2009

# Effects of an audience response system on student learning outcomes in an applied kinesiology course

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# EFFECTS OF AN AUDIENCE RESPONSE SYSTEM
# ON STUDENT LEARNING OUTCOMES
# IN AN APPLIED KINESIOLOGY COURSE

A Dissertation

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

In

The Department of Educational Theory Policy and Practice

by
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December 2009

Acknowledgements

I believe that most people who pursue doctoral education have no idea how much time, discipline, effort and energy it takes to complete it. I certainly underestimated the total cost. I certainly could not have accomplished it alone. Hillary Clinton stated that it takes a village to raise a child. It did take a village to raise me to this level of education. To those members of my village, I owe sincere appreciation.

Yiping Lou, my major professor, kept me on track. She motivated me, comforted me, challenged me and taught me. Her guidance and friendship were the driving forces that pushed me to completion. I would not have done it without her patience and presence.

My committee members, Janna Oetting, Pamela Blanchard, Eugene Kennedy and Alex Garm, each joined my team at a time of need. There were some shaky times when committee members came and went, but you were there for me through the end. I cannot adequately express my appreciation for their time, expertise and guidance.

Leah Geheber and Marty Aime, my co-workers, who so often took the burden of work and teaching to allow me to trudge along over the years. I hope that I can repay the favor some day.

My family who encouraged me to continue and put up with my absence, both in body and in spirit, even though they really did not understand what I was doing much of the time. They kept me sane.

Finally, my husband and better half, Robert Krieg, took over the household and family. His understanding, patience, dedication and love earned him his share of this degree. He worked at least as hard as I did, and pushed and supported me to the end. He was my home and my heart.

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## Abstract

The purpose of this study was to examine the effects of using audience response systems (ARS) on student learning outcomes and learning processes, when the instructional strategy of using sequentially challenging questions and collaborative discussions were held constant across both treatment and control conditions. A quasi-experimental AB alternating research design was employed. Two sections of a Functional Anatomy and Kinesiology course at a small faith-based college participated in the study. One section served as control and the other section as treatment groups until midsemester, when the roles of the groups switched.

Both quantitative and qualitative data were collected and analyzed. Independent t-tests showed no significant impact of ARS in either the unit exams, or the final exam. Chi square tests demonstrated no significant difference in imbedding questions within the presentations. Most students preferred attending class where the ARS are used, citing greater engagement with the instructor, the material and their peers.

# Chapter One

## Introduction

### Context of the Problem

Clinical programs in the Health Sciences are challenged to meet the growing, often conflicting, demands of several stakeholders. Many of the programs are offered on the associate degree level, at the mandate of the discipline's accrediting standards. As educational costs continue to rise, the federal government and the public demand that the educational programs, and the institutions that support them, demonstrate that graduates achieve meaningful learning outcomes that prepare them for the demanding careers that they have chosen (Ryan, J., 2005).

There is a current shortage of health care workers which is estimated to reach critical numbers in the next five to ten years as the baby-boomer generation reach retirement age (http://www.hrsa.gov/). This is particularly true in rural areas and poorer areas of the country. Increasing demand for health care providers is compounded by the expected increase in levels of acuity of patients being cared for, particularly with the uninsured and underinsured populations (http://www.hrsa.gov/). More acute patients are at risk to develop complications, and the medical care must be adapted accordingly. In order to insure patient safety, the health care worker must accept greater responsibility in patient care. Critical thinking and problem solving skills are essential for monitoring and adapting care of the complex patients.

Associate degree programs are challenged to facilitate problem solving and critical thinking abilities in students within a relatively short period of time (two years). The programs respond with the development of accelerated and challenging curricula. Minimal general education core courses must prepare the students to manage the challenging discipline specific courses. Content within the discipline specific courses is usually cumulative and integrative in nature, spanning cognitive, affective and psychomotor domains. Because of the rapidity in which the content is presented, the depth of the learning required is often a difficult adjustment, and it requires that the student have developed the study skills necessary. Students must comprehend complex principles and apply them in real world contextual formats. Lack of preparation for the demanding material often results in high rates of course failure and poor retention of students.

Associate degree programs often attract a large number of non-traditional students, as well as traditional students, because of the relatively short investment of time required to complete the curriculum and enter the workforce. Traditional students are defined as first time freshmen, who transition to college immediately following high school graduation (McGlynn, 2005). Some of them are the first generation of collegians in their families, and most of them graduated from high schools with a traditional lecture style, teacher centered learning environment. As such, passive learning, with predominantly rote memorization and isolated studying, is the successful learning profile of these students as they begin college.

Non-traditional students are defined as older students, generally over the age of 25, who are returning to school after having undergone some critical life event (Justice & Dornan, 2001). Critical events may include searching for a second career or for a first career, after having raised a family or terminated a marriage. Non-traditional students generally work full time and support themselves and their families. They often have school-aged children at home. Some may have completed high school or may have received a GED. Many have been separated from the academic setting for several years. Others may have an advanced degree in a different discipline. These students have responsibilities, personal issues and demands on their time far greater than the traditional student. They contribute to a very diverse class makeup, but require different learning environments than do traditional students (Justice & Dornan, 2001). The mixture of such diverse students challenges the instructors to develop learning activities that address multiple learning styles and capacities.

Most graduates of clinical programs are required to take nationally administered examinations, which enable them to apply for licensure, or registration, to practice. Licensing boards develop rigorous examinations which insure that the licensee is capable of safely managing these complex patients as competent entry-level practitioners. The examinations are generally written by expert clinicians, with academic faculty input. However, current practice in a given discipline is not always cohesive with accreditation standards, upon which academic curricula are designed. The level of difficulty of the examinations is based on the degree of responsibilities and knowledge foundation expected of entry-level clinicians across the country, and it is designed to protect the consumer of the clinical service. Test items are often written at taxonomy levels which exceed those expected of entry-level practitioners by educators. Instructors are challenged to find methods to facilitate the learning process so that all students develop the depth of comprehension necessary to successfully sit for the licensure examinations and to practice safely.

There is a large body of literature investigating the relationships between student learning outcomes, instructional methodology, student engagement and instructional technology. Modern educational technology has made it possible to provide opportunities and activities for learning that complement individual student learning styles and preferences (Lefoe, 1998). Whereas, students once were fed information as passive learners, constructivist theory encourages students to be active in the learning process (Juniu, 2006; Tynjala, 1998). In fact, students are encouraged to construct their own knowledge within the contexts of real world applications. Technological media is particularly supportive of this pedagogy, in that information can be presented in a variety of multimedia styles that meet individual student needs (Lefoe, 1998; Motschnig-Pitrik, 2005; Notar**,** 2005, Tynjala, 1998), making instructional activities more life-like. Students can often participate anonymously, providing a safe medium of participation for students who generally do not participate (Millerand & Gertz**,** 2003; Murphy & Smark, 2006). Active learning also facilitates students' learning how to learn (Paulsen & Feldman, 2005). Active learning is particularly important for individuals pursuing health care careers, where there are continual changes in theory, interventions and administrative management of clinical services (Menon, A. S., Moffett, S., Enriquez, M. Martinez, M. M., Dev, P., & Grappone, T., 2004). Students must learn how to monitor and assess their clinical performance and knowledge; seek resources from which to remediate areas of weakness; and, access opportunities for personal and professional growth. This life-long learning process begins in the college curriculum, as metacognitive skills are developed.

Associate degree programs are challenged to meet the learning needs of their diverse student enrollment, while maintaining high retention of students within the programs. An added caveat is that many accrediting agencies and college administrators gauge a program's worth by the retention rates and first time pass rates on licensure and certification examinations. Instructors constantly strive to develop ways to academically support the needs of all students while providing the challenge needed to develop deeper thinking and learning, and while maintaining the students' motivation to achieve. The effort requires the ability of the instructor to incorporate educational technology with sound educational pedagogy to stimulate cognitive processes in students and to maintain student engagement.

Statement of the Problem

Students in clinical associate degree programs must develop the ability to learn information for deeper understanding and the ability to apply what is learned to real world situations. They must develop critical thinking skills, often within a three or four semester window of opportunity, so that they can determine safe practices with patients and clients, when working autonomously in the clinical setting. Mature learning and integrative thinking must occur quickly, in order to be prepared to successfully pass the licensure examination and to provide safe clinical practice. For many students this requires that they develop learning behaviors which allow them to learn the material in a deep, conceptual manner; enabling them to apply the knowledge in different contexts, as additional information is accumulated and environments change.

Conceptual learning is a metacognitive skill that develops over time, based on a learner's experiences and the learning context (Mayer, 2002). It is the learning of material for true comprehension, rather than for superficial recall. However, most students study to learn material superficially, often the result of passive learning experiences from courses presented as traditionally teacher-centered. Students, who have a conceptual learning strategy when they enter the clinical program, adapt successfully to the accelerated pace of presentation without difficulty, perform well in clinical situations and successfully pass the licensure examination upon graduation. Students, who continue to utilize superficial learning strategies, are often unable to apply the content when tested at deeper levels, experience difficulty explaining concepts when questioned by instructors, clinicians and patients; feel intimidated when asked to participate in class discussions; and, are often required to repeat sitting for the licensure examination multiple times, due to inability to meet minimum passing scores. Repeated failure of the examination is very costly to the graduate, not only because of the high fees assessed per sitting, but also in the graduate's level of confidence in the their ability to successfully complete the examination. In addition to the effect on the graduate, the first time passage rates are often considered a reflection of the quality of the program's curriculum, and they are often used to determine institutional support and continued accreditation.

There are numerous technologies available to support active learning on the market. It is often difficult to develop competency in one technology before it is becomes obsolete, due to emerging new technologies. Literature investigating the impact of technology on education presents conflicting evidence (Lou, Bernard, & Abrami, 2006; Mayer, Stull, DeLeeuw, Almeroth, Bimber, & Chun, 2009). However, societal demands push institutions to provide current technological support to improve student learning outcomes (J. Ryan, 2005). One technology, audience response systems (ARS), also called clickers, personal response systems and voting systems, has emerged as a system which provides both the instructor and the student with the means to assess learning before formal assessment, and which facilitates more active, student-centered learning activities in larger classes. Promising research in the field of physics supports the use of ARS with questions and group discussion to facilitate deeper learning (Crouch & Mazur, 2001; Hake, 1998). Therefore, use of ARS, coupled with sound educational pedagogy integrating appropriate level questions and group discussions, should also improve learning outcomes in courses within clinical curricula.

An applied kinesiology course in the Physical Therapist Assistant Program at a small faith-based college in Louisiana serves as a foundation course for subsequent courses centered on movement rehabilitation. The course presents anatomical and functional aspects of normal movement. Subsequent courses build on that foundation with pathologic processes that impact movement, assessment of movement dysfunction and interventions used to rehabilitate movement dysfunctions. Since the practice of physical therapy centers on rehabilitation of movement dysfunction, it is critical that practitioners maintain strong conceptual knowledge of normal movement characteristics and the structures involved. This course often provides the first experience challenging the way that students learn the material. Although much of the material is presented in a modified lecture format, students engage in activities in the lab that apply concepts and reinforce learning. In addition, students are assessed at levels requiring application of concepts and analysis of movement. This requires the student to integrate the material in different contexts in order to select the correct answer. Test questions mimic those found on the licensure examination, preparing the student to think more comprehensively and utilize the information functionally, thus mirroring real world experience. Students are required to develop methods of study that conceptualizes the material and provides deeper learning. Students who have experienced primarily passive learning resist changing study methods and often fail to successfully complete the course. They often wait until they have failed one or two of the examinations before recognizing their problem and seeking assistance, but the delay often allows insufficient time to learn material presented at the beginning of the course. Therefore, the student continues to struggle with the new material.

## Purpose of the Study

The purpose of this study is to investigate the impact of ARS on student learning outcomes and learning processes, when used in conjunction with instruction based on accepted educational pedagogical principles, as compared to a control group that does not use the ARS. The study explores the relationship between technology use and the development of deeper learning necessary for self regulated learning and critical thinking. The theoretical framework for this study emerges from the wealth of literature on learning theory, educational theory, critical thinking and metacognition, engagement and the use of technology in instruction. This study was different from most of the studies on ARS, and a large number of studies on the effects of technology use on student achievement, that often confound the effects of media and pedagogy, in that the instructional strategy of embedding sequentially challenging questions and student discussion during content presentation were implemented in both the treatment and control conditions. The results of this study add knowledge, understanding and clarity to the sometimes conflicting evidence and confusion about the worth of ARS in the classroom and to the overall discourse of media and pedagogy debate.

## Research Questions

Several research questions informed the design of the study:

1) Does the use of audience response systems significantly improve student learning outcomes?

2) Do questions of sequential difficulty embedded in presentations significantly improve student learning outcomes?
3) How do students perceive the benefit of ARS in the classroom?
4) How do students perceive the benefit of questions within the presentation?
5) How does the use of questions and ARS in the classroom benefit the instructor?

Significance of the Study

The development of mature learning skills early in the clinical program allows the students to form a foundation of knowledge that grows as new information is presented, allowing it to become functional and integrated. The strong knowledge base prepares graduates to confidently enter the work force and practice safely. The self-regulated learning provides the means for the student to maintain competency and to continue to develop expertise in his field. Instructional methods that promote deeper learning and support achievement of student learning outcomes allow clinical programs to graduate students who are safe practitioners and capable of meeting the challenges of the changing health care environment.

As we gain greater understanding of how technology and pedagogy interact to promote student learning, we can provide supportive learning environments that satisfy the needs of all stakeholders in the educational process. Institutions of higher education can justify rising costs associated with technology innovation through sound assessment practices. Finally, instructors can develop more effective and efficient formative assessment methods that identify levels of comprehension early. They can adjust instruction to meet the needs of students in a timely manner and engage in positive interactions that allow the students to become more productive learners.

Limitations of the Study

The study was conducted at a small, private, faith-based college which offers primarily degree programs related to clinical health care. Classes are generally very small (25-35 students per section), and there are only a few sections offered per semester. The applied kinesiology course that is the focus of the study is offered only in the spring semester of each year. This factor limits the participants available to participate in the study.

Because acceptance to the clinical programs is competitive, students are protective of their grade point averages, and they often withdraw from courses by mid-semester, rather than fail the course. This factor further threatens the number of participants. The low number of participants threatens the reliability of the study due to potential sampling error and failure to control type II errors.

The quasi-experimental AB design of the study incorporated both a treatment and a control group to better control for teacher effect and student affect. Because each group served as treatment and control, alternately, the specific effects of utilization of ARS were isolated during the period in which the group served as treatment. The final examination score reflected equal treatment of both groups, resulting in a net equal effect of both groups. The design strengthens the internal validity of the findings. In addition, both quantitative and qualitative measures were used in an attempt to add depth and breadth to the study outcomes.

# Chapter Two

## Literature Review

There is a plethora of literature that explores the various aspects of learning. The complexity of the learning process provides a rich environment for research, as it is difficult to isolate one aspect of learning from the multiple factors that contribute to the process. This literature review presents what is currently understood about active student-centered learning, student engagement, conceptual and metacognitive learning, effective pedagogical methods of instruction and use of technology in the classroom to establish a theoretical framework that investigates and explains how the use of audience response systems in the classroom impact student learning.

### Student-centered Learning

A variety of learning theories have emerged over the years, as educators and scientists attempted to optimize both student learning and instructional methods. Traditional educational practices, based on the Behaviorist philosophy of learning, presents information in lecture format, where the instructor builds the information through instructional sequences based on a pre-designed instructional model (Dori & Belcher, 2005; Lefoe, 1998). This teacher-centered environment presents the instructor as the content expert, delivering knowledge to the passive learner (Åkerlind, 2004; Dori & Belcher, 2005; Larson and Ahonen, 2004).

Traditional lecture based teaching fosters rote memory learning for test content and promotes little comprehension of contextual aspects of the material (Baderin, 2005; Case & Gunstone, 2002; Diaz-Lefebvre, 2004; Dori & Belcher, 2005). These traditional practices have been adequate to educate technical personnel in the nation's industrial development period; however, they have been criticized for failure to meet the needs of today's graduates in the global market. The knowledge acquired is considered inert knowledge, which fails to establish the foundation of complex problem solving and critical thinking necessary to compete in today's competitive global economy (Tynjala, 1998; Weimer, 2003). There is the added dimension that student confusion and boredom occur within 10-20 minutes of traditional lecture (Larsen & Ahonen, 2004), with only

25% student retention of the material at three hours following the presentation and 10-20% three days later (McIntosh, 1996).

Information processing theories, from the cognitive science tradition, provide a more scientific approach to understanding the learning process. Mayer (1984, 2002) explains that knowledge construction requires that the individual select, organize and integrate the material in working memory, tying it to established knowledge. New knowledge is based on experience and existing knowledge. The learner actively selects new information, organizes the information for learning, and integrates new experiences with existing knowledge. Memory is stored as schemas, or “frames”, and when new information is introduced, the learner maps that information against old frames, overwriting old relationships of knowledge in respect to the new information (Adams, 1989). This process requires active integration between sensory systems, working memory and long-term memory. Several brain areas must be stimulated simultaneously, forming new neuron connections and establishing the network representing new knowledge (Wesson, 2002). The multi-sensory presentation of material stimulates multiple areas of the brain simultaneously, gaining greater synaptic activity for memory to occur (Schunk, 1998). New information is spontaneously constructed within the working memory. Instructors explain content and model strategic processing, thereby providing a conceptual foundation from which the students can develop their own knowledge (Muthukrishna & Borkowski, 1995). An effective curriculum continually ties new information to old information and contextual relationships (Rauk, 2003).

Learning is a developmental process. Students do not always process information presented by the instructor as intended, or they often construct their own meaning to the information presented (Schunk, 1998). In addition, individuals vary in the manner in which they process information (Lyons and Languis, 2001), which is highly influenced by the individual’s biology, personality and temperament (Wesson, 2002). Teaching methods must be aligned to the level of student development, and the students should be challenged toward greater development. Instructors could facilitate elaboration of information through repetition and questions (Rauk, 2003).

