A COMPARISON STUDY OF GRADED ASSESSMENTS BETWEEN TEACHING MODALITIES IN RADIOLOGIC TECHNOLOGY

by

Angela Lambert

Liberty University

A Dissertation Presented for Fulfillment

Of the Requirements for the Degree

Doctor of Education

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ABSTRACT

The research conducted in this study focuses on student learning outcomes for students of Radiologic Technology. A comparison between non-traditional teaching using MOODLE® and traditional lecture delivery as related to written and practical assessment results is the focus. This study is important due to the need for programs of Radiologic Technology to produce competent radiographers upon completion of such programs in order to assure patient care and safety standards are met. The surge in online and non-traditional course delivery methods may jeopardize this necessity. The purpose of this research was to compare the use of non-traditional delivery and traditional delivery with the level of competency evidenced by associate degree Radiologic Technology students in each format. The researcher used a quantitative approach for the study. The sample population includes second year students in an associate degree Radiologic Technology Program attending a 4-year college located in a rural setting in the southeastern United States. Courses that include both traditional, face-to-face, as well as non-traditional instructional methods in the respective program were targeted. Learning outcomes specified from the required curriculum and assessment tools used for evaluation of those outcomes were compared to demonstrate the possible differences when traditional and non-traditional instructional methods are used. The researcher sought evidence that non-traditional instruction of identified outcomes is insufficient to demonstrate competency for specific student learning outcomes needed in associate degree programs of Radiologic Technology.

Keywords: virtual instruction, non-traditional instruction, traditional instruction, competency, student learning outcomes, practical assessment, written assessment and learning management systems

Dedication

This study and my research could not have been completed without the support of my husband and children who never let me give up. My co-workers that have never failed to support me and also kept pushing me to the finish line. I could not have completed this new chapter in my life without a loving God and his comfort and peace through so many ups and downs along the way.

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A very special thanks to my family who have stood beside me and pushed me toward the finish line. My children helped me to realize quitting was not an option. I will ever be grateful to my chair Dr. Barbara Boothe who always gave positive feedback and kindly kept me moving forward. I appreciate her willingness to always permit phone calls and the many “stupid” question emails. She always provided excellent guidance and reinforcement.

Lastly and most importantly to a merciful God who gave me a loving family. I thank God for his word that kept me encouraged along the way. While the journey has indeed been long I am thankful for God’s words in the book of Psalms and my favorite scripture, “Wait on the Lord: be of good courage, and he shall strengthen thine heart: wait, I say, on the Lord.” (Psalms 27: 14).

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List of Abbreviations

American Society of Allied Health Professionals (ASAHP)

American Society of Radiologic Technologists (ASRT)

Association of American Colleges and Universities (AAC&U)

Computer Management System (CMS)

Cumulative Index to Nursing and Allied Health Literature (CINAHL)

Education Resources Information Center (ERIC)

Institutional Review Board (IRB)

Joint Review Committee on Education in Radiologic Technology (JRCERT)

Student Learning Outcome (SLO)

Valid Assessment of Learning in Undergraduate Education (VALUE)

CHAPTER ONE: INTRODUCTION

Background

The use of technology and virtual instruction continues to grow in higher education. This area of education is often termed non-traditional, as opposed to face-to-face, lecture style instruction (Lahaie, 2007). Healthcare fields have seen an increase in the use of web-based instructional methods, a common form of non-traditional instruction (Martino & Odle, 2008; Moule, Ward, & Lockyer, 2011). Colleges and universities offer a greater number of courses requiring hands on competency in non-traditional formats (Nicholson, 2012). The profession of Radiologic Technology has not been exempt from this trend. Professions in healthcare such as Radiologic Technology require hands on competency performance with respect to curricular requirements (Meehan-Andrews, 2009; Ward, 2009). The requirement of practical assessment makes the use of non-traditional teaching formats questionable in meeting some stated student learning outcomes.

