and incorporating a spiral manner of teaching by building upon previously learned knowledge. Nelson (1999) also provided strategies to foster higher-level critical thinking which were evident in the use of clicker technologies within this study. Those principles included the review of content questions, providing for a student voice in the classroom, and the formation of student-teacher connections. It was evident that these were being implemented through the use of clickers by instructors and students in this study.

Instructors in this study definitely see clickers as one tool in supporting student learning in their classrooms. The improved participation, immediate feedback, impact on attendance, and relatively easy formative assessment that result from the use of clickers provide the instructors with a method of engaging students in the content that may not otherwise be available without the clicker technology. Instructors however see the process as evolving. They feel like they could do more and have a desire to continue to learn about methods of using clicker technologies to improve student learning in both large and small classrooms.

3. **In what ways do students describe their experiences with using personal response systems in their university level classes?**

While there were slightly mixed thoughts on student experiences with clickers, the majority of the eleven students interviewed in this study held a favorable regard for the use of clickers in the university classroom. While two senior level students expressed a general dislike for clickers, they also were able to validate the benefits available through the competent use of clickers in classrooms. Students noted the use of clickers associated with
class credit points increased their likelihood of attending class and noted the improved learning that occurs upon attending class.

Students felt that being able to make peer comparisons and being able to validate their understanding of the course content were also benefits of the use of clickers. They enjoyed the peer discussions that instructors facilitated with regard to the use of clickers. However, students held some concern about the cost of clickers, especially prior to campus-wide standardization. Some students felt frustration over the competence level of instructors with clicker technology while other students were very forgiving about the learning curve associated with the technology.

The most beneficial activities cited by the students in this study related to clicker use were content comprehensions review, generation of classroom discussion, application questioning, and attendance checks. Students did desire that instructors use the clickers daily and in a variety of ways mainly to justify their purchase of the clicker. The students also requested this increase in use because they felt the use of clickers did supported or enhanced their classroom learning.

Most students in this sample were not able to make the connection between the use of clickers and the enhancement of higher-level thinking, but they did desire more information from their instructors as to why clickers were used in their classrooms. Several students were able to formulate a connection between the use of clickers and the enhancement of higher-level cognitive thinking.

Carla, a senior in human development and family studies said,

“It helps to drive the content home. You get to internalize it, make applications from it. It definitely made me think at a higher-level than without them [clickers].”
Students seemed open to better understanding the pedagogical implications of using clickers and enjoyed having their voice heard about the use of clickers in higher education.

**Recommendations**

Several recommendations are provided to instructors and universities in respect to the findings of this study.

1. **Provide and require technological assistance to instructors and students prior to the implementation of clickers in the classroom**

   Instructors must be given adequate technical education in the use of clickers. This instruction should be provided to instructors prior to the implementation of the clickers in the classroom, thus alleviating some of the student and instructor frustration with technological errors on the part of the students and the instructors. Most students in this study seemed open and willing to use the clickers and even desired greater use of clickers across campus. All students, regardless of their like or dislike of clickers, were able to identify benefits of the clickers to their learning, given the instructor was competent in the clicker technology.

   In addition it is recommended that campuses take the time to standardize on one model of clicker prior to implementing instructor education. Students did not like having to purchase more than one clicker over the course of their time in higher education, and instructors noted frustration and implementation issues prior to standardization to one clicker.

   Students may also desire technical and pedagogical education related to clickers. While the clicker technologies are relatively user-friendly, campuses should make technical assistance available to students. Instructors should also gain enough understanding of the technology to provide minimal technical assistance in the classroom and to explain their reasoning behind their use of clickers in the classroom.
2. **Provide pedagogical design assistance to instructors prior to the use of clicker technologies and in an ongoing format**

Instructors should be provided guidance in developing how they will use clickers in their classrooms. Examples of well-designed clicker questions, syllabus statements, and pedagogical methods for including clickers in the classroom should be given to those instructors just beginning to use clickers prior to their first implementation of the technology.