Constructivist theory proponents perceive learning as an active process, whereby the learner constructs his own knowledge, based upon past experiences and the context within which the learning occurs (Applefield, Huber & Moallem, 2001; Cornford, 2002; Downing, 2001; Lefoe, 1998; Mayer, 2002; Motschnig-Pitrik, 2005; G. Ryan, 1993; Tynjala, 1998). The instructor is responsible for supporting the process of constructing knowledge, rather than providing the knowledge (Jonassen, 2003; Lefoe, 1998). The student must become an active participant in the learning environment through sequences of instructional activities, relating the information to real world experiences (Lefoe, 1998; Simpson and Nist, 2000; Wisker, Tiley, Watkins, Waller, & Thomas, 2001). The instructor becomes a facilitator for learning, as students engage in concept modeling using a variety of tools and resources (Jonassen, 2003; Jonassen, Strobel & Gottdenker, 2005).

Social constructivism, particularly, proposes that learning occurs within a group setting, rather than as a property of a single individual (Dori & Belcher, 2005). Dialogue is an integral component of learning, because deeper learning is facilitated through the social interactions between peers and instructors (Applefield et al, 2001; Downing, 2001; Lefoe, 1998; Napell, 1978). Peer assistance offers different perspectives and reasoning strategies (Applefield et al, 2001); Crouch & Mazur, 2001; Dori & Belcher, 2005). The instructor guides the learning process through thought provoking questions (Napell, 1978; Rauk, 2003; Simpson & Nist, 2000), challenges to one's beliefs and values (Umbach & Wawrzynski, 2005), peer collaboration (Crouch & Mazur, 2001), explanations, and timely support and feedback (Baderin, 2005; D.L. Butler & Winne, 1995; Cooper, 2000; McCune & Hounsell, 2005).

Barr and Tagg (1995) identified the emergence of a new educational paradigm which focuses primarily on the production of learning, which is replacing the traditional paradigm of instructors producing instruction. The shift is fueled by many factors. Greater access to higher education (Barr & Tagg, 1995; Koljatic & Kuh, 2001), coupled with increasing costs of higher education and the need for graduates to participate competitively in the global economy (Barr & Tagg, 1995; Kuh, 2001), have facilitated the instructional paradigm change (Applefield et al, 2001; Kuh, Laird, & Umbach, 2004).

Cornford (2002) proposes that three “pervasive revolutions, technological, economic and social in nature,” have in fact changed the nature of work, skill and knowledge. Continued learning throughout the life span will be required to keep abreast of the changing skill and knowledge requirements. Individuals will need to be able to learn and process new knowledge quickly. This requires metacognitive, self-regulated learning skills.

Traditional quality outcome measures at colleges and universities, such as number of doctorally prepared faculty, admission selectivity, financial resources and library holdings no longer hold the level of trust that they once held (Umbach & Wawrzynski, 2005). Colleges and Universities must answer to legislators and parents in regard to the demands for significant improvements in undergraduate education (Chickering & Gamson, 1991).

Student Diversity

There are more students attending college, many of whom are less prepared for rigorous study (Koljatic & Kuh, 2001; Kuh, 2003). Student populations are very diverse, adding a complex range of student needs into the equation (D. Collins, 2000: McGlynn, 2005). There are currently three different generations of traditional and non-traditional students in the college classroom today; each with individual characteristics, values, learning needs and preferences (D. Collins, 2000; Diaz-Lefebvre, 2004; McGlynn, 2005), and any combination of which can be enrolled in a given course simultaneously.

According to the National Center for Educational Statistics (2006), 44% of students attending college are classified as non-traditional students. Non-traditional students are defined as older students, generally over the age of 25, who are returning to school after having undergone some critical life event. Critical events may include searching for a second career, or for a first career, after having raised a family or terminated a marriage. Non-traditional students generally work full time to support themselves and their families. They often have school-aged children at home. Some may have completed high school or may have received a General Education Degree (GED). Many have been separated from the academic setting for several years. Others may have an advanced degree in a different discipline. These students have responsibilities, personal issues and demands on their time far greater than the traditional student. All of the generations are represented by non-traditional students, and they contribute to a very diverse class makeup, but require different learning environments than do traditional students (Justice & Dornan, 2001).

Baby boomers were born between 1946 and 1964, in the social aftermath of WWII (Fowler, 2004). They were instrumental in the gender-wars, the space race, Watergate and the war in Vietnam (Oblinger, 2003). Many of the baby boomers are technologically naïve, having grown up in the era of land-line telephones and television (Fowler, 2004). Boomers resist change, and are more likely to accept being micro-managed. Teamwork is important, and they are motivated by titles and pay raises.

Generation X-ers, born between 1965 and 1981, are independent and entrepreneurial, and they challenge traditional methods (Fowler, 2004). Many were raised by working mothers or divorced parents. They are willing to work hard within given time parameters (Fowler, 2004), preferring a balanced life. They experienced the reality of the U.S. stock market crash, Chernobyl, Challenger and Exxon Valdez (Oblinger, 2003). They were alive when the first computer disk was sold and computers were introduced to individual homes and educational settings (Oblinger, 2003). They are effective in using technology, although they were not born into it, and they often prefer interaction with technology rather than with people (Collins, D., 2000).

The new wave of students are called Millenials, the Net generation, and generation Y (Fowler, 2004). Millenials were born between 1982 and 2000 (Fowler, 2004). They have grown up with technology, embracing it in every aspect of their lives (Van Horn, 2006) and viewing it as a natural part of their environment (Fowler, 2004; Oblinger, 2003). Millenials are racially and ethnically diverse (McGlynn, 2005; Oblinger, 2003), 20% of whom have at least one immigrant parent (McGlynn, 2005).  Millenials grew up during a time of prosperity, and are used to being indulged (McGlynn, 2005). They identify with their parent's values and are close to them (Oblinger, 2003). They gravitate toward group activities and are fascinated with new technologies (Murphy & Smark, 2006; Oblinger, 2003). They rarely read books; hate busywork, and expect instant feedback ("How the new generation of well-wired multitaskers is changing campus culture", 2007).  The Millenials stay connected (McGlynn, 2005). Between 87% and 94% of them use the internet regularly (McGlynn, 2005; Oblinger, 2003), and most communicate freely through e-mail and text messaging. Because Millenials grew up with technology, they are used to interactive inquiry and have little tolerance for traditional lectures which encourage passive learning (Murphy & Smark, 2006). They are often more comfortable with technology than their teachers, and they are often disappointed with the level of technology in their schools (Oblinger, 2003).

Classes have become significantly larger, with enrollment numbering in the hundreds of students at times, particularly in large auditorium style lecture halls (Debevec,Shih, & Kashyap, 2006; Druger, 2003; Jacobson, 2005; Skiba, 2006). High absentee rates in large classrooms also prevent student-instructor interactions ( Baderin, 2005; Debevec, et al, 2006; Druger, 2003; Jacobson, 2005; Larson & Ahonen, 2004; Moore & Miller, 1996). These factors have contributed to the recognition for the necessity of quality assurance measures that identify measurable student outcomes (Ahlfeldt et al., 2005; Coates, 2005; Koljatic & Kuh, 2001; McCune & Hounsell, 2005; Pike & Kuh, 2005).

Student Engagement

Chickering and Gamson (1991) published *Seven Principles for Good Practice in Undergraduate Education*, in collaboration with other well known educators of the time. The seven identified principles were identified from educational research spanning five decades, and they established a foundation for practices that foster desirable student outcomes (Chickering & Gamson, 1991). The seven principles include: encouraging student-faculty contact, encouraging cooperation among students, encouraging active learning, giving prompt feedback, emphasizing time on task, communicating high expectations, and respecting diverse talents and ways of learning. These findings, along with findings from later research, served as the foundation for the development of the National Survey of Student Engagement.

The National Survey of Student Engagement (NSSE) is a project funded by the PEW Charitable Trusts, the results of which were first published in 2000 (Kuh, 2001, 2003). NSSE is established around five benchmarks of student engagement, which students perceive are quality criteria for excellence in education (Carini, Kuh, & Klein, 2006; Kuh, 2003; Reisberg, 2000). These benchmarks include level of academic challenge, active and collaborative learning, student-faculty interaction, enriching educational experiences, and a supportive campus environment (Coates, 2005). Kuh (2001) supports the use of NSSE benchmarks for several reasons. The practices that they represent are easily identified as good practice in education by instructors, administrators and laymen. They provide empirical evidence of student engagement in educationally sound activities (Kuh, 2003; Pike, 2006). Finally, they provide data that allows comparison of student performance between types of institutions (Kuh, 2001).

Engagement is defined as the manner in which an individual involves himself in a task or activity (Hedman & Sharafi, 2004). Bowen (2005) identifies four related, but different, kinds of engagement. ‘Student engagement with the object of study’ occurs when the student gains direct experience with something new. Students examine, evaluate and experience the phenomena and build knowledge in response to it, determining what is previously known and what is unknown (Bowen, 2005**;** McCune & Hounsell, 2005). Instructors employ frequent short-term feedback, writing assignments, cooperative learning activities and learning communities to facilitate this form of engagement. ‘Student engagement with the learning process’ occurs when the student is actively constructing his knowledge through participation in discussions and research, frequent short term feedback activities, asking questions, working in collaboration, problem solving, etc. Students are challenged to integrate new knowledge with previously learned knowledge and to become transformed, questioning their own beliefs as they become more aware of other truths (Bowen, 2005). But students are often very resistant to transformation and often feel that discussion should only strengthen their already held beliefs (Bowen, 2005). ‘Engagement with the contexts in which the subject of study is situated’ is a form of multidisciplinary learning, which adds another dimension to learning. As the student experiences complementary disciplines and perspectives on an individual subject, the student gains breadth of knowledge and provides a link to the outside world. Ethics are incorporated when social and civic contexts are incorporated. This can shape priorities for future learning (Bowen, 2005). It is often felt that ‘engagement with the human condition’ is the most compelling and important of the four. As humans, we are both capable and responsible for learning about humanity. This engagement builds cultures, and it influences and validates goals set within disciplines. It brings a personal relationship to learning for the student. It gives meaning to what is learned and provides support for the constructivist theory of learning (Bowen, 2005).

Umbach & Wawrzynski (2005) found that colleges with faculty who incorporate active learning and peer collaboration in the learning environment were credited with high levels of student engagement. This is particularly true for first year students and seniors (Pascarella, 2001; Umbach & Wawrzynski, 2005), as well as for under-represented populations of students (Pascarella, 2001; Wasley, 2006). Student engagement is a critical factor for student retention (Kvam, 2000; Umbach & Wawrzynski, 2005; Wasley, 2006).

Metacognitive Development

There is a growing body of knowledge about how an individual's epistemological beliefs about knowledge and learning impact their learning (Butler & Winne, 1995; Duell & Schommer-Aikins, 2001; Schommer-Aikins, 2004; Schreiber & Shinn, 2003). The epistemology, or nature, of one's beliefs of knowledge and learning are systems of implicit assumptions and beliefs held by students (Hofer, 2001; Paulsen & Feldman, 2005), and which change as students progress through their learning (Cano, 2005). Epistemological beliefs are often unconscious, held very tightly, and are uncomfortable and difficult to change. Epistemological beliefs are embedded with other beliefs, which are cultural and relational, and which affect self-regulated learning and classroom performance (Cano, 2005; Duell & Schommer-Aikins, 2001; Paulsen & Feldman, 2005). Epistemology is formed by many factors such as age, gender, parental education, socio-economic status, early family environment, etc., and is unique to the individual. The belief system plays a critical role in student motivation and development of self-regulated learning. The beliefs serve as a lens through which students assess academic tasks and their own performances; monitor and interpret tasks; and, develop behavioral strategies for effective learning (Paulsen & Feldman, 2005).

Schommer-Aikins (2004) conceptualizes personal epistemology as a system of independent, but closely connected beliefs. Beliefs about learning cannot be isolated from beliefs about knowledge, which include the stability of knowledge, structure of knowledge, source of knowledge, speed of learning and ability to learn (Duell & Schommer-Aikins, 2001; Paulsen & Feldman, 2005). There are four distinct components of the multi-dimensional system of epistemological beliefs, as identified by Schommer: 1) fixed ability; 2) certain knowledge; 3) simple knowledge; and, 4) quick learning (Paulsen and Feldman, 2005; Schommer-Aikins, 2004;

Schreiber & Shinn, 2003). Fixed ability relates to the ability to learn on a continuum from ‘genetically predetermined’ to ‘acquired through experience’. Certain knowledge can be measured on a continuum from ‘knowledge is absolute’ to ‘knowledge is constantly evolving’. Simple knowledge can range from ‘compartmentalized’ to ‘highly integrated’, or interwoven. Finally, quick learning grows from ‘knowledge is quick’ to ‘knowledge takes a great deal of time’ (Paulsen & Feldman, 2005). The continuum of each component reflects the characteristics of the learner on the continuum from novice learner to self-regulated learner (Schommer, 1990, 1994).

A learner’s epistemological beliefs are directly related to learning strategies they employ (Case & Gunstone, 2002; Dahl, Bals, & Turi,2005; Hofer, 2001; Paulsen & Feldman, 2005; Schreiber & Shinn, 2003), to their motivations for learning (Paulsen & Feldman, 2005”, to the quality of learning that occurs (Case & Gunstone, 2002; Dahl et al, 2005; Hofer, 2001; Paulsen & Feldman, 2005; Schreiber & Shinn, 2003), and to student  resistance to developing self-regulated learning behaviors (Åkerlind, 2004). The naïve learner is less likely to question the depth or application of knowledge, since their beliefs affect the interpretation and application of the knowledge (Schommer, 1990; Schommer-Aikins, 2004). Students’ beliefs must be challenged; they must be exposed to advanced knowledge and different ways of thinking in order to change their belief systems (Schommer, 1990).

As early as 1975, Marton and Säljö identified two basic levels of learning processing which they labeled deep-level and surface-level. These levels corresponded with the different degrees to which the student focused on the components of the material presented. Surface-level learners primarily focused on the text itself, which promoted rote learning. Deep-level learners focused on the significance of the material, which stimulated deeper thinking strategies.

Current literature generally identifies three basic approaches to learning (Case & Gunstone, 2002, 2003; Justice & Dornan, 2001; Olson & Scanlan, 20002; Schmeck & Geisler-Brenstein, 1991; Schreiber & Shinn, 2003; Sellheim, 2003), although there are some minor differences in operational definitions by various authors. Surface learners generally spot and memorize facts (Sellheim, 2003). Motivation for learning is usually related to fear of failure or desire to complete a course. Surface learners focus on specific comparison of parts within a text sequence, rather than on more important parts. Surface learners often lack orientation toward the whole, as they memorize detail.

Strategic learners are more often influenced by context, rather than the task itself (Sellheim, 2003). Strategic learners tend to be competitive and are motivated by achievement of high grades. Although strategic learners vary their approaches to learning, there is often an incomplete level of understanding achieved. Strategic learners use either superficial or deep learning processes, depending on which they perceive will produce the most success according to course content and assessments administered (McMahon, 1999; Motschnig-Pitrik, 2003; Seale, Chapman, & Davey, 2003; Tynjala, 1998).

Deep learners are motivated by interest in the subject matter, recognizing the relevance of the material (Sellheim, 2003). Studying focuses on the intention to understand the subject's meaning and relate tasks to previous knowledge and experience. Deep learners impose structure to the whole task, relating the individual parts to the whole. With a deep approach to learning, students seek out the author's meaning, integrate components and relate new ideas to previous knowledge and experience. The most important aspect of learning is to see and understand the relevance of the information. Deep learners tend to extrapolate beyond the specific content presented. Additional information is searched out, contrasted, evaluated and organized into concepts (Schmeck & Geisler-Brenstein, 1991).

Schmeck and Geisler-Brenstein (1991) define levels of information processing slightly differently. The deep learner mirrors previously presented deep learning characteristics. However, the agentic learner is identified as one who approaches learning from retention of facts and from serial processing. The agentic learner completes one task at a time; is often good at remembering names and formulae; and performs better on factual tests. The elaborative learner uses prior knowledge as an information resource and reference in order to make associations.

Case and Gunstone (2002) also identify three approaches to information processing with some minor differences to those already presented. The information–based approach is similar to agentic and surface learners, who primarily study to gather and remember information. The algorithmic approach is identified as studying with the intent to remember calculation methods for solving problems. Students focus on method rather than understanding. Learners try to remember solution methods by performing the task over and over. Both the information-based and the algorithmic learners perceive an overwhelming lack of being in control relative to time management, and they avoid time consuming study activities. The conceptual approach focuses on understanding concepts. Conceptual learners are able to link prior knowledge, other subjects, and real life situations; reason out situations from principles; and use their own words to explain concepts. The conceptual learners value the understanding of the information and are willing to invest the time necessary to understand it.

Wynne (1996) proposes that the metacognition model brings together two entities, knowledge objects and cognitive operations we use to understand them. The student develops strategies to learn, which encompass several tactics. As the student receives feedback (internal and external) related to his learning of the object, he can select different tactics from which to increase the breadth and depth of his knowledge. He describes self-regulated learning as a two phase process. The first phase requires students to identify and clarify the learning task, identify the learning goal, and develop a plan to reach the goal. The student relates stores of information to the context. The second phase initiates when the student begins to enact the tactics and strategies. The process continues as the student monitors his learning through various internal and external feedback mechanisms and adjusts his tactics accordingly. Intrinsic to metacognitive learning is the student's acceptance of responsibility for his own learning (Cornford, 2002) and the ability to monitor his cognitive development (Winne, 1996; Zimmerman, 1998).