Mr. Bill May, program director of Radiologic Technology at the MedVance Institute in Nashville, Tennessee and a member of the American Society of Radiologic Technologists (ASRT) task force on new educational delivery methods stated, “I take every opportunity to move students into the electronic world” (Martino & Odle, 2008). The world today revolves on technology, and education is not exempt from the electronic age. At Midwestern State University, the majority of the Radiologic Sciences courses are taught online. James N. Johnston, an associate professor of Radiologic Sciences at Midwestern State University, reported great success with online and hybrid teaching formats in regard to passage rates on American Registry of Radiologic Technology (ARRT) board scores and job placement, which both exceed national averages (Martino & Odle, 2008). Podcasts, hybrid courses, and online delivery have also gained popularity in the delivery of Radiologic Technology courses (Martino & Odle, 2008).

Non-traditional education is unique in that students are no longer face-to-face but at a distance from the instructor. This situation changes the method of interaction and requires attention to the needs of communication between instructors and students as well as varied assignments to assure that learning occurs (Crawley, Fewell, & Sugar, 2009). Williams (2006) summarized research to suggest that learning at a distance is as effective as traditional classroom instruction; the progress of students in such virtual courses results from their prior experience and knowledge. Williams' (2006) analysis, specific to Allied Health programs, noted that distance education students with prior work experience and more professional knowledge had significantly greater achievement gains when compared to their traditional classroom counterparts. Other studies indicated non-traditional instruction to be as effective as traditional methods (Alonso & Blaquez, 2009; Cook, 2007). The research conducted by Alonso and Blaquez (2009) concluded that no important differences in student performance existed between teaching online and face-to-face courses. Alonso and Blaquez (2009) indicated that teachers in either delivery format need to focus on organization, learning activity, and interaction while also considering proper pedagogy relevant to the delivery. Regarding Respiratory Care education, Strickland (2007) noted few statistical differences between the effectiveness of traditional course delivery method and hybrid ones. In fulfillment of dissertation requirements, J. M. Torain (2009) conducted a study using a face to face and an internet based teaching format. The work done in this study used *t-test* analysis with results indicating no significant difference to be found between student test scores and mode of delivery (Torain, 2009). This study like others noted student motivational factors as well as teaching strategies to drive the effectiveness of online education (Alonso & Blaquez, 2009; Strickland, 2007; Torain, 2009). “For online education to be successful, the educator must encourage students to become autonomous and take responsibility for their own education” (Wertz, Hobbs, & Mickelsen, 2014). Changes are thus needed in instructional methodologies when using non-traditional instruction to meet the learning needs of all students as well as to foster competency levels of the stated learning objectives and instill student responsibility for learning (Alonso & Blaquez, 2009). Martino and Odle (2008) cited early studies comparing student learning and non-traditional (online) instruction with traditional (lecture) environments, finding no significant differences in learning outcomes. Their study was specific to the area of Radiologic Sciences, and a variety of non-traditional teaching methods were found to be used including online instruction, podcasting and virtual simulation. Martino and Odle (2008) provide data related only to didactic instruction, failing to include non-traditional delivery of learning outcomes necessary for clinical competency. The study is consistent with others comparing non-traditional and traditional delivery with the didactic sector being the focus. Omar, Kalulu and Belmasrour (2011, p. 21) stated, “The latest educational research indicates that a university can achieve its educational objectives through the use of e-learning as effectively as it does through traditional classroom instruction.” The study by Omar et al. (2011), along with those of Martino and Odle (2008), and Alonso and Blaquez (2009) focused on classroom instruction as opposed to clinical practice. Little attention has been given to this comparison between traditional and non-traditional outcomes in the clinical setting. Due to the requirement of Radiologic Technology programs to have a clinical component, the use of online education is not prevalent in these programs. “Because of the need for clinical application of course content inherent in Radiologic Science education, fully online educational programs are not feasible (Kowalczyk, 2014). Williams

(2006) demonstrated the need for more research in the area of non-traditional instructional delivery to determine the effectiveness within Allied Health science programs.