In addition, continued instruction on pedagogical aspects of using clickers should be provided either at the campus level through instructional technology and teaching services, at the departmental or discipline specific level, or at the instructor level in the form of workshops, a community of instructor users, or even web-based instructional tips and topics.

Instructors noted the process of implementing clickers as evolving. Each of the eight instructors in this sample cited the importance of technological workshops they attended early in the process of incorporating clickers. Each also was very interested in hearing about the results of this study with regard to how others are using clickers in their teaching and what student recommendations are with regard to clickers. Continued education would be beneficial as the use of clickers emerges. This education should also include methods to best facilitate higher-level learning in students through the use of clickers.

3. **Provide information to students relating to the use of clickers in their classrooms.**

Students want to know why clickers are being used, how often clickers will be used, and what is expected of them with regard to the use of clickers. Instructors are using clickers in a variety of ways across campus. It would be beneficial to students for instructors to include a statement in their syllabus relating to the expectations of the use of clickers in their classroom, how clicker abuse relates to academic dishonesty, and how students will be
assessed and graded with regard to classroom clicker use. While faculty do not normally spell out every possible infraction of the university’s academic dishonesty policy, it may be beneficial to mention the abuse of clickers given it is a new technology in many classrooms and given the stated student perceptions in this area.

Faculty may consider taking the time to explain to students why they have chosen to incorporate clickers into the classroom. What does the faculty member see as the benefits of clickers in the classroom? Even if students do not agree with the use of clickers, the student will at least have heard the instructor’s logic behind the decision to use clickers in the classroom. What past experiences has the faculty member had with clickers and how does the faculty see the use of clickers as important to student learning in the classroom? What steps, in the form of workshops, or other methods, has the faculty member taken to ensure an ease of use by the students and the faculty member with regard to clickers? Instructors might also explain how higher-level critical thinking may be facilitated by using clickers. By explaining these items to the students, some frustration may be alleviated, providing a more enjoyable experience for the instructor and the students.

4. **Expect a learning curve associated with the implementation of clickers**

Each of the instructors interviewed in this study mentioned a learning curve associated with their implementation of clickers. Instructors planning on implementing clickers should be aware of this and plan accordingly by using the semester prior to actual implementation to learn the technology. Instructors may also want to examine best pedagogical use of the clickers in their specific discipline. Instructors should seek out others on their campus familiar with clickers and spend time prior to implementation planning for clicker use. This planning might include the design of clicker questions, formulating the
incorporation of the clickers into the overall course format and syllabus, and the development of classroom policies associated with clicker use. Students in this sample desired that instructors be familiar with the technology and to work through issues that may arise. Just knowing that the process is an evolving process will be beneficial to those instructors and students embarking on the use of clickers.

5. **Form a network of instructors using clickers**

   By taking steps to form a network of instructors using clickers, instructors will be able to share ideas and methods relating to classroom use of clickers. Open discussion about pedagogy, syllabus design, points associated with clicker use, and the formulation of well-designed clicker questions will be possible. This could be accomplished at either the campus-wide or departmental level, depending on the number of clicker users.

6. **Consider Bloom’s levels of cognitive domain and the developmental learning levels of university students when preparing clicker sessions**

   When posed the question relating to the consideration of their students’ social, emotional, and cognitive learning levels, most of the instructors in this sample did not feel this was at the forefront of their thinking while designing clicker questions. At the same time, each of the instructors found it interesting when I posed that question and felt it would be something they would consider in the future development of clicker questions. Instructors should consider how to foster higher-level application, synthesis, and evaluation questions and hopefully generate higher-level cognitive learning in the classroom. Looking at examples of clicker questions at a higher cognitive domain as well as conversing with other clicker users as to how to incorporate clickers in the classroom will support this task. In addition,
fostering discussion after clicker questions are posed will help to bring the cognitive learning levels to a higher domain.