When instructors utilize the multiple method approach focused around student centered active learning, the information is solidly secured in the student's reservoir of knowledge and is easier to retain and retrieve (Thompson, Licklider, & Jungst, (2003). The process fosters the metacognitive development of critical thinking (Tynjala, 1998). Critical thinking has been studied in educational research for many years, and has been defined in a variety of similar ways. Generally, critical thinking refers to the skill of using cognitive strategies in a purposeful, goal directed manner to increase the chances for a probable outcome (Burbach, Matkin, & Fritz, 2004; Halpern, 1999). Critical thinking is a skill highly valued by employers (Burbach, et al, 2004), encouraged by the government (Burbach et al, 2004**;** Coates, 2005), and often proposed as the primary graduate learning outcome of many colleges and universities (Pike & Kuh, 2005). Yet there is compelling evidence that, although many instructors proclaim that their instruction fosters critical thinking, the effort falls somewhat short of the desired target (Burbach et al, 2004, Connor-Greene, 2000).

The development of critical thinking skills, a component of metacognitive learning, has been related to conceptually based information presented in real world educational contexts (Barrows & Tamblyn, 1980; Case & Gunstone, 2002, 2003), open-ended written assignments (McCune & Hounsell, 2005), peer collaboration and discussion (Barrow & Tamblyn, 1980; Burbach et al, 2004; Crouch & Mazur, 2001; Hoover, 2005**;** Jefferson, 2001; G. Ryan, 1993), learning autonomously (Boekaerts, 1995; Butler, 2002, Cleary & Zimmerman, 2004; McMahon, 1999; Paulsen & Feldman, 2005; Schunk, 1995, 2005; Sperling, Howard, Staley, & DuBois, 2004; Winne, 1996), reflection (Burbach et al, 2004; McAlpine, Weston, Beauchamp, Wiseman & Beauchamp, 1999; McMahon, 1999; Ngeow & Kong, 2001; Plack & Santasier, 2004; Thorpe, 2000), structured and challenging questions (Burbach et al, 2004; Crouch & Mazur, 2001; Napell, 1978), student engagement with content (Ahlfeldt, Mehta, & Sellnow, 2005; Bowen, 2005; Carini, etal, 2006; Coates, 2005; Hoover, 2005**;** Howard, 2002; Koljatic & Kuh, 2001; Murphy & Smark, 2006; Pike & Kuh, 2005; G. Ryan, 1993) service learning (Burbach et al, 2004) and constructive feedback ( Baderin, 2005; Motschnig-Pitrik, 2005; Schunk, 2005), all of which are considered active, student centered learning strategies. In order to develop critical thinking skills, students' assumptions, beliefs and values must be challenged (Plack & Santasier, 2004). They must explore alternatives and develop a level of skepticism in order to understand the contexts that influence how they think (Plack & Santasier, 2004).

Critical Thinking has been identified as a combination of cognitive skills and attitudes that span five domains: inference, recognition of assumptions, deduction; interpretation; and, evaluation of arguments (Wilson, 2000). It is associated with several elements of reasoning: purpose of the thinking, key issue or questions being considered, assumptions, point of view, evidence, concepts and ideas, inferences or interpretations and implications or consequences (Celuch & Slama, 1999). Critical thinking is not automatic, but it can be learned (Tapper, 2004). However, it is a process that develops over several years and is a product of exposure to diverse perspectives and challenges to an individual's values and beliefs that occur over that time (Halpern, 1999) Students often have very limited understanding of what critical thinking entails. According to Tapper (2004), critical thinking involves questioning, evaluation, analysis, reflection, inference and judgment. Students, as well as faculty, often resist the change to more active, responsible learning activities (Åkerlind & Trevitt, 1999; S. Hall, Waitz, Brodeur, Soderholm, & Nasr, 2002). Change theory (G. Hall, Wallace, & Dossett, 1979) suggests a model of resistance related to concerns held by the individuals required to make the changes. Acceptance is a process that occurs when the concerns have been met. This model can be applied to the resistance encountered when students initially participate in new instructional methods, particularly those that require an active immersion into the learning process. In a study with reluctant high school learners (Daniels & Arapostathis, 2005), the authors identified several inherent needs learners required to become actively engaged with the learning process. These included, but were not limited to, the need to be able to succeed; the need to feel that the learning was building up to something better; interest in the content; and, recognition of ability. Åkerlind & Trevitt (1999) recognized that students, whose main educational experiences were as passive learners, were often set up for failure when suddenly thrust into environments where there was greater autonomy in learning for which they were unprepared. Effective learning for many students is a paradigm shift of how students conceive of, and approach, learning. It requires increased independence in the learning process and can be very stressful for the learner. Change can be approached through force or persuasion, but it involves both attitudinal and conceptual changes on the part of the learner (Jackson, 2004). In any case the learner must accept ownership of the learning process and become a self-regulated learner. Students must value good thinking and work to achieve it.

Social-cognitive theory supports three phases of learning in the self-regulation process (Schunk & Zimmerman, 1997). The initial phase requires self-observation, where the learner pays deliberate attention to specific aspects of his own learning behaviors. The self-judgment phase occurs next, as the learner compares his current performance to some standard. Finally, the self-reaction phase emerges as the learner evaluates his own performance. The opportunity to engage in peer collaboration and discussions in the student centered classroom provides a rich environment for the development of the autonomous learner.

Modeling is an antecedent to self-observation. Students observe the instructor and their peers' learning behaviors, and then model the behaviors. Schunk & Zimmerman (1997) note several levels of self-regulation that occur as the learner progresses through the three stages which identify the social-cognitive relationships. Modeling is a very social activity, where the learner imitates the general form of the model. This is most apparent in motor performance. The self-controlled level occurs when the learner develops the ability to use strategy and becomes independent when performing tasks. At this level there is an internalization that occurs, based upon the model standards. As the learner systematically adapts learning strategies to changing personal and contextual conditions, he becomes a self-regulated learner. A shift from social to self sources occurs. Learners can be instructed in self-regulated learning behaviors (Cleary & Zimmerman, 2004). When learners are empowered to self-regulate, they become proactive learners, and they become motivated to continue learning (Jensen, Gwyer, Shepard, & Hack, 2000). When instructed in goal setting, self-monitoring and self-reflection, they are able to self-generate thoughts, feelings and behaviors that are planned and adapted, based on performance feedback and attainment of self-set goals (Cleary & Zimmerman, 2004). Student goals must be realistic and challenging, yet attainable (Schunk, 1990).

Instructional Strategies

Effective student centered, active learning environments provide the opportunities for students to construct knowledge in the manner best suited to the student. Instructors are very important to the learning process. The instructor facilitates the learning process by incorporating teaching strategies which "contribute to the breadth and depth of content knowledge, assist students in learning how to organize knowledge around major concepts and principles, enhance retention and retrieval, and contribute to student development of metacognitive abilities" (Thompson et al, 2003). Student centered approaches to learning results in improved learning outcomes (Confessore, 2003; Kuh, 2003), as well as overall student development (Kuh, 2003**),** increasing respect for self and others and increasing self-confidence (Confessor, 2003; Motschnig-Pitrik, 2005). Students themselves, perceive self-directed learning as important, particularly the more they participate in the environment and come to understand the degree to which learning occurs (G. Ryan, 1993).

It could erroneously be assumed that the instructor becomes somewhat obsolete in the student centered culture. In fact, the instructor becomes even more important in designing pedagogically sound learning activities, which challenge and interest students. Students who are active in the learning process perceive greater learning outcomes from their undergraduate education in institutions where faculty create environments which emphasize effective learning strategies (Cross & Nagle, 1969; Umbach & Wawrzynski, 2005).

Educators continue to seek methods by which to facilitate more active processes in the classroom, and to assess the quality of those learning activities. Two strategies that have gained merit in recent years are 1) challenging the students to apply and use the information by asking carefully constructed questions to stimulate deep thinking, and 2) facilitating peer collaboration in construction of knowledge.

Questioning Strategy

Questioning has been a very common and effective tool in clinical education for many years (Graffam, 2008), because it stimulates critical review of information in real world contexts. Effective questioning can stimulate metacognitive practices and development, and it can provide the means by which students become self-directed learners (Wiggins, 1992). Questioning engages the student with the information and places the material in contexts that broaden its application. Questions guide thought processes and direct discussion to add depth and breadth to the meanings (Bean & Peterson, 1998; Graffam, 2008). Inquiry challenges the learner to move beyond mere data; to adapt the data to the context. The depth to which students learn is directly related to the level at which the questions are asked (King, 1995; Thomas & Holcomb, 1981). Questions should be designed to provoke thought and to allow student expression (Beatty, Gerace, Leonard, & Dufresne, 2006; Crouch & Mazur, 2001; King, 1990, 1991; Martinez, 1999; Napell, 1978; Thomas & Holcomb, 1981; Wiggins, 1992). Students require frequent opportunities to consider complex issues and integrate them before being challenged (King, 1990; Napell, 1978; Nicol, 2007).

However, the benefit that questions hold for learning is only as great as the degree to which the question challenges the student and guides the learning process (King, 1995; Thomas & Holcomb, 1981). While many instructors report that asking questions stimulate student learning, that perception is often misleading, because questions are often asked on the level of basic content knowledge, rather than stimulating integration of concepts and application of material in different contexts (Graffan, 2008; Sellapah, S., Hussey, T., Blackmore, B. & McMurray, A., 1998). Thomas and Holcomb (1981) found that in classes where teachers spent the majority of time reviewing factual material, the students performed lower on IQ tests, while students whose teachers facilitated more cognitive processes performed significantly higher on cognitive assessments. Their findings supported the belief that students learn at the level to which they are challenged.

Literature related to assessment of student learning outcomes has presented very conflicting opinions regarding which types of questions are most effective. Many experts feel that multiple choice formats assess students on only a very factual basis (Hancock, 1994; Martinez, 1999; Thomas & Holcomb, 1981), and support only constructed response assessments which challenge students to higher levels of thinking. Multiple choice formats are often preferred over other formats because they are less costly to develop and administer, have very high test reliability and they have nearly perfect scoring reliability (Martinez, 1999). Although there are some disadvantages to multiple choice format questions, when constructed according to specific taxonomic levels, they have been shown to assess higher cognitive function skills (Haladyna, 1992; Hancock, 1994; Martinez, 1999).

In recent years, the push by accrediting agencies for educators to demonstrate effective formative as well as summative assessment of learning effectiveness (Hagstrom, 2006) has called attention to various ways in which formative assessment can be addressed. Formative assessment provides timely feedback to both the student and the instructor regarding the quality of learning, and it has a direct impact on the development of values and beliefs about a selected profession and the student's image of himself as a professional (Hagstrom, 2006). Because of the developmental role formative assessment holds, it is the responsibility of both the instructor and the learner to participate.

The concept of accountability for student learning is not new to education. For years, institutions have used summative data to support student acquisition of knowledge, such as grade point averages and scores on standardized examinations. As early as the mid-1950's, researchers identified the variance between instructors' perception of student learning and the actual level of knowledge that students achieved. The development of a taxonomy of cognitive behaviors, by B. S. Bloom and his colleagues in 1959 was the result of such studies (Hagstrom, 2006). The six level hierarchy of learning is well known to educators and researchers alike. The original taxonomy identified learning benchmarks that educators have used in formative assessment of students. While the taxonomy addresses the breadth of student learning, many educators and researchers feel that the taxonomy fails to address the types of learning that occur, and it reflects a teacher centered environment (Blumberg, 2009; Krathwohl, 2002).

In 2001, A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy was published by several of Bloom's associates (Blumberg, 2009; Bumen, 2007**,** Hagstrom, 2006; Krathwohl, 2002). The original taxonomy arranged levels of learning from knowledge to evaluation, in a unidimensional model. The developers of the revised taxonomy have reorganized the model as two dimensional, by aligning a four level cognitive-process dimension (horizontal axis), with a six level knowledge dimension (vertical axis) (Blumberg, 2009; Bumen, 2007, Hagstrom, 2006; Krathwohl, 2002). The knowledge dimension levels have been scaled from remember to create, and each level is presented in the verb form. The cognitive process-dimension is scaled from factual knowledge to metacognitive knowledge. The taxonomy provides a scheme to address both breadth of learning outcomes and depth of learning process. Utilizing the revised taxonomy as a format upon which to build formative assessment measures more closely matches the student centered environment approach to learning (Blumberg, 2009;Hagstrom, 2006).

The manner in which questioning can impact a student's cognitive processing can be supported by comparing progressive questioning to reading comprehension. In investigating aids to facilitate text comprehension, Mayer (1984) developed a model which illustrate how the student processes reading text through a three step process for meaningful learning. By manipulating aspects of text organization and emphasis, Mayer proposed that, as a student reads text, he selects information from the text and adds that information to working memory by focusing attention to it. As the student processes the information in his working memory, he builds connections to previously learned facts and organizes the information into a coherent and structure. Finally, the student integrates that content with other familiar knowledge structures already stored in memory. This process essentially builds external connections, thereby moving the material into long-term memory. Generative learning, or the active processing that occurs in the learner during the learning process, is promoted by questioning methods. Students are more likely to work hard to understand the content, when they feel involved (Mayer, Stull, DeLeeuw, Almeroth, Bimber, Chun, Bulger, Campbell, Knight & Zhang, 2008). An instructor can conceivably facilitate similar processing through the sequentially prepared questions according to a taxonomic structure.

The primary purpose of asking questions is to stimulate discussion, providing the opportunity for students to share perceptions, assess their understanding of the material, challenge ideas and facilitate the peer collaborative model. As students engage in questions and discussions, they must apply core concepts and express their perceptions, thus engaging the student with the content. However, there are barriers to effective questions and group discussions. S. Hall, et al (2002) found that teachers often find it difficult to generate questions at levels required to stimulate deep and effective class discussions. Additionally, students are often reluctant to participate in class discussions (Bean & Peterson, 1998). The reasons for this reticence vary. Some cultures do not encourage questioning in educational environments (Girgin & Stevens, 2003). Some international students, particularly those of Asian culture, are raised to be polite listeners who guard against loss of 'face' (Watson, 1999). Older non-traditional students tend to participate more in open class discussions, while traditional students tend to be non-talkers (Howard, 2002). Other students are too intimidated by the potential embarrassment, and lack of confidence in their own knowledge to openly risk being incorrect when discussing new material.

Educators have understood the value of peer collaboration for many years. Problem-based learning practices (Barrows & Tamblyn, 1980; Dunlap, 2005; Jefferson, 2001; G. Ryan, 1993) and project based learning (Lou & McGregor, 2004) evolved from this philosophy. Students work in small groups with an instructor facilitator to solve problems based in real world contexts. Students research individual aspects of the problem and report the findings to the rest of the group, thereby supporting the learning of their peers. Peer collaboration has been credited with improved student outcomes (Hake, 1998; Lou & McGregor, 2004**;** Slavin, 1991), improved critical thinking and problem solving (Barrows & Tamblyn, 1980; Dunlap, 2005; Jefferson, 2001), development of autonomous and self-regulatory learning practices (Barrows & Tamblyn, 1980; Dunlap, 2005; Jefferson, 2001; Motschnig-Pitrik, 2005; Ngeow & Kong, 2001; G. Ryan, 1993; Tynjala, 1998), respect for others (Barrows & Tamblyn, 1980; Slavin, 1991), improved communication skills (Boud**,** Cohen, & Sampson, 1999; Slavin, 1991), improving class participation, and changes in students' epistemological beliefs about learning (Paulsen & Feldman, 2005; Reybold, 2001; Schommer-Aikins, 2004; Schreiber & Shinn**,** 2003). Peers provide pooled expertise (King, 1991) and reciprocal learning opportunities, often facilitate generalization of knowledge and diversity in a student's thought processes (Leat & Lin**,** 2003). This in turn leads to improved self-confidence and more complex learning.

While the focus of research on group collaborative learning has centered on problem-based and project-based, the factors that influence learning from peers can also be elicited through guided classroom discussion. Small group discussion provides a non-threatening forum for students to exchange perceptions and to model problem solving processes that lead to deeper understanding of contexts. This feedback allows students to assess their level of understanding and to seek additional explanation if needed.

Feedback

Timely feedback is critical to the learning process (Baderin, 2005, Butler & Winne, 1995; Eggert 2004; McCune & Hounsell, 2005; Thompson et al, 2003). Feedback can be presented in a variety of ways and must be reciprocal between student and instructor for optimum effect ( Baderin, 2005). Butler & Winne (1995) proposed that both external feedback and internal feedback processes are critical components of the self-regulated learning process. In fact, internal feedback is connected to an individual's epistemological beliefs and can impact whether or not a student expends the effort to learn (Butler & Winne, 1995). Feedback on student performance and on processes of learning allow students to develop greater understanding of instructor expectations (Baderin, 2005); increases student self-confidence (Cooper, 2000); facilitates greater motivation (Butler & Winne, 1995; Motschnig-Pitrik, 2005) attendance in class ( Hughes, 2005) and participation in class (Baderin, 2005); allows students to realize errors in thinking processes (Butler & Winne, 1995; Kuh et al, 2004); and provides an experience of realness and transparency which contributes to understanding "bigger picture" realities (Motschnig-Pitrik, 2005).

Feedback to the instructor allows the instructor to focus on areas of confusion and to gauge students' understanding of material presented (Baderin, 2005; Hughes, 2005). Feedback establishes a method of formative assessment, which allows shareholders to self-assess performance and make timely modifications (Leat & Lin, 2003). Feedback can be presented formally as quizzes (Cooper, 2000; Hughes, 2005), writing assignments (Cooper, 2000; McCune & Hounsell, 2005; Motschnig-Pitrik, 2005) scheduled appointments (Baderin, 2005), or informally through class discussions or e-mail communications. Feedback and faculty student interactions are highly regarded as important benchmarks of student engagement in the undergraduate college experience (Carini, et al, 2006; Koljatic & Kuh, 2001; Kuh, et al, 2004; Nelson L. & Kuh, 2005; Pike & Kuh, 2005) and in improved student learning outcomes (Pascarella, 2001).

Effective educational strategies incorporate multiple factors which provide both students and instructors with the tools they need to build effective learning environments where the student can construct knowledge, guided by instructor facilitation and peer support, in real world contexts. Technologies are now available that contribute to the active student-centered environment and which support multiple types of learners.