Allied Health is defined by the American Society of Allied Health Professionals (ASAHP) as a group of licensed medical practices that support medical professionals. Professions within Allied Health disciplines require some form of practical instruction to prove competency within the field. According to the ASAHP, Radiologic Technology is included in this category. The focus of this study is in an area in which limited research has been conducted: the possible effect of non-traditional teaching methods during clinical practice and student mastery of student learning outcomes.

Programs of Radiologic Technology are driven by established accrediting agency standards. These standards are set forth by the Joint Review Commission on Education in Radiologic Technology (JRCERT) to guide programmatic student learning outcomes, course objectives, and the assessments used to show mastery of those objectives. Figure 1 demonstrates the flow of information within these programs.

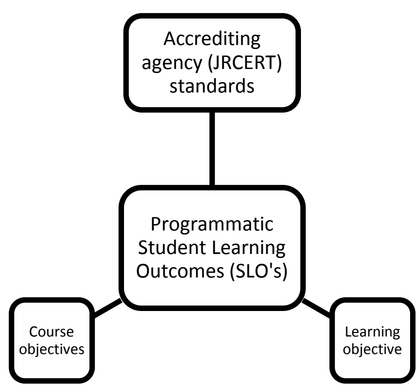

Figure 1

The learning environment in programs of Radiologic Technology requires both a didactic and clinical setting. The clinical learning environment requires students to be active participants and to apply critical thinking skills needed in practice. Since student engagement in the clinical setting is necessary, it is important to know if non-traditional teaching methods adequately prepare students to master clinical learning outcomes. While current technology provides the stage for interactive activities through virtual classrooms, students have still noted missing face-to-face interaction as acquired in traditional classrooms (Martino & Odle, 2008). The proper integration of technology and non-traditional capabilities for instruction in Radiologic Technology is critical to promote effective learning (Wertz, Hobbs, & Mickelsen, 2014).

The researcher compared student learning outcomes with course assessment in face-to-face and non-traditional formats in an associate degree program of Radiologic Technology at a rural 4-year college in the southeast. The student learning outcomes (SLOs) used in this study are specific to all accredited programs of Radiologic Technology and are guided by the standards required by the JRCERT in conjunction with curriculum guidelines from the American Society of Radiologic Technologists (ASRT). The standards assessed by the JRCERT for purposes of accreditation of programs of Radiologic Technology pertinent to this study include standard 3/3.2 and 5/5.1/5.4 (JRCERT, 2011). These standards include the provision of a competency-based curriculum with plan of assessment measuring student learning outcomes related to programmatic goals. Specific program SLOs and course objectives linked to these outcomes are driven by accreditation standards. Student learning outcomes mandated by individual programs are also linked to the accreditation standards. The objectives within the curriculum are used to meet the SLOs. Each objective is assessed providing data indicating mastery of these objectives.

The accreditation standards assessed by the JRCERT pertinent to this research study included standard 3/3.2 and 5/5.1 (JRCERT, 2011).

Standard Three Curriculum and Academic Practices: The program's curriculum and academic practices prepare students for professional practice.

3.2 Provides a well- structured, competency-based curriculum that prepares students to practice in the professional discipline.

Standard Five Assessment: The program develops and implements a system of planning and evaluation of student learning and program effectiveness outcomes in support of its mission.

5.1 Develops an assessment plan that, at a minimum, measures the program's student learning outcomes in relation to the following goals: clinical competence, critical thinking, professionalism, and communication skills.

The effectiveness of face-to-face and non-traditional formats for teaching in relation to student outcomes as measured by a comparison of course assessments and practical exam scores was studied. The focus of the study was in the clinical area where face-to-face instruction is vital. JRCERT standards three and five were used due to their requirement(s) of curriculum and assessment in the area of clinical competence. The link between these standards to program objectives and specific SLOs was identified. The assessments selected were based on discussion with program faculty and prevalence in the clinical setting. Non-traditional instruction methods included the use of MOODLE® as a teaching format.