7. **Instructors should use clickers often and in a variety of ways.**

   As shown previously in the student results section of this study, the small sample of students interviewed desired that clickers be used more frequently both within individual classes and across campus. Instructors should plan an adequate amount of class session time for clicker questions and activities. Instructors using clickers should showcase their techniques and experiences within their home department and across campus to generate additional interest and use of clickers.

**Future Research**

The body of research relating to the use of clickers is continuing to emerge. The findings from this study support current literature in the field of clicker technologies and academic learning with regard to an increase in attention and motivation, an enhancement to student learning (Trees & Jackson, 2007), and the feeling that clickers are fun to use (Weiman & Perkins, 2005). Large scale quantitative studies are still needed to examine the effectiveness and acceptability of clickers in higher education. Instructors in this sample felt that clickers have improved their students’ attendance and participation, have decreased student incivility, and have possibly improved academic performance. Research should continue to test these hypotheses in an experimental manner by comparing classes with clickers and classes without clickers. Pre-post use design studies may also be used to capture the perceptions of students and instructors about using clickers.

Courses, workshops, publications, and programming should continue to be developed to support the technological and pedagogical instruction of faculty and students using
clickers. A short list of the technological steps that an instructor can follow during in-class implementation of clicker technology would be beneficial. Faculty members in this study and others I have spoken with have noted that while lists are available through the Turning Point website, the list is too cumbersome and a simpler, step-by-step pictorial may be more beneficial. Faculty would also like to see an easy to use troubleshooting manual. Each of these should be very short in length and basic in content.

Workshops, publications, and webinars should be provided on the technological and pedagogical aspects of using clickers. Examples of ways for faculty to implement the technology into assignments, class activities, and syllabus design could be developed. Slide sharing and examples of higher-level cognitive domain questions can be developed and shared within and across disciplines. For example, there was great value to me, as someone who uses clickers in my teaching, to see the ways in which other instructors formulate and introduce the clickers in their classrooms, in their slide development, and in their syllabi. A short publication listing various discipline specific examples of clicker slides, with a brief explanation of how the slides are incorporated into the classroom, would also be of great value. Given the relatively large sub-sample from human development and family studies in this study, this is something I hope to pursue in the future for my specific discipline.

In addition, more in-depth qualitative analysis is necessary to provide a voice to those currently using clickers. With funded research, a larger student sample size may lead to reaching a saturation point in the perceptions of students about clicker use. Mediating factors such as academic grade level, gender, instructor experience with clickers, student frequency of clicker use, discipline, and grade point average should be considered and researched with regard to student perceptions of clicker use. In addition, an increase in the sample size of
instructors may produce a much different view of implementation of clickers in higher education. Discipline specific studies could result in a breadth and depth of understanding of the use of clickers in both large and small classroom environments. Such factors as student population, faculty experience in teaching, faculty experience with clickers, and class enrollment size may be studied as mediating factors in future clicker research.

As a technology that is emerging and evolving, clickers provide a venue for sustained future research on implementation, effectiveness, and general regard of the clicker as a tool in higher education. Personally, my investigation into the use and impact of clickers in higher education does not end with this study. I have already begun collecting pre-post use data from a multi-class sample of approximately 400 students. This quantitative survey explores the perceptions of students with regard to the use of clickers. I am currently in the process of preparing a manuscript from that data and have also collaborated with a home horticulture instructor on submitting an abstract in her discipline relating to the results of that study.

It is also my intent to develop and publish a simple sequenced pictorial card listing the technical steps required to implement the clicker technologies in the classroom. This idea was developed out of an expressed need from instructors to have a “recipe” to follow when setting up the clicker technology in their classroom. I had already begun the development of that card however a modification to the technology placed that on hold for a brief period of time.