## Educational Technology

Technology is often viewed by faculty as a means to improve teaching (Peluchette & Rust, 2005), offering greater independence on the part of the student (Åkerlind & Trevitt, 1999) and access to tools that can be used to facilitate problem solving (Halpern, 1999; Jonassen, 2003). The internet opens up the educational environment, providing 24/7 access to learning opportunities through course systems, software and various hardware (Brewer, 2004; Juniu, 2006; Lefoe, 1998), thereby enhancing the processes involved in learning

(Hedman & Sharafi, 2004). When technology is integrated with education, students gain more experience with the manner in which knowledge is discovered, shared and shaped in various disciplines (Brewer, 2004). Various software packages allow students to create multi-dimensional models (Jonassen, 2003; Jonassen et al., 2005), and have increased the need for critical thinking skills in order to use the programs effectively (Halpern, 1999; Marion, 2002) and to critically evaluate and determine the value of the information (Marion, 2002).

Use of technology and multimedia for active, student-centered learning has also been associated with increased student attendance in school (Baderin, 2005; Connor-Greene, 2000; Debevec, 2006; Hughes, 2005; Jacobson, 2005; Larson & Ahonen, 2004; Moore & Miller**,** 1996). The extracurricular responsibilities of non-traditional students (Hughes, 2005) and lack of interest in traditionally presented lecture courses (Moore & Miller, 1996) have created high levels of absenteeism. There is great concern shared by faculty that attendance in class is critical to learning (Baderin, 2005; Druger, 2003; Hughes, 2005; Larson & Ahonen, 2004; Moore &Miller, 1996), because students miss experiences, perceptions and insights that may be gained from peer and instructor interactions and from engagement with the active learning process and their peers (Baderin, 2005; Debevec, 2006; Jacobson, 2005; Larson & Ahonen, 2004).

However, the use of technology in the classroom is not without its disadvantages. Instructors are particularly challenged to effectively utilize technology with pedagogically sound instructional activities (S. Hall et al., 2005), which allow students to become actively engaged in the learning process (Halpern, 1999). Ongoing faculty development becomes paramount in the process of providing current information and ever-changing technology in the classroom (G.Hall et al., 1979; S. Hall et al., 2002; Halpern, 1999; Weimer, 2003).

Literature on the value of integrating technology in education reveals significant conflicts of opinion. Advocates praise the versatility and opportunities to use multimedia in order to establish rich contexts for active learning (Lefoe, 1998; Motschnig-Pitrik, 2005); to develop critical thinking skills (Jonassen, 2003; Jonassen et al., 2005)**;** to engage student interest (Carini et al.,2006; Moore & Miller, 1996); to facilitate peer collaboration (Crouch & Mazur, 2001); to assist students to prepare for class (Debevec, 2006); and, to address the needs of different types of learners (Diaz-Lefebvre, 2004).

Richard Clarke (1983, 2001) argues that media does not teach; it is merely a "vehicle" by which to deliver knowledge developed through good pedagogy. The review of current research supporting the positive effects of media on learning is often confounded by varied research designs and constantly changing technology that is being researched, and it fails to demonstrate that there is any evidence of the direct effect of media on learning (Clarke, 1983). Kozma **(**1994) rebuts with the argument that different media characteristics provide different physical symbols and systems to the learner, which potentially facilitate different cognitive functions and complement the learning style of individual learners. Kozma (1994) cautions that it may be too premature to determine that media has no effect on learning; that we have yet to discover discreet methods which measure the direct effects of media on cognitive function.

Regardless of one's stance on the media-learning argument, there is strong evidence that the combination of educational pedagogy, coupled with authentic learning tasks and technologies, which engage students in the learning process, provide an active-student centered environment for conceptual learning and critical learning to occur. More quality research is needed in evaluation and understanding the role of various technology tools in helping students engage and learn more effectively.

Audience Response Systems

Audience response systems (ARS), also known as clickers, personal response systems, group response systems and classroom performance systems (Murphy & Smark, 2006), etc., have been utilized in higher education for more than 30 years (Judson & Sawada, 2002). Originally designed as a means to gain feedback in large lecture halls, ARS have evolved from low tech systems, using flash cards to provide visual feedback to the instructor (S. Hall et al., 2002; Kellum, Carr, & Dozier**,** 2001), to high tech systems, using remote infrared and radio frequencies integrated with computer software, which provide active learning experiences (Lowery, 2005).

Most modern systems have three main components: student input devices, operating system software on the instructor's computer, and overhead projection systems (Lowery, 2005). The system allows three core capabilities upon which the instructor can build interactive learning experiences: presentation of probing questions; rapid and anonymous collation of student responses; and, aggregation of a public display of the variance in group ideas (Roschelle & Penuel, 2004). The operating system software integrates with the instructor's presentation program, so that questions can be inserted at strategic points during the presentation. When students answer the questions through the remote devices, the software collates the data and provides graphs depicting overall student response to the question, which can then be projected on the screen. The graph provides instant feedback to the instructor and to the students regarding the level of student learning. The instructor can then determine if the material needs additional attention, or if the level of knowledge indicates that the presentation can proceed (Brewer, 2004; Murphy & Smark, 2006). The feedback provides the student with immediate information regarding the level of their learning as compared to their peers. When the instructor adds opportunity for class discussion following receipt of the feedback, peer interaction provides multiple interpretations of the content, and the instructor can clarify faulty learning. The instructor often has the option to assign students to specific remotes, allowing individual documentation of student attendance, participation and performance (Murphy & Smark, 2006; Skiba, 2006).

Advantages of ARS

The system can be used for a variety of activities. Short quizzes assessing previously presented information provide the learner and the instructor formative assessment regarding student retention of information, and can facilitate remediation before formal assessment (Cooper, 2000; Murphy & Smark, 2006; Stein,Challman, & Brueckner, 2006). Questions intermittently placed within a presentation, allow the instructor and the student to assess acquisition of content knowledge and establishes a foundation for group discussion (Skiba**,** 2006; Wit,2003). Peer discussion supports learning by requiring that the students articulate their understanding (Judson & Sawada, 2002; Kennedy & Cutts, 2005); confront their own misunderstanding (S. Hall et al., 2002); integrate the diverse perceptions presented; and, acknowledge their responsibility for learning (Murphy & Smark, 2006), thereby reinforcing a deeper understanding of the material (Judson & Sawada, 2002; Kennedy & Cutts, 2005; Roschelle & Penuel, 2004).

Questions based on information in assigned work, given at the beginning of class, promotes student attendance and preparation for class (Judson & Sawada, 2002; Murphy & Smark, 2006; Wit, 2003); freeing classroom time for discussion (Crouch & Mazur, 2001). The system can also be used to accumulate and analyze data regarding student demographics, backgrounds, attitudes and opinions (Murphy & Smark, 2006); thereby, assisting the instructor to better understand the student population. The utilization of ARS changes traditional lecture presentation to interactive, student-learning experiences (Judson & Sawada, 2002; Kennedy & Cutts, 2005; Murphy & Smark, 2006; Skiba, 2006; Wit,2003), and it facilitates engagement between the students, the content and the instructor (Murphy & Smark, 2006; Skiba, 2006).

The immediate feedback to the students allows timely self assessment of knowledge acquisition (Judson & Sawada, 2002; Kennedy & Cutts, 2005; Miller *etal.*, 2003; Murphy & Smark, 2006; Wit, 2003), providing the opportunity for students to ask for clarification early in the learning process. This is particularly important for students who do not ask questions in class, either due to embarrassment, lack of confidence or shyness (Watson, 1999). The ARS allows these students to participate anonymously and encourages more participation (Murphy & Smark, 2006; Skiba, 2006; Wit, 2003).

Disadvantages of ARS

There are potential disadvantages to incorporation of ARS in the classroom. The systems are expensive and may be cost prohibitive (L. Collins, 2007; Murphy & Smark, 2006). Depending on the students' orientation to ARS, students may be intimidated by the technology or feel "spied on" (Murphy & Smark, 2006). If the system is used ineffectively, the system itself may distract students from the material and become the focus of the lesson (Murphy & Smark, 2006). From an instructor's perspective, additional time is required to build the lessons and prepare the system for use (L. Collins, 2000; Murphy & Smark, 2006). The heart of the system is the quality of questions used, which are often difficult to write at the appropriate taxonomy levels (L. Collins, 2000; S. Hall et al., 2002). In addition, the generated discussion consumes class time and requires instructors to plan content around discussions (Judson & Sawada, 2002). However, effective utilization of ARS can provide greater learning opportunities in lecture classes.

Question Design

Effective utilization of the ARS depends on the manner in which the instructor integrates questions and discussions through the presentation and the level at which students are questioned. Wit (2003) recommends that questions be written in comprehensible language, so students clearly understand what is being asked; that options in the answers be logical, to stimulate cognitive processes; that the students be allowed to express ignorance of the question as an "I don't know", to minimize guessing at answers; and, that options be limited to four or five answers. Beatty, et al (2006) propose that questions be engineered for maximum learning. Questions should be written to address one of three goals: content, process or metacognition (Beatty et al., 2006). The mechanism through which questions can accomplish the goals is to design the questioning activity to focus attention on specific content or issues; stimulating cognitive processing by requiring pondering of the question; displaying the response data in graphic format to provide students feedback about self and group understanding; and, stimulating discussion to facilitate confrontation of varying perspectives and articulation of ideas (Beatty, et al., 2006).

Whereas early research failed to identify significant increase in learning outcomes using ARS, more recent research does demonstrate the value of ARS coupled with sound pedagogy and student interaction (Judson & Sawada, 2002). Kennedy & Cutts (2005) found a relationship between students' ability to answer questions correctly using the ARS, and their performance on formal assessments. In an extensive study investigating the effect of interactive engagement of students using ARS in Physics courses, Hake (1998) found an average two standard deviations difference between the normalized gains of students in interactive engagement environments versus the traditional lecture environment (Hake, 1998). Other studies found that use of ARS in the classroom increased the active engagement of students in the classroom (S. Hall, et al., 2002; Kellum, et al., 2001; Miller, et al.,2003), improved student learning outcomes (Crouch & Mazur, 2001; Kellum, et al., 2001; Schackow, Chavez, Loya, & Friedman, 2004) and improved student retention of knowledge (Schackow, et al., 2004). Students overwhelmingly endorse the use of ARS. In surveys and qualitative studies, students perceive that they participate more in class (Wit, 2003) with greater focus on the material (Latessa &

Mouw, 2005), studied more effectively (Kellum, et al., 2001), and gained confidence in their knowledge of course material (Brewer, 2004).

Theoretically, the use of ARS in the classroom, coupled with sound educational pedagogy (questions designed to build knowledge and stimulate cognitive processing, and group discussion) improves student learning outcomes and increases student engagement with content, instructors and peers; thereby, increasing critical thinking ability and metacognition. The theoretical framework, grounded in evidence from literature related to educational pedagogy, learning, student engagement and technology in education form a solid foundation, which supports the proposed research questions:

1) Does the use of audience response systems significantly improve student learning outcomes?
2) Do questions of sequential difficulty embedded in presentations significantly improve student learning outcomes?
3) How do students perceive the benefit of ARS in the classroom?
4) How do students perceive the benefit of questions within the presentation?
5) How does the use of questions and ARS in the classroom benefit the instructor?

# Chapter Three

# Methodology

The purpose of this study is to examine the impact of ARS on student learning outcomes in a Functional Anatomy and Kinesiology class. Qualitative and quantitative data provide a comprehensive perspective of both objective findings regarding student learning outcomes, and perceptions of participants in the study. Test scores and performance on specific test questions provide objective measures of student comprehension, while reflective journals by the instructor, student interviews and student surveys provide supportive evidence to better capture the qualitative impact of the learning activities.

## Research Design

This research study, conducted during the spring semester, 2009, was designed as a two part mixed method study using both quantitative and qualitative research, in order to gain a greater depth of understanding the impact of audience response devices on student learning outcomes and learning processes. Part one was designed as a quasi-experimental, AB study, using two sections of one course taught by the same instructor, who was also the researcher. One section of the course served as the treatment group, and the other served as the control group for the first half of the semester, following which the roles reversed. The independent variable was the use of ARS in the treatment group class, which provided an anonymous means for student participation, and which provided immediate feedback throughout the course. The dependent variables included student achievement in the course, as measured by test scores and performance on individual test questions.

Part two of this study included data elicited from student and instructor participants in the study via journals, interviews and surveys**.** While the literature supports the benefit of peer collaboration, active class discussion and immediate feedback on student learning outcomes, it was expected that weaker students would gain the greatest benefit from the ARS and peer collaboration activities. Therefore, two to three students who performed in the lower quartile of the class in each of the sections were interviewed regarding their perception of how the imbedded questions, the use of the ARS (the treatment group) and the small group interactions impact their learning processes during the course. From that data, a survey was developed and distributed to all student participants to complete. In addition, the instructor (researcher) utilized reflective journaling to add a different perspective, to chronicle student and group dynamics, and to corroborate with other qualitative and quantitative data.

The sample was one of convenience, in that there are only two sections of the course offered each spring semester. However, the course is specifically designed for students seeking admission to the Physical Therapist Assistant Program at a small faith-based college and is unique to that program.

The researcher was granted approval to conduct the study by the Institutional Review Boards of both, Louisiana State University, Baton Rouge, and at the college where the study was conducted, Baton Rouge.

Participants

Participants for the study include students enrolled in two sections of PTAP 2310, Functional Anatomy and Kinesiology at a small faith-based college in Baton Rouge, Louisiana. The college is a private Level III institution, which primarily offers programs related to health care, many of which are associate degree programs. Students at the college are classified as both traditional entering freshmen (23%) and non-traditional (75%) students.

In order to enroll in the course, students must have completed BIOL 2310, Anatomy and Physiology I, with a grade of C or better, and they must have completed, or be enrolled in, BIOL 2311, Anatomy and Physiology II. Enrollment is limited to students applying for admission to the PTA Program.  There is a maximum enrollment cap of 24 students in each section. Student enrollment is generally diverse, including both traditional and non-traditional students in numbers reflective of overall student enrollment at the college.

Section one enrolled fifteen students at the beginning of the semester (as determined after the drop/add period). Because section one was scheduled to begin at 7:45 in the morning, the majority of students registered for this section after section two filled up early. Three students dropped the course at midsemester with a WU grade, and three students discontinued attending and participating in the course after midsemester, without resigning (or notification).  As a result, data from these students were not included in the analysis of test score means to determine student learning outcomes. Section one was randomly selected as the treatment group for the first half of the semester.

Section two enrolled 22 students at the beginning of the semester. One student developed scheduling conflicts and participated in section 1 classes. Data from this student were analyzed with those of section one students. Three students resigned at midsemester with a WU grade, and two students discontinued attendance and participation after midsemester, without resigning from the course. Data from these students were not included in the analyses of examination scores.

The instructor (researcher-participant) has taught this course for 11 years. As a physical therapist clinician, she was able to integrate real world applications in physical therapy throughout the course, and she could frame questions in clinical applications so that students could grasp the relevance of the questions.

Course Description

Functional Anatomy and Kinesiology is a pre-requisite course, which must be successfully completed in order to enroll in the Physical Therapist Assistant Program (PTA). The contents of this course serve as the foundation for subsequent courses in the PTA Program. Because of this fact, the students must have a deeper understanding of the content. Student learning outcomes are based on the students' ability to apply principles of biomechanics and anatomy in order to evaluate and analyze aspects of movement. The expected level of student learning, by the end of the semester, correlates to the analysis level in the cognitive processing domain, according to the original Bloom's Taxonomy (original and revised) (Imrie 1995; Mayer, 2002). This means that the students are expected to analyze basic motions, differentiate accelerating and decelerating forces, distinguish various kinds of muscle contractions, etc. The first half of content in the course relates to basic characteristics of biomechanics and components of the musculoskeletal system. This content provides the concepts, and general application of concepts, which the students later use in evaluating movement. The second half content focuses on characteristics of motion related to specific areas of the body. The students are required to apply the basic contents and analyze functional movement patterns. In some instances they are expected to anticipate certain dysfunctions related to specific areas of the body, based on their understanding of normal movement.

Description of Audience Response Systems

The ARS system used in the study was the Beyond Question system, purchased from Beyond Question Learning Technologies, Inc. The deluxe set contains 35 student remotes, one instructor remote, interface software and an infrared receiver (See Appendix A for a picture of the Beyond Question System.). Beyond Question software, downloaded at the instructor's computer terminal, interfaces with the Microsoft PowerPoint software currently used by instructors at the college.  The instructor remote controls data projected onto the classroom screen from overhead. Beyond Question software allows the instructor to set up a class roll (See Appendix B for an example of the class roster), which became the basis for documenting student participation.

The remotes were assigned to seating locations within the classroom, according to the location of students on the first day of class. Through the Beyond Question software, the instructor can monitor student progress; documenting student attendance; identifying students with problems early in the course; and, modifying the pace and intensity of course content, as needed for learning. Beyond Question software offers several screens through which the instructor can maneuver, using the instructor's remote device. Questions were placed in the PowerPoint presentation. Prior to the presentation in Beyond Question, the instructor identified the question slides and indicated the correct answer for each question in the lesson (See Appendix C for an example of the Beyond Question lesson.). This interfaced with Beyond Question as the data collection point.  The presentation was opened using the remote tab feature of the software. When the question slide was opened during the presentation, numbered boxes appeared below the question, one for each assigned remote device (See Appendix D for an example of a presentation question slide.). The boxes on the slide change colors once a student enters an answer, providing visual confirmation of receipt of the selected answer. When all of the answers were received, or at the termination of time allowance, the instructor changed to a graphic screen, which provided visual representation of the percentage of students selecting each option (See Appendix E for an example of a response graphic.), depicted as a histogram. The instructor then used the results to generate discussion, initially in small groups, then the class as a whole, providing the opportunity for students to discuss the values of each option.