A summary of the SLOs with course, objective and assessment tool indicated for purposes of this study are identified in Table 1.

Table 1

Programmatic SLOs	Course Name	Course ID Number	Learning Objective	Assessment Tool(s)
The student will evaluate image quality, applying the knowledge of positioning and technical selection necessary for diagnostic images.	Clinic Radiographic Procedures II, Radiographic Procedures II lab	RADT 119 RADT 121L	Apply knowledge of anatomy to evaluate radiographic images. Properly evaluate image quality.	Graded competency evaluations for practical performance Quizzes/Exams Critical thinking trauma assignment
The student will provide the patient with proper care during medical imaging procedures. This will include knowledge of body mechanics, patient immobilization, basic life support techniques, patient education for examinations, and overall patient care of comfort.	Clinic Radiographic Procedures II & III	RADT 119 RADT 211	Apply patient preparation for imaging procedures and answering questions concerning the procedure and proper explanation.	Graded competency Evaluations for practical performance
The student will demonstrate knowledge of basic human anatomy and physiology, demonstrating the ability to radiographically identify anatomic structures and basic pathologic findings.	Clinic Radiographic Procedures III	RADT 211 RADT 212	Apply knowledge learned of anatomy to evaluate radiographic images per exam criteria. Apply knowledge obtained during clinical and class to pathological findings on imaging procedures.	Quizzes/exams Critical thinking trauma assignment
The student will utilize problem solving skills and exercise independent thinking while performing medical imaging examinations.	Clinic Radiographic Procedures II & III	RADT 119 RADT 211	Apply observed and taught skills to procedures outside normal positioning.	Graded competency evaluations for practical performance Critical thinking trauma assignment

MOODLE®, a computer management system (CMS) was utilized as the non-traditional teaching platform for this study. This CMS is a modular object-oriented dynamic learning environment (TechTerms.com). MOODLE® allows educators to create online courses, providing students access to documents, assignments, exams, and even a virtual classroom. The format allows students to engage in assignments, online interaction and course materials from off campus. The selected course objectives and assessments for this study included instruction only with the MOODLE® system for one group of students. A second group of students received traditional lecture and demonstration instruction utilizing the same objective(s) and assessment(s) as those students on the MOODLE® system.

The data from graded assessments comparing outcomes of non-traditional and face-to-face formats was evaluated. A graded written critical thinking assessment was utilized for the didactic instruction as well as practical assessments evaluating performance in the clinical setting. The *t-test* evaluation for demonstration of significant differences within data assessed was conducted to show the variance between test scores within the two teaching formats (Creswell, 2009). The *t-test* was used to test the null hypothesis when computing difference in the mean test scores (Patten, 2005). For this study a series of *t-test(s)* were performed in order to evaluate any difference in written and practical assessment tools within each form of delivery.

The theories of distance education as detailed by Moore and Kearsley (1996) framed the theoretical context associated with non-traditional teaching methods. The pedagogical foundation of constructivist approaches to the learning process demonstrated the basis of varied teaching methods (Mayes & de Frietas, 2004). The theory of distance learning as stated by Moore (1996) is relevant to this study due to the question if the use of MOODLE® as the instructional method for course delivery is adequate to meet student learning outcomes.

Additionally students in the fields of Allied Health are best taught by recognition of learning needs as well as a development of the content to acquire knowledge (Olmsted, 2010). This need is in line with the constructivist theory and will be detailed further in the literature review.