Following the results of the current qualitative, exploratory study, I would also like to develop a publication outlining various examples of clicker slides and clicker classroom activities. Seeing the slides of other instructors and observing their use of clickers in the classroom was invaluable to me as a fellow clicker user. This type of publication could be
discipline-specific or broadly based, with an added component relating to fostering higher-level cognitive thinking in students.

Upon entering my graduate program of study, I had not even heard the work “clicker.” My experience with the clickers has provided for a detour in my educational and career path that has enhanced my understanding of teaching and learning at the university level. It has also provided an added connection to looking in depth at who our university students really are in cognitive, social, and emotional ways. I believe this connection between the tools I use in my teaching, student developmental domains, and strategies to foster improved student learning will forever enhance my teaching abilities.
APPENDICES
Appendix A: IRB approval

The Institutional Review Board (IRB) Chair has reviewed this project and has declared the study exempt from the requirements of the human subject protections regulations as described in 45 CFR 46.101(b). The IRB determination of exemption means that:

- You do not need to submit an application for annual continuing review.

- You must carry out the research as proposed in the IRB application, including obtaining and documenting (signed) informed consent if you have stated in your application that you will do so or if required by the IRB.

- Any modification of this research should be submitted to the IRB on a Continuing Review and/or Modification form, prior to making any changes, to determine if the project still meets the Federal criteria for exemption. If it is determined that exemption is no longer warranted, then an IRB proposal will need to be submitted and approved before proceeding with data collection.

Please be sure to use the documents with the IRB approval stamp in your research.

Please note that you must submit all research involving human participants for review by the IRB. Only the IRB may make the determination of exemption, even if you conduct a study in the future that is exactly like this study.
Appendix B: List of Courses Requiring Clickers for Spring 2008

<table>
<thead>
<tr>
<th>Course</th>
<th>Section(s)</th>
<th>Class Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>AERE161/161H</td>
<td>1,2,3</td>
<td>108</td>
</tr>
<tr>
<td>BIOL 173</td>
<td>2</td>
<td>140</td>
</tr>
<tr>
<td>BIOL 212</td>
<td>1,2</td>
<td>501</td>
</tr>
<tr>
<td>CHEM 164</td>
<td>all</td>
<td>192</td>
</tr>
<tr>
<td>CHEM 165</td>
<td>all</td>
<td>288</td>
</tr>
<tr>
<td>CHEM 177</td>
<td>all</td>
<td>264</td>
</tr>
<tr>
<td>CHEM 178</td>
<td>all</td>
<td>456</td>
</tr>
<tr>
<td>FIN 400</td>
<td>a,b</td>
<td>48</td>
</tr>
<tr>
<td>FOR 302</td>
<td>a</td>
<td>50</td>
</tr>
<tr>
<td>FSHN 360</td>
<td>1,2</td>
<td>360</td>
</tr>
<tr>
<td>GEOL 101</td>
<td>a</td>
<td>251</td>
</tr>
<tr>
<td>GEOL 102</td>
<td>a</td>
<td>40</td>
</tr>
<tr>
<td>HDFS 220</td>
<td>1-15</td>
<td>60</td>
</tr>
<tr>
<td>HDFS 240</td>
<td>1</td>
<td>140</td>
</tr>
<tr>
<td>HDFS 340</td>
<td>1-5</td>
<td>30</td>
</tr>
<tr>
<td>HDFS 373</td>
<td>1</td>
<td>40</td>
</tr>
<tr>
<td>IE 305</td>
<td>all</td>
<td>220</td>
</tr>
<tr>
<td>ME 330</td>
<td>a,b</td>
<td>112</td>
</tr>
<tr>
<td>NE 231</td>
<td>a</td>
<td>48</td>
</tr>
<tr>
<td>MICRO 302</td>
<td>all</td>
<td>150</td>
</tr>
<tr>
<td>MICRO 475</td>
<td>all</td>
<td>80</td>
</tr>
<tr>
<td>NREM 120</td>
<td>all</td>
<td>220</td>
</tr>
<tr>
<td>PHYS 101</td>
<td>all</td>
<td>260</td>
</tr>
<tr>
<td>PHYS 106</td>
<td>all</td>
<td>168</td>
</tr>
<tr>
<td>PHYS 111</td>
<td>all</td>
<td>440</td>
</tr>
<tr>
<td>PHYS 221</td>
<td>all</td>
<td>800</td>
</tr>
<tr>
<td>PHYS 222</td>
<td>All</td>
<td>534</td>
</tr>
<tr>
<td>POL S 215</td>
<td>8</td>
<td>220</td>
</tr>
<tr>
<td>SPAN 322</td>
<td>1</td>
<td>35</td>
</tr>
</tbody>
</table>