Procedures

The study was explained to all participants on the first day of class. Consent forms (See Appendix F for an example of the consent form.) were developed prior to the initiation of the semester. The forms were distributed on the first day of class and explained fully. After the students signed them, they were collected.

Remotes were attached to the table next to each student seat using Velcro, in an attempt to control location of the remotes. Once seated, students in section one of PTAP 2310 were assigned the Beyond Question remote at their places, and the remote number was recorded, in an attempt to control for consistency in use. The use of the remotes was explained to the students prior to presentation of material. As the students submitted an answer, the response was recorded using the Beyond Question software for each question. Within the software, the answer submitted by each remote was recorded. However, it was not possible to completely control for relocation of students or remotes for a variety of reasons. Students occasionally sat in different seats, particularly if arriving late for class. There were also occasions of malfunction by the remotes, requiring replacement of the remote in the middle of class. Therefore, data regarding individual student performance on questions embedded within the presentations were inconsistent, and the data was used globally in the analysis, rather than individually.

The instructor taught both courses identically, using the same presentations and asking the same questions to facilitate class discussions. The only difference between treatment and control groups was the use of the ARS. Course content was presented in a traditional lecture format using Microsoft PowerPoint as the presentation media. Questions were embedded in each unit and presented in multiple choice format, projected from the overhead projector. Each question related to content previously presented in the unit. Questions were designed by the researcher/instructor, according to course outcome objectives and taxonomy of lesson objectives. The questions reflected the level of expected learning for the given content. Similar questions were matched in developing unit assessments (Table 3.1), as noted in the outcomes measures section.

Table 3.1 Examples of Questions

| Presentation Question Content | Exam Content | Taxonomy Level |
|---|---|---|
| **Upon which of the following planes does knee flexion occur?**<br>a. sagittal plane<br>b. coronal plane<br>c. transverse plane<br>d. frontal plane | **The movement that is characterized by all parts of the object moving the same distance in the same direction at the same time is**<br>a. rotary movement<br>b. linear movement<br>c. angular movement<br>d. diagonal movement | Level 1—Remember |
| **The movement that occurs in the shoulder when the hand moves anteriorly on the sagittal plane around a frontal plane axis is**<br>a. abduction<br>b. flexion<br>c. internal rotation<br>d. adduction | **The movement which occurs on the sagittal plane around a frontal axis is**<br>a. flexion<br>b. rotation<br>c. abduction<br>d. pronation | Level 2—Understand |
| **When driving to school, you step on the brakes of your car, and the book on the passenger's seat slides to the floor. This is an example of**<br>a. Law of Action and Reaction<br>b. Law of Inertia<br>c. Law of Acceleration<br>d. Law of Deceleration | **A therapist wants to palpate the rectus abdominis muscle contraction against gravity. The most appropriate position in which to place the patient is**<br>a. left sidelying<br>b. right sidelying<br>c. prone<br>d. supine | Level 3—Apply |
| **In the action of stepping down from the curb to the street, the motion occurring in the thigh is**<br>a. quads contracting eccentrically<br>b. quads contracting concentrically<br>c. hamstrings contracting eccentrically<br>d. hamstrings contracting concentrically | **After taking a sip from your cup, you begin to lower the cup to the table. The motion that occurs in the elbow is**<br>a. flexion<br>b. extension<br>c. abduction<br>d. adduction | Level 4—Analyze |

Once the question was projected onto the screen, students in both sections were allowed no more than 60 seconds to select an answer to the question. Students in the treatment group were instructed to use the remote to select the answer. As each student submitted the selection, the remote number was illuminated on the bottom of the screen, indicating that the selection was received. Once the selection was completed, or at the end of 60 seconds, the instructor displayed the graphic screen denoting the distribution of student answers by percentage of students selecting each possible answer in histogram format. This provided immediate feedback to the individual student related to his/her level of comprehension compared to the class as a whole, and it provided immediate feedback to the instructor related to the class' comprehension of the content. The screen was returned to the question screen to facilitate peer discussion. Students in the control group were offered the opportunity to volunteer the correct answer. If the correct answer was given it was validated by the instructor. If an incorrect answer, or no answer, was provided, the correct answer was given by the instructor.

Students in both sections were given up to two minutes to review the answer in a collaborative manner with a neighbor. This opportunity allowed the students to clarify understanding of the question and its answer. The instructor then generated general class discussion to clarify the information. Salient parts of the question stem were identified in order to explain how to extract contextual clues from the question, in order to select the best answer. Once questions were addressed, the lecture resumed.

At the completion of each class, lessons were saved to the instructor's computer. If the presentation was not completed in the time allowed for class, the presentation was reconfigured to begin the next session with appropriate review questions, and to complete the lecture content. Both classes received identical instruction.

## Outcome Measures

### Student Achievement

Student learning outcomes were measured by non-cumulative unit examinations and cumulative final examination grades. There were four, non-cumulative unit written examinations assigned to the course, the second of which was administered at mid-semester, and a cumulative final examination. Because the classes were held back to back, both sections were administered the same examinations on the same day. Each of the tests were primarily made up of multiple choice questions designed to assess learning at the taxonomic level of the provided unit objectives, as were the questions prepared for embedding within the presentations. Taxonomic levels were mixed in the examinations, and subsequent examinations contain greater numbers of items testing content at the application and analysis levels.

Although the literature reflects conflicting support of multiple choice questions as appropriate to assessing a student's cognitive abilities at the higher levels related to critical thinking and mastery of concepts (analysis and evaluation), multiple choice formatting of test questions remains a dominant mode of assessment (Fellenz, 2004; King, 1991; Martinez, 1999; Nicol, 2007). Martinez (1999) acknowledges that, although multiple choice questions are often associated with testing very low level cognitive skills, this is often a product of how the questions are written, rather than an inherent weakness in the test format itself. Appropriate multiple choice questions are very difficult to write, but they can be written to evoke complex cognition such as prediction, evaluation and problem solving. There are many additional advantages to the multiple choice item format. These include the consistent test reliability, scoring reliability and economy of development, administration, scoring and reporting. In addition a greater range of conceptual assessment per unit of time can be achieved with multiple choice questions, as compared to lengthy essay questions (Fellenz, 2004; Martinez, 1999). Utilization of sequentially higher levels of multiple choice questions in courses within the PTA curriculum has the added advantage of preparing students to take high stakes multiple choice assessments, such as the licensure examination, that all graduates are required to successfully sit in order to be allowed to work in their chosen field. The evidence supports that use of multiple choice questions can both provide the levels of cognitive development and provide the process to reduce the detrimental effect of test anxiety on the outcome of the assessment (Fellenz, 2004; Martinez, 1999; Nicol, 2007).

Questions imbedded within presentations and questions on each of the examinations were coded according to the revised Bloom's taxonomy level. Mayer (2002) defines the levels of the taxonomy relative to cognitive science theories of learning. Level one, remember, identifies material that is taught similarly to the way it is intended to be retained. This level of content relies on rote memorization. Level two through level five (understand, apply, analyze, evaluate and create) are designed to promote transfer of knowledge so that it can be more deeply conceptualized. Level two, understand, is the largest category of objectives in schools and colleges. The ability to understand allows students to construct meaning from instruction. This serves as a foundation from which to develop more complex cognitive processes. Level two builds connections between old and new knowledge. Included in this category are interpret, exemplify, classify, summarize, infer, compare and explain. Level three, apply, involves using procedures to solve problems. This level is most closely linked with procedural knowledge, and includes the ability to execute and implement. Level four, analyze, involves recognizing integral parts of a problem and determining how the parts are related. The ability to differentiate, organize and attribute are categorized as analyze. Level five, evaluate, involves making judgments based on certain criteria. This involves the ability to check and critique. Finally, level six, create, involves putting parts together to form a coherent whole. This involves producing an original product. Table 3.2 illustrates examples of questions of the four taxonomy levels according to the Revised Bloom's Taxonomy (Krathwohl, 2002) which were used in the presentations and on the exams.

In developing the questions for this course, it was determined that the majority of cognitive processing would occur at level 2, or understanding. While factual knowledge is necessary to build a foundation of recallable knowledge, students need to understand the content in order to apply concepts and analyze movement, which was the ultimate level of cognitive processing sought in this course. Therefore, it was expected that while the amount of level two content would remain somewhat constant, and level three processing was limited due to the nature of the course material presented, there would be a gradual increase in the number of level four, analyze processing, occurring. The questions within the presentations were developed according to this assumption and to the questions within the cumulative final examination.

The cumulative final examination was the same examination that was given in 2008. The Kuder Richardson 20 value for the 2008 final examination was .90. The Kuder Richardson 20 value is essentially the same as the Cronback alpha, in that it is a measure of the examination's reliability, or internal consistency (http://www.ericdigests.org/2002-2/reliability.htm). The internal consistency denotes the degree to which the individual items correlate with each other, which is considered an acceptable measure of internal consistency in a classroom based test. According to Ericdigests.org, high stakes tests should have an internal consistency of .95 and no less than .90. However, in examinations where the instructor has the ability to gauge student performance over time in the classroom, the internal consistency value should range from .50 to .60. Therefore, the final examination for 2008 was considered a reliable measure against which to compare student learning outcomes for the course.

Student and Instructor Perceptions of Learning Processes

Qualitative and quantitative data were collected in the form of student interviews, surveys and instructor reflections exploring the perception of the participants in regard to the benefits of using ARS on student learning processes. Student interviews were conducted with two students at midsemester from section one, and with three students from section two at the end of the semester. Each of the students performed in the lower quartile on all of the examinations taken during the time they were in the treatment group. It was hypothesized that students, who performed in the lower quartile, would gain greater benefit from the treatment. Higher performing students have developed skills needed to perform well and would continue to perform well regardless of the treatment. Guided interview questions were loosely constructed, consisting of five basic questions (See Appendix G for a list of student interview questions), according to the interview guide approach (Johnson & Christensen, 2004, p 183). Students were allowed to elaborate on the questions during the interview, because the purpose of the interview was to generate data (Portney & Watkins, 1993, p 240) and to gain an understanding of the students' perspectives (Johnston & Christensen, 2004, p 183). The interviews were taped by the interviewer. The tapes were transcribed by a secretary**.**

Data from the interviews were then used to develop a survey that was sent to all participants who completed the semester. The survey was constructed, distributed and analyzed at Survey Monkey (surveymonkey.com). Survey items focused on three main categories: 1) student perception of peer collaboration on learning; 2) student perception of questions embedded within the presentation on learning; and, 3) Student perception of the use of clickers on learning (See Appendix H for a copy of the student survey). The survey was written in the form of statements related to the three main topics, with a four item Likert scale response option. The scale selections ranged from strongly agree (four), agree (three), disagree (two) and strongly disagree (one). The surveys were distributed over email to the students' college email addresses. Reminder emails were sent at one week and two weeks following initial distribution.

The instructor participant maintained a weekly journal of her observations and perceptions of student interaction relative to student activity in class. At the end of each week, the instructor reflected briefly on the participation in both sections and documented those reflections. The reflections were coded and the results were used to further explain the impact of the ARS within the context of the class.

Finally, data from course surveys collected at the end of the semester were used as a measure of student perception of course value. Although course evaluations are often biased by student outcome, items from the course evaluation, which were pertinent to the student satisfaction with the instructor and course content were analyzed. The course evaluation is a standardized assessment tool, measured on a five point Likert scale ranging in responses from strongly agree to strongly disagree.

Data Analysis

Descriptive statistics were run on student participant attributes, in order to provide a greater understanding of the sample as a whole, and on test item and presentation item attributes. This data were organized into chart format for clarity.

In order to address the question related to the significance of the ARS on student learning outcomes, independent t- test analysis was used to compare mean learning outcomes in the form of unit and final examination and course grades. Performance on non-cumulative unit examinations and the cumulative final examination were compared across conditions. It was hypothesized that the non-cumulative unit examinations results would reflect the impact of the treatment, since section one served as the treatment group for tests one and two, and section two served as treatment for tests three and four. The cumulative final examination should reflect no significant difference relative to the treatment, since all students in both sections would have received equal benefit from the treatment over the course of the semester.

In order to address the issue related to the use of presentation questions designed in sequentially more difficult format on student learning outcomes, the final examination test items were coded for taxonomy level, according to the revised-Bloom's taxonomy (Krathwohl, 2002), Chi square analyses were conducted in order to compare student performance on different levels of the final examination to those responses to the same items from previous classes. Items that were in common in the final examinations for this semester and for the previous three years were identified. The final examination in 2006 and 2007 contained 50 multiple choice items. The final examination was expanded to 100 items in 2008. Although there were some revisions to the examination each year, the majority of the test items were used each year. The first fifty items on the 2006, 2007 and 2008 were used to determine expected outcomes for the current examination, and the forty-eight of the final fifty items from the 2008 final examination were used to determine the expected outcomes for the current examination.  For those items that covered more than one year, a weighted average response was calculated by determining the percentage of correct answers for each item and multiplying that average by the number of students participating in the given examination. The sum of the products was then divided by the total number of responses for the item across all examinations. That weighted average was then used to depict the expected outcome on the given item. The observed outcome was determined by the average of correct responses for the given item. Chi square analysis was then performed on the results from each of the four taxonomy levels and a representative graph was developed to illustrate the findings. In addition, a chart illustrating the comparison of student response from the final examinations in 2008 and 2009 was developed, in order to detect similarity of performance.

Qualitative data related to perceptions of the participants were gathered through audiotapes of student interviews and through journals. The taped interviews were transcribed by a secretary and coded. Weekly reflections of the instructor were kept by the instructor in the form of journals. Reflective journaling is a method of data collection with roots in ethnographic methodology.  Although it can be used for a wide variety of applications (Goldenhar & Kues, 2006; Ortlipp, 2008; Woolf & Quinn, 2009), its use in this instance provided ongoing documentation of the instructor's perceptions of student participation and classroom dynamics. This method reduces the distortion that may occur when trying to recall events at a later time. At the end of each week, the instructor reflected briefly on the participation in both sections and documented those reflections. The reflections were coded and the results were used to further explain the impact of the ARS within the context of the class.

All qualitative data were coded according to the constant comparative method of data analysis, to gain meaning from the data (Goldenhar & Kues, 2006; Woolf & Quinn, 2009). Open coding initially identifies concepts found within the text, and provides a basis for categorizing the data. Axial coding refines the categories so that the categories determined are the most relevant to the study. Selective coding groups the categories so that they are integrated. These findings provide a greater depth of understanding the findings than statistical analysis alone.

The results from the survey that was developed from the results garnered from the interviews were aggregated and placed in table format (See Table 4.6). Surveymonkey.com provided analysis of the data according to frequencies of response for each item selection. The aggregated data were then used to develop the table depicting the results.

# Chapter Four

## Results

This research study was designed to examine the impact that ARS have on student learning outcomes when used with pedagogically sound instructional methods.

Students enrolled in two sections of an applied Kinesiology course served as participants in the study. Thirty-seven students enrolled initially, fifteen in section one and twenty-two in section two. However, following midsemester, nine students in section one and seventeen students in section two remained to the completion of the semester. Table 4.1 illustrates demographic information about the students who participated in the complete study. Mean grade point average and age, across the two sections, were not significantly different. Eight students earned previous baccalaureate degrees and were returning to school in another discipline.

Table 4.1 Participant Demographics

| | Section 1 (N=9) | Section 2 (N=17) |
|---|---|---|
| Male | 2 | 4 |
| Female | 7 | 13 |
| Mean Age | 26.1 | 23.1 |
| Mean GPA | 2.74 | 2.87 |
| Earned Degree | 2 | 7 |

The study was designed as a mixed methods, quasi-experimental, AB research study. Section one served as the treatment group for the first half of the semester while section two served as the control. Following midsemester, section two served as the treatment group and section one served as the control group. The same instructor taught both classes identically, and the students were assessed using identical written assessments.

Questions of graduating difficulty were embedded within the presentation slides. The treatment group responded to the questions using ARS remotes, and the class aggregate was projected onto the screen as a histograph depicting overall class response by frequencies. The correct response was solicited from the control group, but the correct answer was provided if the incorrect response was given. Both groups were then allowed to work in small groups to discuss the question and answer, and full class discussion followed.

Student learning outcomes were assessed with four written, non-cumulative, unit assessments (two for each treatment group) and one cumulative final examination. The instructor journaled weekly. Interviews were conducted with five students, and a survey was designed to garner feedback from students related to the effects of the questions and ARS on their learning. The data were analyzed, and the results follow as they pertain to specific research questions.

Does the Use of ARS Significantly Improve Student Learning Outcomes?

Table 4.2 depicts the descriptive statistics and independent t-test analysis of the four unit examinations. Independent t-test analysis was used to compare the means of the students' grades on non-cumulative unit examinations, the cumulative final examination and the final course grades using SPSS 14.0. No significant differences were noted in student scores for either section when comparing student performance across the semester. No significant differences were noted in student scores when comparing means for individual unit examinations.

Table 4.2 Comparison of Student Learning Outcomes: Unit Examination Comparisons

| Measures | Section 1 (n=9) | | Section 2 (n=17) | | t-tests | | |
|---|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | *t* | *df* | *p* |
| Exam 1 | 84.67 | 10.05 | 85.77 | 8.48 | -.295 | 24 | .771 |
| Exam 2 | 81.30 | 11.80 | 85.88 | 8.38 | -1.143 | 24 | .264 |
| Exam 3 | 83.06 | 11.26 | 87.65 | 17.41 | -.713 | 24 | .483 |
| Exam 4 | 80.22 | 11.68 | 81.41 | 12.24 | -.239 | 24 | .813 |

Table 4.3 compares student means on the final examination and the final course grade. There were no statistically significant differences noted in final examination or final course grades between the two sections. This finding is expected, since there were no differences noted throughout the course on individual examinations.

4.3 Comparison of Student Learning Outcomes: Final Exam and Course Grades

| Measures | Section 1 (n=8) | | Section 2 (n=17) | | t-tests | | |
|---|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | *t* | *df* | *p* |
| Final exam | 75.50 | 8.90 | 79.75 | 11.75 | -.908 | 23 | .373 |
| Final grade | 89.70 | 4.66 | 89.25 | 6.64 | -.514 | 23 | .612 |

Results illustrated in the previous two tables denote that no statistically significant differences could be identified between the two sections that could be attributed to the ARS.