Problem Statement

The outcomes of this study suggest that the assessment of selected learning outcomes for Radiologic Technology is comparable in traditional and non-traditional teaching formats. The study targeted the clinical setting due to concern by the researcher regarding elimination of face-to-face instruction. Clinical education requires performance of procedures in a hands-on environment. While studies in other Allied Health disciplines are available, research specific to Radiologic Technology is limited (Gosnell, 2010). Allied Health fields such as phlebotomy, dental hygiene, respiratory and physical therapy have some research regarding clinical skills and meeting discipline specific outcomes (Fydryszewski, Scanlan, Guiles & Tucker, 2010; Jette, Nelson, Palaima, & Wetherbee, 2014; Olmsted, 2010; Strickland, 2007). The field of nursing provides extensive research in regard to student learning outcomes and the need to teach in a variety of methods in order to meet student learning needs, as well as established accreditation and professional standards (Bonne1 & Tarnow, 2015; Carpenter, Theeke, & Smothers, 2013). Each of the fields noted require a clinical component to meet professional educations standards. Allied Health professionals, regardless of the area of expertise, need application in a clinical setting to assess clinical reasoning and problem solving abilities.

The clinical setting used in this research includes one associate degree program of Radiologic Technology. The specific content area includes the assessment for trauma radiographic procedures with both a written (didactic) and practical (clinical) graded tool. The practical assessment were inclusive of graded trauma upper and lower extremity exams as well as a trauma shoulder. Each assessment includes the need for critical thinking skills to be applied. The problem is there is little quantitative research specific to the field of Radiologic Technology and the use of non-traditional teaching formats to assure that the competency of student outcomes are met.

Purpose Statement

The purpose of this study was to examine the effectiveness of non-traditional instruction related to student learning outcomes assessed in associate degree Radiologic Technology programs. The comparison of the results of the assessments of selected student learning outcomes with the course delivery method was the emphasis of the study. The student learning outcomes were chosen from the content areas specific to trauma clinical procedures. The assessments chosen were a critical thinking written assignment and graded practical trauma exams including shoulder, upper and lower extremity. These provided the independent variable data. The dependent variable was the course delivery method. The delivery methods were face-to-face instruction with hands on performance in a clinical setting and instruction via the MOODLE® class management system. The participants for this study were in the second year, third semester of an associate degree Radiologic Technology program. All students in the study were enrolled in Radiographic Procedures II and a clinical component in their respective semester of study. A total of 33 students were included in the study. The face-to-face cohort consisted of 20 students while the participation in the MOODLE® instructional format consisted of 13 students.

Significance of the Study

The results of this study are important due to the need for hands-on clinical training in Radiologic Technology. Jette et al. (2014), state the need for similar training necessary for physical therapy. Their position paper states, “The imperative of clinical education in health professions is development of students’ knowledge, skills and behaviors essential to competence as new professionals.” The effectiveness of mastering clinical outcomes taught only by non-traditional methodologies needs clarification for the education of new Radiologic Technologists. Olmsted (2010), in research regarding dental hygiene education as well as other Allied Health disciplines notes that increases in distance learning delivery increases the need for a sound pedagogy and framework by which to assure educational experiences meet required outcomes. The nature and design of non-traditional instruction traditionally aids students who are self-motivated and predisposed to remain at a computer monitor without interruption. The outcomes of this study may aid Radiologic Technology program faculty to better design courses that accommodate various learning styles while including critical thinking and visual components as aids to gain competency in all curriculum areas. Gosnell (2010) states, “In reality, all healthcare providers, regardless of specific profession must possess and apply competent clinical reasoning and judgment in the course of caring for patients.” Assuring this competence is necessary to produce qualified Radiologic Technologists. The need to assess competency is standard practice for Allied Health professions. This study will add to this assurance be examining the relationship between assessment (both written and practical) that are used to measure competency of stated student learning outcomes and the method of delivery for the content specific to Radiologic Technology.

Research Question(s) and Hypotheses

RQ1: Is there a difference in the written and practical assessment scores of non-traditional students using MOODLE® as the delivery system as compared to traditional students being instructed in lecture and lab delivery formats?

Null hypothesis (H_{01}): There will be no significant difference in the results of each of the three practical examinations (trauma upper extremity, trauma lower extremity, and trauma shoulder), for the students taught in the non-traditional course delivery format and those taught by traditional delivery.