Total: 6255
Appendix C: Instructor Recruitment Solicitation

Faculty Email Request

Dear _________________.

I am conducting a study for my doctoral dissertation on the use of personal response systems, or clickers, on campus. I received your name from the campus book store as a person who is currently using clickers in your teaching. I would love to interview you with regard to your experience and perceptions of using clickers in the classroom. I expect the interview to last no more than 30 minutes. In addition, if you agree to participate in my study, I would need to observe your classroom on a date of your choosing, review clicker slides of your choosing, and interview 3-4 of your students as to their perceptions of the use of clickers.

This is an exploratory, qualitative study with the purpose of learning more about how clickers are being used on campus to foster higher-level thinking in college students. As one who uses clickers in my own teaching, I am interested in the methods, perceptions, and experiences of other instructors currently using clickers.

Thank you for your time and consideration of participation in this study. I look forward to hearing from you as to whether or not you would be willing to participate.

Jennifer Diers, Doctoral Candidate
Human Development and Family Studies
REQUEST FOR STUDENT PARTICIPATION IN CLICKER STUDY

Here is your chance to voice your opinion as a student in this class!! Jen Diers, a doctoral candidate, is looking for students from this course to participate in a study on the use of clickers. The focus of the study will be to better understand how clickers were used in this course and what your perceptions were of the use of clickers.

TIME COMMITMENT: 1 interview (no more than 30 minutes)
WHEN: at your convenience
WHERE: at your convenience
BENEFIT: The opportunity to be a part of cutting edge research and to voice your opinion on the use of clickers!

TO PARTICIPATE: Contact Jen Diers at ________________.
Appendix E: Instructor Interview Question Protocol

Faculty Interview Question Protocol

1. How long have you
   a. taught at the college/university level?
   b. used clicker technologies?

2. Describe to me the ways in which you use clickers in your class?
   a. Give examples of how you use them and/or of the questions you pose.
   b. How are clickers incorporated into your syllabus/course points?
   c. Can you provide an example of a “teaching moment” with clickers?

3. What process did you go through to decide the ways in which you would use clickers in your classroom?
   a. Did you receive any guidance on this?
   b. Would you have any recommendations on this process of deciding how to use the clickers in the classroom?

4. Do you feel clicker technologies affected participation in the class?
   a. If yes, how?
   b. Can you provide an example of this?

5. Do clicker technologies affect attendance in the class?
   a. Can you share how you came about this feeling of the affect clickers had on attendance?

6. Do you think clickers would be beneficial in both large and small classes?
   a. Why or why not?
   b. What might be some differences one would need to consider?

7. What do you feel
   a. is most beneficial about clickers?
   b. are some limitations to clickers?

8. What did you like
   a. best about clickers?
   b. least about clickers?

9. Did using clickers change your teaching?
   a. Can you provide an example of this?

10. What is your perception of your students’ feelings on the use of clickers in the classroom?
a. Can you provide an example of how you came to know what your students’ thoughts were?

11. Have you ever considered the developmental learning level of your students when designing the ways in which you will use clickers?
   a. Would you use clickers in a different way if you were teaching a different age of students? Please describe?
   b. Would you use clickers in a different way if you were in a different discipline?