### Do Questions of Sequential Difficulty Embedded in Presentations Significantly Improve Student Learning Outcomes?

Questions used in the presentation were similar to those used in the examinations (See Table 3.2), according to taxonomic levels of difficulty. When developing the unit tests, a minimum of test items were written on the apply level, level three, because application of the material was primarily tested in the accompanying laboratory course. Less than 1/3 of the questions were written on level one, remember, because more focus was placed on the understanding of the material in various contexts for deeper learning. Therefore, approximately 1/3 to ½ of the items were written on level two, understand, and level four, analyze, levels.

Table 4.4 illustrates the descriptive statistics relative to the percentage of correct answers per taxonomic level across the four non-cumulative unit examinations. While the mean number of correct answers for levels one through three remain relatively constant across the four exams, level four means demonstrate a steady increase of correct answers, ranging from a mean of .66 for exam one to .74 for exam four.

Table 4.4 Mean Correct Answers Per Taxonomic Level Across Non-Cumulative Unit Examinations.

| | Exam 1 (N=26) | | | Exam 2 (N=26) | | | Exam 3 (N=26) | | | Exam 4 (N=26) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Items | Mean | SD | Items | Mean | SD | Items | Mean | SD | Items | Mean | SD |
| Level 1 | 11 | 0.9 | 0.3 | 6 | 0.79 | 0.4 | 15 | 0.83 | 0.37 | 14 | 0.8 | 0.4 |
| Level 2 | 20 | 0.86 | 0.34 | 20 | 0.76 | 0.43 | 21 | 0.79 | 0.41 | 24 | 0.83 | 0.37 |
| Level 3 | 5 | 0.9 | 0.3 | 6 | 0.88 | 0.32 | 1 | 0.54 | 0.51 | 3 | 0.88 | 0.32 |
| Level 4 | 8 | 0.66 | 0.47 | 15 | 0.63 | 0.48 | 10 | 0.67 | 0.47 | 9 | 0.74 | 0.44 |

Table 4.5 depicts the attributes of the final examinations from 2008 and 2009. No significant difference is noted between student achievement on the different levels between 2008 and 2009, but a slight increase in percentage of correct answers can be noted in responses to questions identified as level two, three, and four. There is also a drop noted in correct responses to level 1 questions in 2009 as compared to 2008.

Table 4.5 Percentage of Correct Responses on the Final Examination Per Taxonomy Level.

| | 2008 Final Examination (N=38) | 2009 Final Examination (N=25) |
|---|---|---|
| 1 | 75.24 | 69.71 |
| 2 | 74.94 | 77.62 |
| 3 | 76 | 77 |
| 4 | 75.75 | 77 |

Chi square analysis was performed on the results from each of the four taxonomy levels. Table 4.6 presents the results of the Chi Square analysis. No statistical significance was found between year 2008 and 2009 results at each level.

Table 4.6 Comparison of Test Items Per Taxonomy Level

| Taxonomy Level | $X^2$ | df |
|---|---|---|
| 1 - Remember | 1.052 | 20 |
| 2 - Understand | 3.373 | 49 |
| 3 - Apply | 0.135 | 3 |
| 4 - Analyze | 7.226 | 19 |

$p>.05$

How Do Students Perceive the Benefit of Questions Within the Presentations?

It was assumed that the weaker students would gain the most out of using the ARS and question/per discussion activities, since stronger students would perform well in spite of the technology. Therefore, loosely structured guided interviews, of six basic questions, were conducted with six students representing students performing in the lowest quartile in each section of the course. The interviewer did interject additional questions in order to clarify student responses when needed. The interviews were then transcribed by a secretary, and data were coded and used to develop a survey, which was electronically delivered to each student enrolled in the two sections of the course. The surveys were sent to the college email addresses of all 26 participants. A follow up email was sent at one week and two weeks post distribution. Eighteen participants responded to the survey, constituting a 69% return. Portney & Watkins (1993) propose that a response return between 60% to 80% is considered an excellent return, but most surveys net a return of 30% to 60%.Three primary categories were included in the survey; 1) questions related to peer collaboration; 2) questions related to the questions embedded in the presentation; and, 3) questions related to the ARS use. Table 4.7illustrates student responses to the survey questions related to the benefit gained from questions embedded within the presentations.

Table 4.7 Online Survey Results Related to Questions.

| | Strongly Agree/Agree | Disagree/Strongly Disagree |
|---|---|---|
| Questions did not affect how well I learned the material. | 11.80% | 88.20% |
| Reviewing questions helped me understand how to read test questions. | 94.10% | 5.90% |
| Answering questions helped me know how well I understood the material. | 100% | |
| Answering questions helped me apply the content. | 100% | |
| Answering more difficult questions made me learn the content in a deeper manner. | 94.50% | 5.60% |
| Reviewing questions improved my performance on tests. | 100% | |

Students appeared to relate the use of clickers to presentation questions. For example, when asked if there was anything that he did not like about using the clickers, AB reported "there wasn't enough of them," indicating that he wanted more opportunities to answer questions during the presentation. He was not the only interviewee to respond in this manner. This was supported by the request from multiple students, particularly those in the treatment group, for more questions during the presentation of content.

Responses by the students to items related to use of questions in the presentations was consistently positive (See Table 4.7). On interviews, students were more specific about the benefits. LP identified that, "just by answering it…either correctly or incorrectly, you know if you're on the right level of understanding…" MP indicated that the analysis of the questions in class helped her process the information. It was most helpful to "take these parts out and analyze it so it was really helpful to me." KS added "you really pay attention to the lecture, so when the questions were there you know the answer."

Feedback was valuable to the students from two perspectives. The students knew immediately whether they understood the material as presented, and the students were able to assess how their understanding compared to other members in the class. The participants unanimously agreed that the immediate feedback was beneficial to reinforce their understanding. As MP stated that she had the opportunity to see, “what everyone else’s answer was and…where you were at in the class.” AB felt that it supported his learning in that it reinforced what was learned that day and it “gave us time to think about…what I don’t know.”

The benefit of the immediate feedback was extended and reinforced when students discussed the question and answers with peers. The peer discussion often clarified contexts and corrected misconceptions. Although several participants identified the benefit of peer interaction, KS summed it up when she stated, “I think that talking among your peers makes a difference, because they see things in a different perspective than you do, and sometimes they say something, and it just, like, clicks.”

An unexpected benefit of the use of clickers themselves was identified in this study. Students acknowledged the fact that they were forced to commit to an answer in order to use the ARS. KS summed it up when she said, “it made you really think about the question and not just wait for somebody else to answer, cause you want to make sure you’re right.” CG admitted that when the clickers were not used, “we were all just looking around at each other” waiting for reinforcement before admitting what they thought.

Discussing the imbedded questions allowed the students to prepare for written assessments. Although the questions were not identical to those in the examination, students were able to gain an understanding of the depth of understanding required of them. KS stated, “It gives me a really good idea of what questions to expect on the test and how to prepare for the test.” AB stated, “The questions that you asked us was showing us more like the format kind of questions that you’re going to be asking.” LP added that remembering the questions asked in class helped her form her own questions when studying for the test.

Finally, many students have difficulty taking multiple choice questions because they fail to read the question thoroughly and ignore clues within the question stem that provides the context within which to select the correct answer. Reviewing the questions during the class discussion identified the factors framing the context teaches the students how to read the question and identify qualifiers. MP added that, “you would go over it and …you would analyze it so it was really helpful to me”.

How Do Students Perceive the Benefit of ARS in the Classroom?

Student responses to the survey questions related to their perceived benefit of using ARS in the classroom are depicted in Table 4.8. Overwhelming agreement was noted in the areas of student participation and other forms of student engagement.

Table 4.8 Student Perception of ARS Benefits.

| | Strongly Agree/Agree | Disagree/Strongly Disagree |
|---|---|---|
| Clickers did not impact participation in class. | 10% | 90% |
| Reviewed notes more often. | 60% | 40% |
| Read chapters before class more often. | 50% | 50% |
| Clickers made class more fun | 100% | -- |
| Paid attention more with clickers. | 90% | 10% |
| Clickers motivated student to learn. | 100% | -- |
| Clickers increased class participation. | 100% | -- |
| Immediate feedback was beneficial. | 100% | -- |
| Graphs helped student assess understanding. | 100% | -- |

Virtually all of the students, who were interviewed, admitted that they do not generally participate in classroom discussions, and 90% of the participants surveyed agreed that the clickers impacted their participation in class. The literature supports that students often lack confidence in their knowledge and don’t want to appear stupid in front of their peers. CG stated that using the clickers “helped a lot, because when we didn’t use them it was just way more difficult.” MP admitted that it “forced us to participate… it gave us the opportunity to participate.” GP liked them because “it’s more private and I can participate more.” She added, “right or wrong answers don’t really matter.” AB added, “it helped me participate a lot more in class just because we actually got to interact by…answering the questions.”

Few of the students interviewed acknowledged that they read chapters prior to class or reviewed the notes regularly, if ever. However, 50% of the students stated that the clickers and questions motivated them to prepare ahead of class and 60% stated that they reviewed the notes more often (Table 4.6). As MP stated, “I was, like, I’m gonna have to start cause I felt like a dummy…I would have to review before class.” CG concurred as she admitted, “if I wasn’t using them [ARS], then I probably would just, you know, not even look at the book until you get to class.” KS admitted that, “I made sure I read over my notes before I came to class and try to read ahead in class.” Students agreed that using the clickers in class made the sessions more interesting and fun (Table 4.6), possibly because of their interactive nature. KS stated that, “it makes it more fun because you really pay attention to the lecture so when the questions are there you know the answer.” Some students felt very strongly about the benefit of using the clickers. AB reiterated what many of the participants stated when he suggested that more questions be integrated into the lecture content. MP also praised the use of clickers and suggested that, “I think we should have them in, like, every class.”

How Does the Use of Questions and ARS in the Classroom Benefit the Instructor?

The instructor’s journals were coded for recurring threads that occurred throughout the semester. Five threads were initially identified. These included student participation in class, student engagement, test taking, formative assessment and technology issues (See Appendix I, Instructor’s Reflections). Further coding categorized instructor benefits of using ARS focused primarily on four main observations, two of which were positive and two which were negatively perceived. Table 4.9 illustrates major concepts associated with both. Although the noted disadvantages were minor inconveniences, the advantages were greater and overshadowed the disadvantages.

Table 4.9 Instructor Observations

| Advantages of ARS | Disadvantages of ARS |
|---|---|
| Formative assessment | Time commitment |
| • Percentage of correct/incorrect responses informed student comprehension of concepts | • Writing effective questions for both presentation and examinations |
| • Provided for immediate remediation of misunderstanding | • Decreases time available to present new material |
| • Allowed for monitoring of individual students’ comprehension | • Time consuming to code individual answers to questions on each slide in Beyond Question |
| • Able to adjust attention to content as needed | • Must save each component of data separately |
| • Able to model and guide analysis of questions to select correct answer | • Software dropped answers |
| | • Occasional slide interface problems |
| Participation | Technology malfunctions |
| • Able to monitor classroom dynamics | • Broken remotes |

(Table 4.9 continued)

| | |
|---|---|
| • Able to observe degree of individual students | • Software |
| • Long term change in participation behaviors | • Administrator rights |
| • Improved student motivation and initiation | |

Participation

Section one of the course served as the initial treatment group, and they began using the clickers immediately. By the second week, the students spontaneously initiated conversation with their peers after viewing the response graphs. As the class began to discuss the question as a whole, there were contributions from most of the students, without requiring prompting. Students spontaneously asked questions to clarify remaining misunderstandings. When a student noted that they answered the question correctly, particularly if several other students did not, there was obvious pride noted in the accomplishment by facial expression and verbal exclamation.

When section one changed to the control group and no longer used the clicker or had graphic feedback to discuss, the students seemed at a loss to begin discussions. As one student stated, she did not have to commit to an answer, so there appeared to be no starting point to the discussion. The discussions were less robust and students often appeared to have less confidence in their decision. In spite of this phenomenon, section one continued to enter into discussions with peers and as a class with greater ease than was observed during the first week.

Section two served as the control group, and, although they were provided the questions, they did not have access to the clickers or response graphs during the first half of the semester.  Three students in section two seemed to be the primary contributors to class discussion. Following the question presentation, one of these students would eventually suggest an answer, often reluctantly. Attempts by the instructor to have another student answer the question often resulted in an “I don’t know” response. Peer discussions were generally hesitant, with students apparently reluctant to take a decisive stand on an answer. Although the initiation of conversation became easier over time, there never appeared to be a robust conversation occurring.

When section two changed to the treatment group at midsemester, there was an immediate impact on the overall behavior of the class. Some of the students became competitive and requested additional questions to test themselves. Students who never contributed would do so when called upon. There appeared to be a greater confidence in the participation level, and several students, other than the initial three, contributed spontaneously. However, it was noted that in spite of the increased participation of section two, the students did not appear to reach the same level of confidence in general class participation that section one did.

Formative Assessment

The responses to the questions provided immediate feedback regarding student comprehension. The peer collaboration activity helped most of the students clarify misunderstood concepts, and the class discussion following became directly focused on problematic content. The activities provided "teachable moments" early in the content presentation. The instructor did not have to make guesses about what the students comprehended, and she was able to modify how a concept was presented for greater clarity. Although the data from the answers was not retained consistently due to problems with the software interface and instructor error, the instructor noted anecdotally that the percentage of correct responses seemed to improve significantly toward the end of the semester. Students appeared to enjoy participating in class and appeared engaged with each other, the instructor and the material. Since student engagement is a benchmark of colleges of high quality, this aspect of the findings cannot be ignored.

Disadvantages of ARS

As previously noted, the system that was used occasionally dropped the answers to the questions in the presentation. In those instances, students were unable to use remotes to indicate their responses, and it was not possible to graph the results. Occasionally, an individual slide would format with a different background color than the rest of the slides. When the slide was too dark, students could not read the information on the slide.

The instructor did not hold administrative authority to download programs, and was dependent on IT services to reload the receiver when it was unplugged from the computer. Although this was a minor inconvenience, it did occasionally cause a disruption in the flow of the class.

The remotes that were used were provided to the students for use in the class. The remotes were attached to the tables at student places with Velcro attachments. However, the repeated forces used to disengage the remotes for use in the class caused the plastic backing to dislodge from the remote, releasing the batteries. The students often switched remotes in order to find one that worked; thereby, causing data to record to the wrong student.

Finally, preparing questions of appropriate taxonomy level is very time intensive, particularly when matching them to assessment tools. Greater preparation time is required initially to develop the questions and incorporate them within the ARS software. Data from student responses must be saved separately from the lesson holding the questions. This was not initially apparent when reading the instruction manual. As a result, student response data was initially lost and unavailable for analysis in this study.

Overall Student Satisfaction

Student satisfaction is often gauged by responses on course evaluations, although these evaluations often demonstrate poor reliability and validity. However, it was felt that student responses on the course evaluation would provide depth to other qualitative data collected from interviews and the survey, and that they would help to inform student perceptions of the course. Items from the course evaluation that were pertinent to the student satisfaction with the instructor performance and the material itself were analyzed (Table 4.10). Students were asked to respond to the question using a five point Likert scale, with 5 representing "strongly agree" and 1 representing "strongly disagree."

Student satisfaction was consistently high, rating a mean of 4.0 or better in all items. Although there were few additional comments, the majority of them were positive in nature. One student stated, "I love the new way that [the instructor] teaches. It makes me read more to understand rather than memorize." Sharma, et al (2005) found that both students and faculty value the benefits of ARS in facilitating student participation and engagement with the faculty and other students.

Table 4.10 Student Satisfaction Survey at Course Completion

| | Section One (n=10) | | | | Section Two (n=16) | | | |
|---|---|---|---|---|---|---|---|---|
| | Max | Min | Mean | SD | Max | Min | Mean | SD |
| Audiovisuals were beneficial in understanding the class content. | 5 | 4 | 4.43 | 0.53 | 5 | 3 | 4.33 | 0.78 |
| Exams corresponded to material covered in class and assigned reading. | 5 | 3 | 4 | 0.82 | 5 | 2 | 4.69 | 0.79 |
| Exam items were stated clearly. | 5 | 4 | 4.7 | 0.48 | 5 | 4 | 4.88 | 0.34 |
| Class assignments required me to think. | 5 | 3 | 4.2 | 0.63 | 5 | 2 | 4.5 | 0.82 |
| The instructor was supportive and helpful. | 5 | 4 | 4.7 | 0.48 | 5 | 4 | 4.81 | 0.4 |
| The instructor utilized a variety of methods to facilitate learning. | 5 | 4 | 4.67 | 0.5 | 5 | 4 | 4.94 | 0.25 |
| The instructor was well-prepared for each lecture. | 5 | 4 | 4.5 | 0.53 | 5 | 4 | 4.94 | 0.25 |
| The lectures were stimulating. | 5 | 3 | 4.3 | 0.82 | 5 | 4 | 4.88 | 0.34 |
| The instructor was interested in the subject matter. | 5 | 4 | 4.7 | 0.48 | 5 | 4 | 4.81 | 0.4 |
| The instructor apparently enjoyed teaching the class. | 5 | 4 | 4.7 | 0.48 | 5 | 4 | 4.88 | 0.34 |
| I was given the opportunity to adequately express my views. | 5 | 4 | 4.7 | 0.48 | 5 | 2 | 4.81 | 0.75 |
| I was treated respectfully in the course. | 5 | 4 | 4.6 | 0.52 | 5 | 4 | 4.81 | 0.4 |

Summary of the Key Findings

1) No statistical significance was found between treatment and control classes at each of the four unit examinations. Analyses of the achievement data by four cognitive levels showed no changes at level 1-3 but a trend of consistent improvement over time at level 4 was noted across the four unit exams and between year 2008 and 2009. However, chi-square analysis comparing year 2008 and 2009 data showed that the difference was not statistically significant.