Null hypothesis (H_{02})): There will be no significant difference in written trauma critical thinking assessment results for students taught in the non-traditional course delivery format and those taught by traditional delivery.

Definitions

Allied Health: A group of licensed medical practices that support medical professionals (ASAHP, 2003).

Clinical Education: A part of curriculum designed to provide patient care and assessment, competent performance of radiologic imaging and total quality management. Levels of competency and outcomes measurement ensure the well-being of the patient preparatory to, during and following the radiologic procedure. Concepts of team practice, patient-centered clinical practice and professional development are discussed, examined and evaluated (ASRT, 2012).

Competency: Performance of a procedure independently, consistently, and effectively (ARRT, 2013).

Distance Education: A planned learning that normally occurs in a different place from teaching and as a result requires special techniques of course design, special instructional techniques, special methods of communication by electronic and other technology, as well as special organizational and administrative arrangements (Moore & Kearsley, 1996, p. 2).

A method of imparting knowledge, skills, and attitudes which is rationalized by the application of division of labor and organizational principles as well as by the extensive use of technical media, especially for the purpose of reproducing high quality teaching material which makes it possible to instruct great numbers of students at the same time wherever they live. It is an industrialized form of teaching and learning (Schlosser & Anderson, 1994, p. 12).

MOODLE®: An open source course management system used by educational institutions around the world to provide an organized interface for e-learning, or learning over the Internet. MOODLE® allows educators to create online courses, which students can access as a virtual classroom (TechTerms.com).

Non-traditional: Methods of teaching that do not involve "traditional" lecture style formats. According to Martino and Odle (2008), examples of non-traditional instructional methods for programs of Radiologic Technology may include e-learning environments, simulation, various methods of distance education, online instruction, web-based or computer aided education and the use of electronic devices.

Non-traditional Student: Non-traditional status is based on the presence of one or more of seven possible non-traditional characteristics. These characteristics include older than typical age, part-time attendance, being independent of parents, working full time while enrolled, having dependents, being a single parent, and being a recipient of a GED or high school completion certificate (U.S. Department of Education, 1993). *F*or purposes of this study is considered to be those students 24 years of age or older and in many cases in single parent agreements.

Practical assessment: a part of clinical education during which the student practices performing procedures on real patients in a community based healthcare facility such as a hospital or outpatient center. (Gosnell, 2010).

Student Learning Outcomes (SLOs): A desired result that provides expectation of student learning to provide the ability to assess the broad goals and mission of a program. The outcomes should be specific, measureable, attainable, realistic, and timely (JRCERT, 2011).

Traditional: Traditional enrollment in postsecondary education is defined as enrolling immediately after high school and attending full time (U.S. Department of Education).

Virtual Instruction: is considered to take place through computer mediated communication and is typically at a distance (Feyten & Nutta, 1999). Virtual instruction is set apart mainly by the synchronous approach and incorporates active learning and interaction. The World Wide Web is utilized as a tool for providing materials and/or assessing learning outcomes in a virtual format. Specific to this study will be the use of computer aided instruction tools and the use of the MOODLE® course delivery system.

Written assessment: considered a form of formative assessment which can be defined as a process evaluation of student learning; an assessment for learning that is done before and during teaching to inform instruction (International Literacy Association; The Glossary of Education Reform).

CHAPTER TWO: REVIEW OF THE LITERATURE

Introduction

The review of literature for this study included a historical background of virtual education and other forms of non-traditional teaching formats. Since distance education sets the stage for all forms of virtual learning available today the historical context was founded in this area. Additionally the educational needs for clinical education in Allied Health fields was reviewed. The Liberty University library online data base search engine was used for acquiring sources as well as the library available to the researcher. A variety of information from journals, peer reviewed articles, texts and websites were utilized. Several searches were conducted using the Education Resources Information Center (ERIC) as well as the Cumulative Index to Nursing and Allied Health Literature (CINAHL). The review of literature conducted includes necessary pedagogy for non-traditional teaching and learning environments as well as how these methods relate to the field of Radiologic Technology and Allied Health care profession.