12. Would you recommend to other instructors the use of clickers? Why or why not?

13. Is there anything else you would like to tell me about the use of clickers?
Appendix F: Bloom’s Taxonomy

Bloom et al.‘s Taxonomy of the Cognitive Domain


<table>
<thead>
<tr>
<th>LEVEL</th>
<th>DEFINITION</th>
<th>SAMPLE VERBS</th>
<th>SAMPLE BEHAVIORS</th>
</tr>
</thead>
<tbody>
<tr>
<td>KNOWLEDGE</td>
<td>Student recalls or recognizes information, ideas, and principles in the approximate form in which they were learned.</td>
<td>Write, List, Label, Name, State, Define</td>
<td>The student will define the 6 levels of Bloom’s taxonomy of the cognitive domain.</td>
</tr>
<tr>
<td>COMPREHENSION</td>
<td>Student translates, comprehends, or interprets information based on prior learning.</td>
<td>Explain, Summarize, Paraphrase, Describe, Illustrate</td>
<td>The student will explain the purpose of Bloom’s taxonomy of the cognitive domain.</td>
</tr>
<tr>
<td>APPLICATION</td>
<td>Student selects, transfers, and uses data and principles to complete a problem or task with a minimum of direction.</td>
<td>Use, Compute, Solve, Demonstrate, Apply, Construct</td>
<td>The student will write an instructional objective for each level of Bloom’s taxonomy.</td>
</tr>
<tr>
<td>ANALYSIS</td>
<td>Student distinguishes, classifies, and relates the assumptions, hypotheses, evidence, or structure of a statement or question.</td>
<td>Analyze, Categorize, Compare, Contrast, Separate</td>
<td>The student will compare and contrast the cognitive and affective domains.</td>
</tr>
<tr>
<td>SYNTHESIS</td>
<td>Student originates, integrates, and combines ideas into a product, plan or proposal that is new to him or her.</td>
<td>Create, Design, Hypothesize, Invent, Develop</td>
<td>The student will design a classification scheme for writing educational objectives that combines the cognitive, affective, and psychomotor domains.</td>
</tr>
<tr>
<td>EVALUATION</td>
<td>Student appraises, assesses, or critiques on a basis of specific standards and criteria.</td>
<td>Judge, Recommend, Critique, Justify</td>
<td>The student will judge the effectiveness of writing objectives using Bloom’s taxonomy.</td>
</tr>
</tbody>
</table>
Appendix G: Student Interview- Question Protocol

1. What is your year in school? What is your major?

2. How many courses have you had in which you used clickers?

3. In what ways did your instructor use clickers in this current class?
   a. What methods did he/she use?
   b. How often did you use them? Was this enough?

4. Did the use of clickers affect your attendance in this class?

5. Did the use of clickers affect your participation in this class?

6. Do you think clickers would be beneficial in both large and small classes? Why or why not?

7. What do you feel
   a. is most beneficial about clickers?
   b. are some limitations to clickers?

8. What did you like
   a. best about your instructors using clickers?
   b. least about your instructors using clickers?

9. Do you feel the use of clickers supports your learning?
   a. Why or why not?
   b. In what ways?
   c. In relation to your developmental/social/emotional levels as a college student?

10. Is there anything your instructor could do with clickers to enhance your learning?

11. Is there anything else you would like to tell me about the use of clickers?
## Appendix H: Clicker Slide Examples of Bloom’s Taxonomy