2) Students overwhelmingly perceived benefit from ARS, questions embedded within presentations and peer discussion of questions.

3) The instructor perceived generally advantageous results from using ARS that can benefit both students and the instructor.

## Chapter Five

## Discussion

This study was designed to investigate the effect of the ARS technology in regard to 1) the impact of the ARS on the student learning outcomes; 2) the impact of the questions of graduated taxonomy level embedded within the presentations on student learning outcomes; 3) the students' perception of the benefit of ARS on their learning; 4) the students' perceptions of the benefit of the questions embedded within the presentation on their learning; and, 5) the instructor's perception of the benefit of ARS on student learning. Results of this study identified three key findings that contribute to the body of knowledge regarding ARS, and which form the structure upon which the discussion will ensue.

### Significance of ARS on Student Achievement

It was assumed that, if the ARS did improve the student learning outcomes, one would expect to see improved performance on the unit exams one and two for section one students, and an improvement of unit exams three and four for section two. Because each of the groups received the same treatment, albeit in different parts of the course, it was expected that no difference would be noted on student performance on the cumulative final exam, or in the final course grades. No statistical significance could be found to demonstrate an increase in student learning outcomes or the learning process through this study, when comparing student performance on non-cumulative unit examinations, the final examinations, or comparing final examination scores to those of the previous year. Although section two consistently out-performed section one in all unit examinations, there was no statistically significant difference noted that could be attributed to the use of ARS. No statistically significant differences were found between final examination or final course grades.

While these findings do not coincide with findings by Hake (1998), the significant difference in sample size may explain the difference in the results. Although 37 students originally enrolled in the course, and agreed to participate in the study, only 26 students were retained throughout the semester. PTAP 2310 is a pre-requisite course to a competitive entry program, and it is taught at a very accelerated pace. Students are required to learn the material at deeper knowledge levels than most traditional first and second year college courses. For most students, there is a learning transition that must occur, which often requires a change in study habits to match the level at which the students are assessed. Some students, particularly those who are more experienced, or who have earned prior degrees, have developed more mature critical thinking and study skills. Students tend to be very conscious and protective of their grade point averages, and they withdraw from the course at midsemester if they feel that they are in jeopardy of failing the course. Approximately 1/3 of the participants withdrew or failed to complete the course. The students who withdrew were in the lower quartile of the class, and their withdrawal skewed the class profile. This fact, combined with the low participant numbers, may have affected the ability to control for type II errors. Hake (1998) sampled six thousand students, and this sample was more reliable for controlling type II error. Hake compared student learning outcomes across 62 introductory courses, based on pre-test post-test performance comparisons. However, Hake was unable to control for consistency across instructors, and he could not control for consistency in content presentation.

Schackow, et.al. (2004) also reported significant improvement in learning outcomes using ARS with residents in Family Practice Medicine. Although the sample size was comparable to the sample size of this study, there was no control noted for the questions used to assess residents' learning. Since the literature shows that questions are often written at very low levels of comprehension, it is difficult to ascertain whether the questions themselves biased the results.

Mayer, et al (2008), conducted a study very similar to the one presented here, and found a significant difference in student learning outcomes across the two groups. However, the participants in the treatment and control groups did not enroll in the courses under study synchronously. The control group enrolled in the course during the 2005-2006 academic year, and the treatment group enrolled during the 2006-2007 academic year. The treatment was provided for the entire semester, and the number of participants in each group exceeded 100 students (Mayer, et al, 2008). In addition, there was no control of instructor participation noted within the study design, which may have biased the final results.

The findings in this study support those of Clarke and Feldman (2005) and Judson and Sawada (2002), who state that most research exploring the impact of ARS do not report gains in student achievement. Technology is merely the means by which to present pedagogy. There has historically been significant inconsistent control of variables across studies, which potentially have confounded the findings (Clarke, 2001; Clarke & Feldman, 2005; Lou et al, 2006). The strength of this study design was the ability of the researcher to control for pedagogical impact and to isolate the measurement of the impact of the ARS. The ability of the researcher/instructor to insure identical instructional methodology and content, across both the control and the treatment groups, provided the control to measure only the effect of the ARS on student achievement.

One threat to the reliability of this study is its short duration. While the AB design of the study controlled for homogeneity within the groups, each treatment group received the treatment for only seven weeks. Research does support the idea that learning self-regulatory learning behaviors is a developmental process that occurs over time (Case & Gunstone, 2002; Dahl, Bals, & Turi, 2005; Paulsen & Feldman, 2005), and is based on student experiences and challenges to their belief systems (Schommer, 1990). Student resistance to changes often extends the temporal component of that developmental process (Åkerlind, 2004). The duration of the treatment for each group may not have provided adequate time for the students to develop learning behaviors that would significantly impact the learning outcomes and learning processes.

Literature supports the tradition of posing questions to students in a way that challenges them to think deeply and in context, improves deep conceptual learning (Crouch & Mazur, 2001; King, 1991, 1995; Graffam, 2008, Wiggins, 1992). While there are conflicting findings in the literature, it is a generally held belief that failure to ask questions designed to facilitate higher order thinking is primarily responsible for the conflict. This study incorporated the control of questions throughout the course, in both presentations and examinations, on questioning which covered four levels of the revised-Bloom’s taxonomy. In fact, although no significant difference could be determined between 2008 and 2009 performance on the final examinations, there were some interesting trends noted in the data that warrant consideration. The mean number of correct answers for the various levels indicate that the students in 2009 performed better on the higher level questions, than did the students in 2008. Students in 2008 performed better on level one questions. However, the same students performed better on level two, three and four questions than did students in 2008. The lower performance on level one questions by the 2009 class might indicate a change in learning away from basic rote memorization and toward more contextually applied knowledge, as indicated by the higher scores on the higher level questions (See Table 4.4). Also, while the mean number of correct answers for levels one through three remain relatively constant across the four non-cumulative unit examinations, level four means demonstrate a steady increase of correct answers, ranging from a mean of .66 for exam one to .74 for exam four (See Table 4.3).

Finally, it should be noted that the small sample size caused from student attrition within the course could have failed to control for type II error. The fact that 1/3 of the 2009 class failed to complete the course resulted in 1/3 fewer students in 2009, as compared to the 2008 class.

Students' Perception of Benefit From ARS, Questions and Peer Discussion of Questions

The interactive nature of the clickers allowed the students to engage with the content in a manner that is not possible to duplicate in a traditional lecture class. As a result, the participation in class increased and the students' motivation to participate and to learn the material increased as well. Students overwhelmingly felt that the quality of their learning improved because of the challenge of the questions, the ability to clarify questions immediately and the interactive nature of the classes.

This coincides with findings of Umbach and Wawrzynski (2005), who found that faculty were credited with high levels of engagement with the students, when they incorporated active learning and peer collaboration into the educational environment. Bowen (2005) contends that student engagement with the content and with peers allows students to build new knowledge on previous experiences. This phenomenon allows the deeper learner to extrapolate knowledge beyond the specific content presented (Schmeck & Geisler-Brenstein, 1991).

Students particularly appreciated the immediate feedback provided by the ARS instructional method, which allowed them the opportunity to anonymously gauge their achievement to their peers. The literature supports the value of immediate feedback to student (Kennedy & Cutts, 2005 ). Winne (1996) recognized the importance of feedback, which allows the student to select tactics that increase the breadth and depth of learning. Stein, et al, (2006), and Graham et al (2007) report that one of the advantages of ARS is the ability of the student and instructor to instantly assess student comprehension of material presented. Cognitive science identifies the importance of connecting new knowledge in working memory to experience and previously learned knowledge in long term memory. The addition to the schema contributes to the deeper learning (Clarke & Feldman, 2000; Schmeck & Geisler-Brenstein, 1991).

It appears that the use of the questions and clickers followed by peer collaborative processing and class discussion provided the framework where students could confidently participate in a non threatening environment that supported the learning process. These findings are well supported in the literature (Graham et al, 2007; Judson & Sawada, 2002; Sharma, Khachan, & O'Byrne, 2005).This attribute is one that appears in most of the literature related to use of ARS.  Although it is not quantifiable, except as a student perception, students consistently report that using ARS in the classroom makes the lectures more interesting and fun (Graham, et al, 20007; Latessa & Mouw, 2005; Wit, 2003), that they are more attentive in class (Graham, et al, 2007; Judson & Sawada, 2002; Latessa & Mouw, 2005), and that they feel more engaged with the instructor (Judson & Sawada, 2002).

Instructor's Perception of Benefit of ARS, Questions and Peer Discussion of Questions

The benefit of the ARS for the faculty became evident almost immediately, and the findings mirrored those identified in the literature (Baderin, 2005; Hughes, 2005).  The immediate feedback provided ongoing formative assessment of student comprehension of basic content and overall themes.  The instructor was able to monitor the group achievements as well as those of specific students.  Additional clarification and focused teaching in response to immediate student needs contributed to class participation and appeared to have minimized the need for later, more time consuming remediation of misconceptions. Students appeared to have generally gained confidence and were more willing to ask questions and participate in discussions as the semester progressed.

# Chapter Six

## Conclusions

The literature is full of conflicting information about the impact of media and technology in general, and ARS specifically, on student learning outcomes and learning processes (Clarke& Feldman, 2005; Judson & Sawada, 2002). At the very heart of the conflict is the inconsistent control of variables that inform the findings. Clarke and Feldman (2005) state that media must be separated from the instructional methods and the sensory modalities to which they are directed in order to clearly define the role of each. Media can be used as an instructional method to provide adequate examples of contexts to promote student learning, but does not, itself, impact the learning processes. Rather, technology and media provides the means for controlled delivery of instruction over optimum sensory modality stimulation to enhance learning.

The results of this study align with the position of Clarke and Feldman (2005), in that no significant impact of ARS could be found on student learning outcomes and learning processes. However, the practical significance to both students and instructors cannot be ignored. The value of the technology to provide the means by which to deliver quality instructional activities is identified by the students and instructors themselves.

Although no statistically significant relationship could be determined between the use of ARS and student achievement, students reported an increased focus of attention on the material presented in class and an increase in confidence in their knowledge base. It also translated in to increased effort and reported change of study habits. This attitude was particularly noticeable in students who were identified as the lower achievers in the course. This increased attention has been reported in other studies (Graham, et al, 2007; Judson & Sawada, 2002; Latessa & Mouw, 2005). Students appeared more energized and focused during the lecture, particularly those actively using the ARS. Most students identified perceptions indicative of engagement with the instructor, the content and peers. The increased level of interest in the content could potentially translate into deeper learning experiences.

Although the researcher was able to control for measuring the impact of the ARS technology itself through this study design, there were several limitations that may have impacted the results of the study. First, the environmental context, within which this study was conducted, limited the number of participants available to participate. This factor was further compounded by the high number of students who resigned from, or failed to complete, the course. The small number of participants prohibited the researcher's ability to control for type II error.

Second, the sample was one of convenience and may not accurately represent the population from which the sample was selected. Although every attempt to identify the homogeneity and appropriateness of the sample was made, it was impossible to provide randomization of the sample to control completely for errors related to sampling.

Since the researcher served as the instructor, we cannot rule out the third limitation of the study, researcher bias. Every attempt was made to control for research bias by insuring that the instructional methodology for both sections were identical except for use of ARS, the possibility remains that findings were influenced by the instructor's enthusiasm and confidence in the impact of the treatment.

The potential for effects from the novelty of the technology cannot be ruled out, providing the fourth limitation. ARS is a new technology, and the use of ARS in this study was the first experience most of the participants have had with the technology. This potential is supported by the excited response of the students, both during the class and in the survey responses.

Finally, while students appeared to be motivated by, and enjoy, the use of ARS, the impact of technical difficulties must be addressed, adding a fifth limitation. The system selected, Beyond Question, exhibited some unexplained peculiarities that may have impacted results. While none of the technical difficulties were major, the inconveniences interrupted the information flow and pace of the class. In addition, the software instructions on the methods used to save data were not very clear and much student response data were lost before the researcher recognized.

There has been much debate, and conflicting research findings, in the literature about the value of technology on student achievement. Much of the inconsistency in results can be attributed to lack of consistency in study design and in the difficulty in accurately measuring student achievement. Technologies are constantly changing and improving. Often new technologies are adopted before value can be ascertained of the older technologies. This creates difficulty in controlling for unidentified confounding variables within the research designs (Lou et al, 2006). There can be no question of the value of application of strong pedagogical principles on student learning outcomes. Technologies can serve as a means by which environments and cultures of active student learning are provided. Students can build knowledge within real world contexts, which prepare them to meet the demands of competitive employment markets.

Whether or not the technology directly impacts the learning outcomes, there is significant evidence in this, and other, studies that technology provides the means by which students can engage with educational content, peers and instructors. As noted in research (Kennedy, 2000; Laird & Kuh, 2005), technology, when used appropriately with sound pedagogical methods, serves as a vehicle to engage students in the educational process, and often leads to engagement in other areas. Regardless of where one stands on the debate, the evidence of increased student engagement with instructors and peers, directly related to integration of technologies, must be considered, particularly with younger, traditional students.

Additional studies are needed to add to the growing body of knowledge of the impact of technologies on student achievement. The manner in which future generations of students engage in the learning processes will place greater demands on institutions of higher education to use sophisticated technology to drive the instructional process. While we may never develop the means to measure the impact of technology on student learning outcomes, as Nelson Laird & Kuh (2005) concluded, we need to determine whether value is added to the learning process by using technology, and we need greater understanding of how students use the technology to engage with the learning processes.

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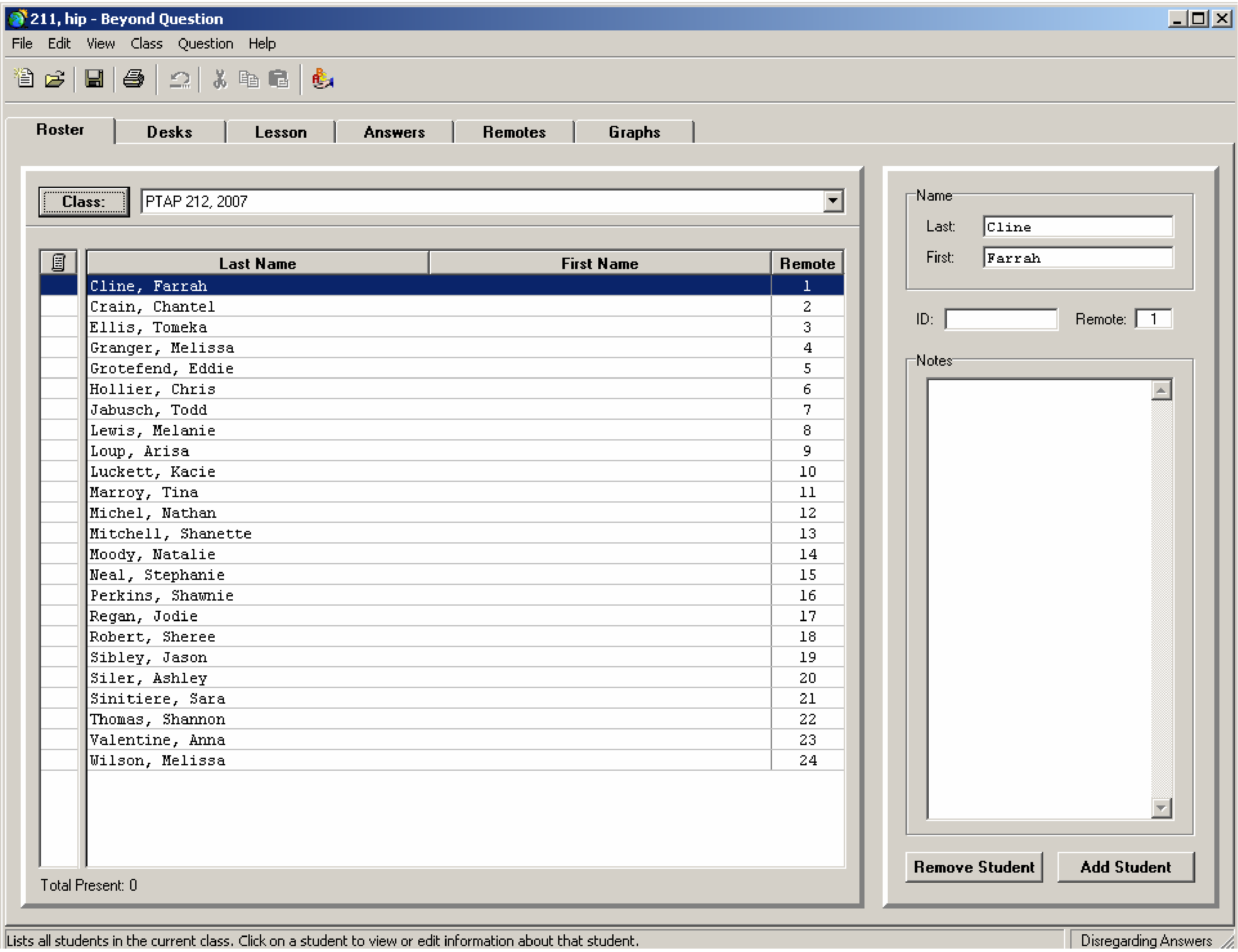
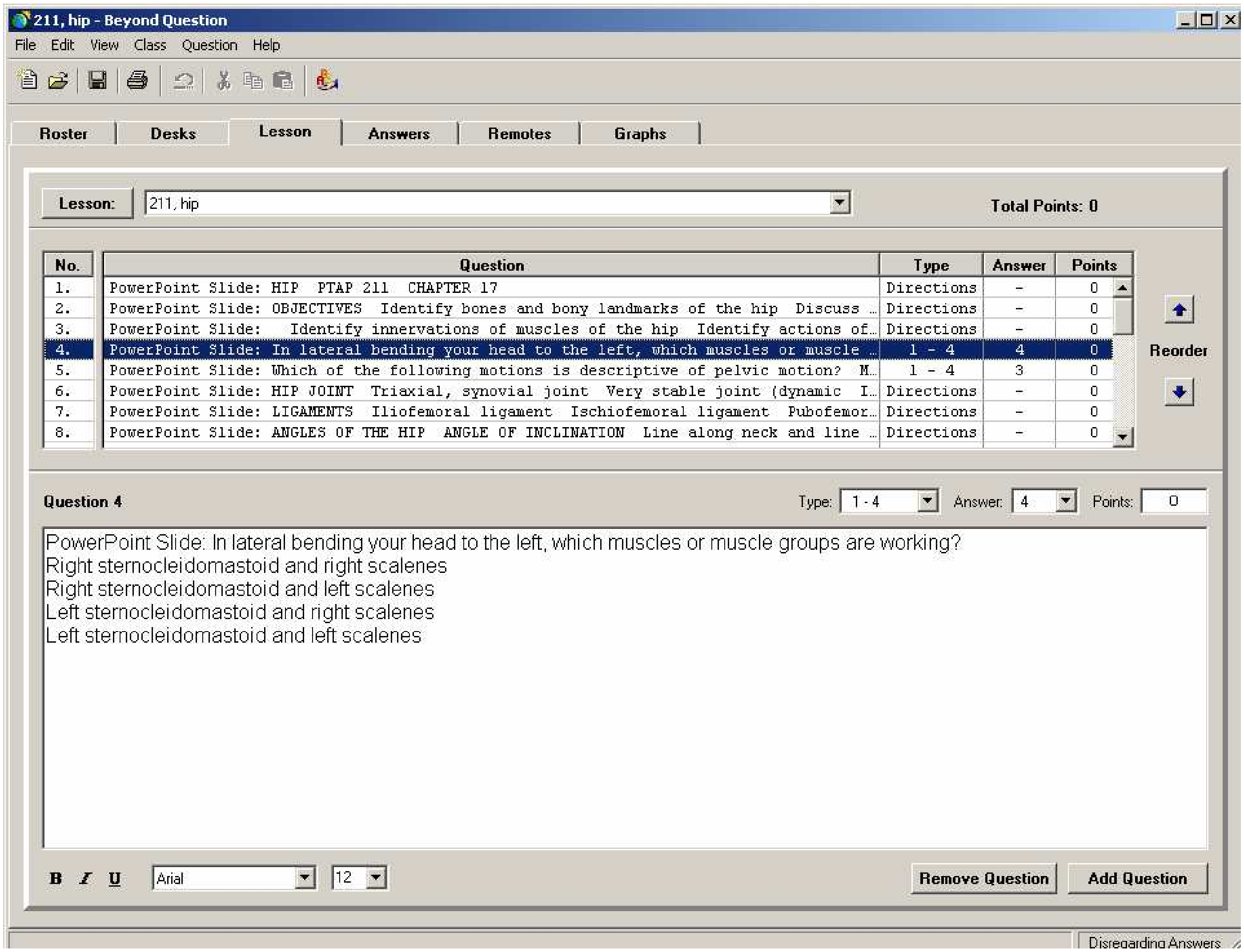
Appendix A: Beyond Question Audience Response System

## Appendix B: Class Roster

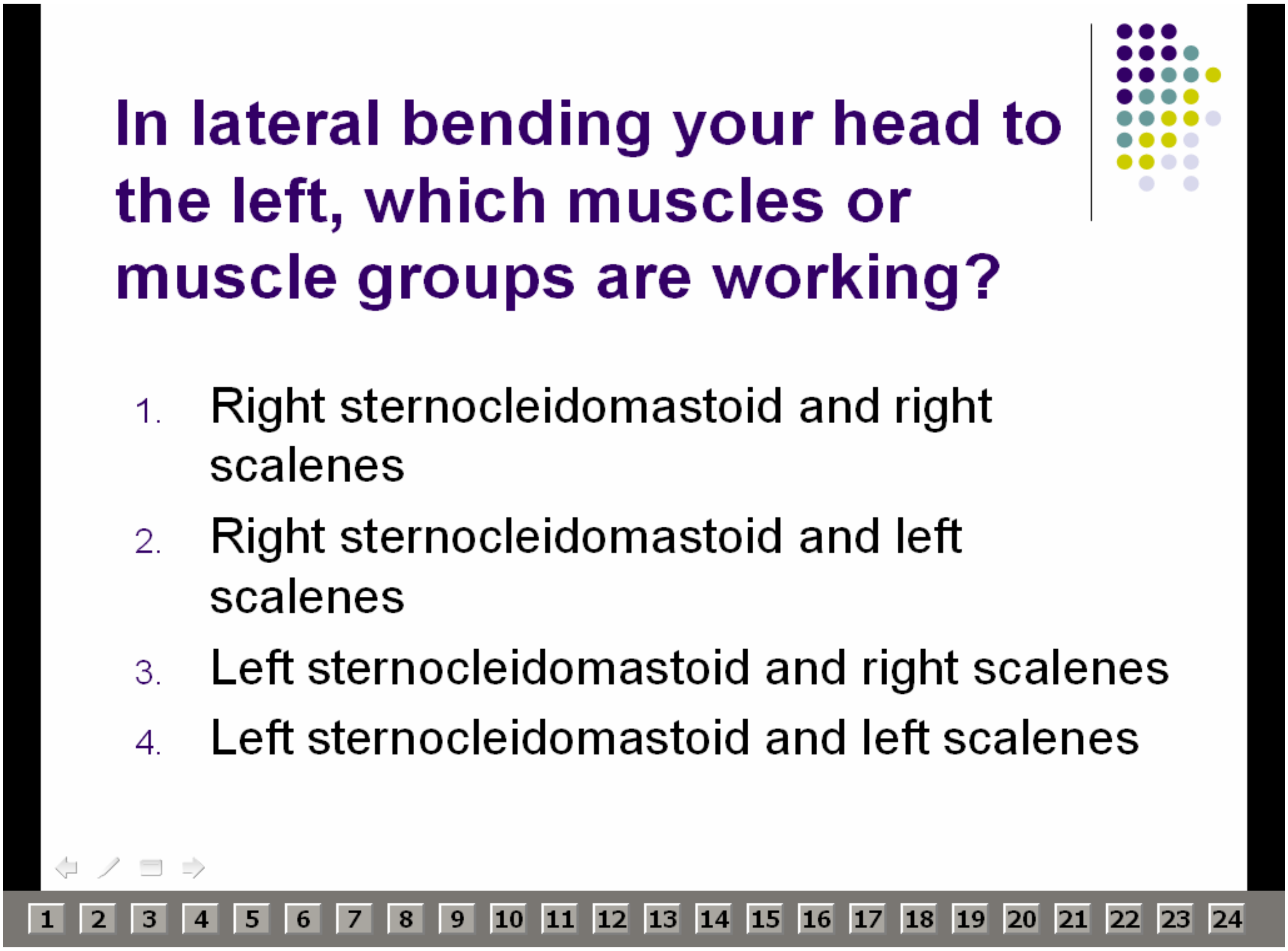
These names are not those of the participants in the study.



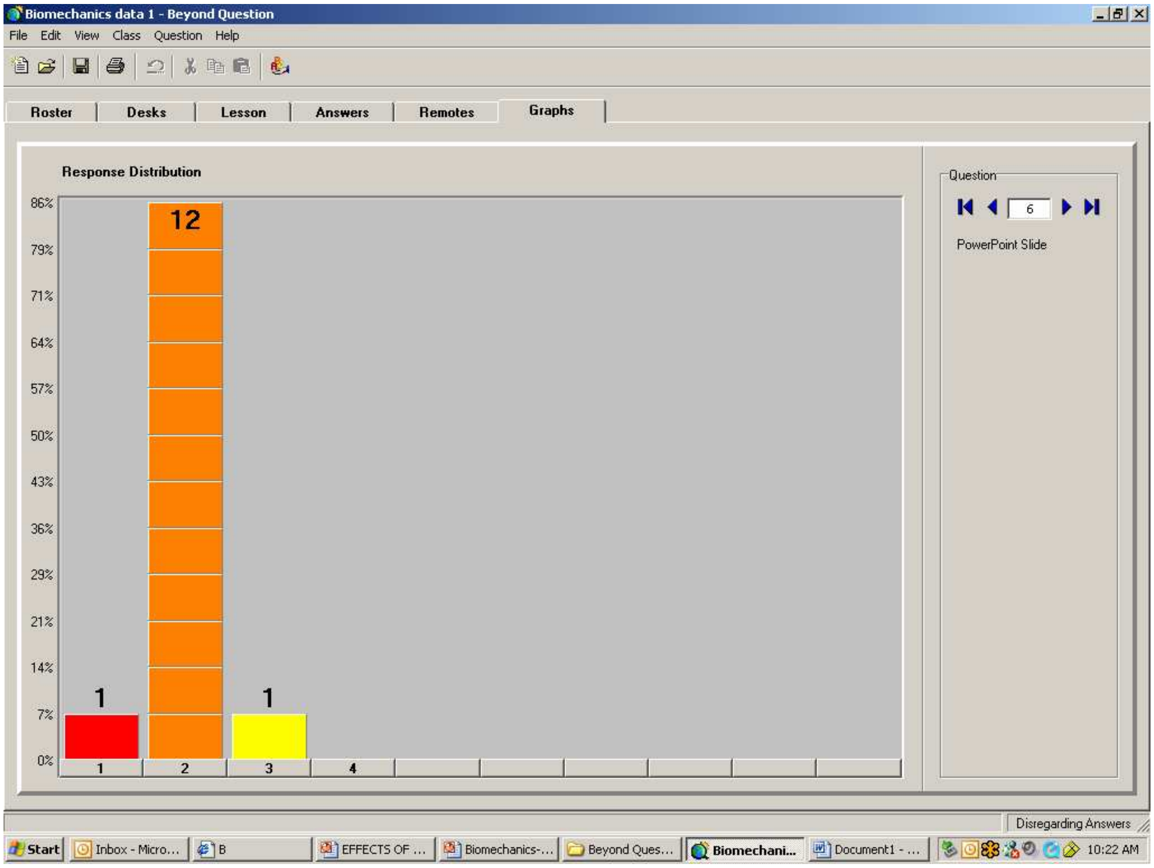
# Appendix C: Beyond Question Lesson



Appendix D: Beyond Question Presentation Question Slide



Appendix E: Response Histogram



Appendix F: Consent Form

CONSENT FORM

1.Study Title: Effects of an Audience Response System on the Student Learning Outcomes in an Anatomy and Physiology Course
2.Performance Site: Our Lady of the Lake College, School of Arts and Sciences, 5414 Brittney Dr., Baton Rouge, 70808.
3.Investigators: Questions regarding this study can be directed to Kitty Krieg, Chair Department of Rehabilitation Sciences, 225-768-1702, kkrieg@ololcollege.edu, M-F, between the hours of 8 and 4.
4.Purpose of the Study: The purpose of this study is to determine whether there is an association between use of audience response systems in the classroom and student learning outcomes.
5.Subject Inclusion: Students enrolled in BIOL 210, Anatomy and Physiology, taught by Denise Vigee during the spring semester, 2008.
6.Number of Subjects: Approximately 70
7.Study Procedures: Two sections of BIOL 210 taught by Mrs. Vigee will participate in the study. Both sections of the course will be taught identically, but one section will be assigned remotes with which they will participate in class. The James Madison Critical Thinking Assessment will be administered at the beginning of the semester and at the end of the semester.
8.Benefits: Results will help to determine feasibility of purchasing audience response systems (ARS) college wide, and the findings will assist us in understanding how ARS contribute to student learning.
9.Risks: There is a very slight risk that data may inadvertently be disclosed. However, care will be taken to preserve the privacy and confidentiality of the data and the participants. Data will be stored and maintained in secure locking cabinets in locked offices, with only the investigator given access to it.
10.Right to Refuse: Subjects may refuse to participate in, or withdraw from, the study at any time without penalty or loss of benefit to which they may be entitled.
11.Privacy: Results from the study may be published, but no names or identifying information will be used. Subject identity will remain confidential unless disclosure is required by law.
12.Signatures: The study has been discussed with me, and all my questions have been answered. I may direct additional questions to the investigator at any time regarding specific study information. If I have questions about subjects' rights or other concerns, I may contact Robert C. Matthews, Institutional Review Board, 225- 578-8692. I agree to participate in the study described above and acknowledge the investigator's obligation to provide me with a signed copy of the consent form.

__________________________________________

Signature of the participantDate

## Appendix G: Student Interview Questions

1. How did using ARS change your participation in class?
2. How did using ARS change how you prepared for class/tests?
3. What did you like about using ARS?
4. What did you dislike about using ARS?
5. Do you think using ARS in class helped you learn more?

## Appendix H: Student Survey

Demographics

1. Gender

   ___Male

   ___Female

2. Please indicate age range

   ___ 21-25 years

   ___ 26-30 years

   ___ 31-35 years

   ___ 36-40 years

   ___ More than 40 years

3. Ethnicity

   ___ Caucasian

   ___ African-American

   ___ Asian

   ___ Asian American

   ___ Hispanic

   ___ Other

4. Highest earned degree

   ___ High school

   ___ Associate degree

   ___Baccalaureate degree

   ___ Masters Degree

| 5. Indicate the degree to which the use of the clickers affected your learning. | Strongly | Agree | Disagr | Strongly |
|---|---|---|---|---|
| Using clickers did not impact my participation in class | | | | |
| I reviewed the previous day's notes more often. | | | | |

| | | | | |
|---|---|---|---|---|
| I read the chapters before class more often. | | | | |
| Using clickers made class more fun. | | | | |
| Using clickers made me pay attention in class more. | | | | |
| Using clickers motivated me to learn the material. | | | | |
| Using clickers increased my participation in class. | | | | |
| Immediate feedback helped me know how well I understood the content. | | | | |
| Graphs helped me see how my understanding compared to others in the class. | | | | |
| I participated more because I was anonymous in responding. | | | | |
| Using clickers made me commit to an answer for the question. | | | | |

6. Indicate the degree to which questions imbedded in the presentation impacted your learning.

| | | | | |
|---|---|---|---|---|
| The questions did not affect how well I learned the material. | | | | |
| Reviewing questions helped me understand how to read test questions. | | | | |
| Answering questions helped me know how well I understood the material. | | | | |
| Answering questions helped me apply the content. | | | | |
| Answering more difficult questions made me learn more deeply. | | | | |
| Questions changed how I studied the material. | | | | |
| Reviewing questions improved my performance on tests. | | | | |
| Indicate the degree to which peer collaboration impacted your learning. | | | | |
| Reviewing questions with my peers did not impact my learning. | | | | |
| Peer reviewing questions gave me a different perspective of the material. | | | | |
| Reviewing questions with my peers helped me apply the content in contexts. | | | | |

## Appendix I: Instructor Reflections

Participation

Week 3

-"only 3 students in section 2 are willing to participate in discussion of questions with the class"

"noticeable difference in number of students asking questions and participating …and quality of participation between classes"

Week 6

"I see a broader contribution from everyone in section 1"

Week 7

"Continue to see a marked difference in active participation between th e2 groups with section 1 more active"

Week 8

"section 1 appears less focused in group activities…continue to participate and seem at ease with each other"

Week 10

"both sections interacted in groups…worked well together"

"sections 1 appeared more timid answering questions initially"

"definitely better class participation with the clickers"

Week 11

"students seem more comfortable bringing up apparent conflicts in material from different sources more easily"

Week 15

"I see students in both sections asking appropriate questions and participating when encouraged"

"they are readily answering or trying to answer in class"

Engagement

Week 3

"I don't think that most students are reading the chapter…waiting for me to cover material"

'questions make students stop and think about the material"

Week 7

"students indicate out loud when they get a question correct"

"section 1 coming to class better prepared…ask questions to review previous material"

Week 8

"section 2 seems more engaged..'game-like'..more at ease with each other"

Week 10

"section 2 jumped right in with the clickers…disappointed when we finished with the questions

"I can tell when students are stumped and I can help them problem solve better…can tell how they think about the material"

Week 12

"I liked the way the students worked together to explore material on the hip"

"students seem more engaged and focused on the material…harder to hide in the back of the classroom"

Week 14

"students seem much more confident in their understanding and applying concepts"

Week 15

“the new treatment group really enjoy using the clickers”

“I am amazed at the number of students who answered questions correctly during this lesson”

“students are obviously more engaged with the material and appear less intimidated with the material”

“students have come to me and expressed enjoyment of the clickers and believe that they helps them learn the material better”

Test taking

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Week 6

“students read questions fast without considering the context clues. Reviewing questions help them understand the context and prepare for the tests”

“ provides students with test question experience and it offers me the opportunity to teach students how to read higher level test questions”

Formative assessment

---

Week 11

“they are getting better at applying the kinematics to the areas of the body”

Week 12

“they seem to have a better grasp of the content than I anticipated”

Week 14

“most of the more difficult questions were correctly answered by the vast majority of the students”

Week 15

“I can gauge immediately how well a student grasps presented information and I can assess in the following class how well the material is retained…I can address confusion immediately…can see which students apply themselves”

IT issues

---

Week 2

“only 2 of the first 3 questions held the answer to the questions” (unable to respond or graph)

Week 11

“slides change colors unexpectedly and are occasionally difficult to see”

“occasional changes in the correct answers”

## Vita

Katherine H. Krieg completed her bachelor of science degree in physical therapy from the University of Alabama in Birmingham in 1975. She received her master of health science degree in physical therapy, with a focus in physical therapy education, from the Louisiana State University Medical Center in 1999. Mrs. Krieg will receive the degree of Doctor of Philosophy at the December 2009 Commencement.

Mrs. Krieg has served as the program director of the Physical Therapist Assistant Program at Our Lady of the Lake College since 1996. She currently serves as Associate Dean, School of Arts, Sciences and Health Professionals at Our Lady of the Lake College.