<table>
<thead>
<tr>
<th>Knowledge</th>
<th>The first theorist to start worrying about human population growth was:</th>
<th>The second number on a fertilizer bag tells you the amount of:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1. Charles Darwin</td>
<td>1. nitrogen</td>
</tr>
<tr>
<td></td>
<td>2. Thomas Malthus</td>
<td>2. potassium</td>
</tr>
<tr>
<td></td>
<td>3. Paul Erlich</td>
<td>3. phosphorus</td>
</tr>
<tr>
<td></td>
<td>4. Garret Hardin</td>
<td>4. carbon</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Comprehension</th>
<th>Piaget’s theory relates to death &amp; dying in that:</th>
<th>19 year old Jane drives after drinking at a party. She rebukes protests by saying that nothing is going to happen to her. This is…</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1. children cannot begin to understand death &amp; dying</td>
<td>1. socialization</td>
</tr>
<tr>
<td></td>
<td>2. Cognitive development underlies understanding DD</td>
<td>2. invisible death</td>
</tr>
<tr>
<td></td>
<td>3. Adults should use metaphors when discussing death with children</td>
<td>3. altruism</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. personal fable</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Application</th>
<th>What nutrient deficiency is this? (picture of a diseased plant is included on slide)</th>
<th>After a routine check up, your doctor expresses concerns. She discussed possible scenarios involving serious illness. What would you do that evening?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1. phosphorus</td>
<td>1. not think about it</td>
</tr>
<tr>
<td></td>
<td>2. nitrogen</td>
<td>2. call someone I love</td>
</tr>
<tr>
<td></td>
<td>3. iron</td>
<td>3. look up info on the internet</td>
</tr>
<tr>
<td></td>
<td>4. calcium</td>
<td>4. figure out what this may mean</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Analysis</th>
<th>Bone marrow is unable to respond? (based on a medical case study)</th>
<th>Anemia of chronic renal disease? (based on a medical case study)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1. erroneous</td>
<td>1. erroneous</td>
</tr>
<tr>
<td></td>
<td>2. correct</td>
<td>2. correct</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Synthesis</th>
<th>The most worrisome sort of pollution is:</th>
<th>How is the water quality in Iowa?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1. Disease organisms</td>
<td>1. excellent-no worries</td>
</tr>
<tr>
<td></td>
<td>2. Sediment</td>
<td>2. very good</td>
</tr>
<tr>
<td></td>
<td>3. Oxygen-demanding wastes</td>
<td>3. ok for people</td>
</tr>
<tr>
<td></td>
<td>4. excess nutrients</td>
<td>4. sometimes a worry</td>
</tr>
<tr>
<td></td>
<td>5. toxics</td>
<td>5. ongoing concerns</td>
</tr>
<tr>
<td></td>
<td>6. heavy metals</td>
<td>6. fundamental worries</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation</th>
<th>Who should pay to provide clean and abundant water?</th>
<th>People should have the right to die on their own terms.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1. government</td>
<td>1. strongly agree</td>
</tr>
<tr>
<td></td>
<td>2. business</td>
<td>2. agree</td>
</tr>
<tr>
<td></td>
<td>3. consumers</td>
<td>3. neutral</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. disagree</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. strongly disagree</td>
</tr>
</tbody>
</table>
REFERENCES CITED


ACKNOWLEDGMENTS

It had never been my intent to include an acknowledgments section in my dissertation. However, having come to the end of this long process of research and writing, I feel there are several people I must thank in writing.

*Sedahlia*- None of this would have been possible without your constant encouragement, excellent revisions and suggestions, and continued patience with me! Thank you sincerely!

*Corly*- You have no idea the impact you have had on my life as an educator and a person! I will never forget that day we sat in the Lab of Mechanics and like two blind mice decided to use clickers in HDFS 102! What a journey it has been! My words can not express the gratitude and friendship I have in you!

*Kim, Mack, and Cathy*- Thank you so much for agreeing to be a part of this human development and family studies dissertation that was so far in left field from the normal dissertations in our department. I so value the flexibility, expertise, and encouragement each of you has brought to my work!

*Doug, Kobe, Luke, and Faith*- There simply are not words to express my gratitude and love for each of you!

I thank God daily for His divine presence in every step of this journey. I am overjoyed by the experiences and friendships I have gained during my time in graduate school and I look forward to the next steps in His plan for my life!