The concepts of assessment and understanding of learning are not new to the field of education nor is the concept of teaching at a distance. The beginning of distance education can be traced back at least 150 years (Schlosser & Anderson, 1994). Between 1833 and 1840, newspaper advertisements were found in Sweden and England offering instruction via correspondence. Some of the early fields lending themselves to correspondence studies were composition, shorthand, and language studies (Schlosser & Anderson, 1994). These courses started a trend, and by 1891, a course was offered by the editor of *The Mining Herald* via correspondence studies on topics of mining and the prevention of mine accidents. The idea of learning at a distance continued to grow, and in 1920 distance education began to seep into secondary school curriculum. The early 1930s ushered in television teaching programs from universities such as Purdue and the University of Iowa and it took almost 20 years for these courses to be offered with college credit applied (Schlosser & Anderson, 1994). The early correspondence courses lead to telecourses, Internet courses, satellite uplinks, and compressed video systems. Distance learning has made it possible for many students to return to school that otherwise may have never had the opportunity and has also provided the opportunity for the learner to progress in his/her own time and frequently at their own pace.

Distance education involves students and teachers separated by physical space. This distance may be across campus, across town, a state or even across an ocean, but always involves a physical separation of teacher and student. This distance between teacher and student creates the need to explore options for enhancing interaction and assuring student participation (Crawley et al., 2009). Colleges need to have consideration for faculty developing web-based course(s) to allow movement toward pedagogy of critical thinking learning and structured course development (Lee & Rha, 2009). The definition of distance education implies that these methods are not traditional teaching environments. Traditional teaching involves a teacher in front of students seated at desks listening, writing and watching. Teaching becomes non-traditional when the teacher is remote and therefore creates a difference in educational delivery. The vision of student(s) multi-tasking in front of a television or doing work at home may paint the picture of the non-traditional learner. This image makes the process of learning appear more difficult for many individuals. Educators thus require diligence in engaging the student(s) and keeping them on task.

Theoretical Framework

A presentation made by Moore in 1972 included the need for building a theoretical framework to embrace teaching and learning for people who choose to be apart from their teachers and thus a pedagogical theory of distance education was formed (Moore & Kearsley, 1996). Moore was interested in independent methods of teaching and learning and studied the theories of Wedemeyer and Peters as well as the ideas of Knowles and the concept of self-directed learning. The research conducted lead Moore to notice that there was no theory to account for teaching and learning when the teaching was apart from the learning (Moore & Kearslye, 1996). Moore found from studies of Peters (1965) and Wedemeyer's (1971) that attempts to detail a theory for distance education were founded in independent studies by learners (Moore & Kearsley, 1996). The continued studies by Moore sparked interest in the need for self-directed learning, and learner centered activities when teaching at a distance. Combined with the ideas of Wedemeyer and Peters, Moore also gained interest in the pedagogy presented by Knowles. Knowles (1980) focused on the pedagogy of education for adult learners. Distance education encompasses a large percentage of adult learners, thus Moore felt these ideas important to the theoretical framework for which he sought. Knowles theory focused on learning from experience. This theory suggested changing the traditional pedagogy of teaching to a method by which self-directed practices drove the educational process (Knowles, 1980). Moore found these ideas to be relevant to the features needed for success in distance education courses (Moore & Kearsley, 1996). These thoughts are consistent with common theories for adult learners.

The early development of the theory of distance education demonstrated that the distance between the educator and learner meant implementation for changes in teaching would be needed as compared to traditional face-to-face instruction. Keegan (1986) defined six essential elements to regulate such needs specific to distance education. The elements include:

1. Separation of teacher and student.
2. Influence of an educational organization, especially in the planning and preparation of learning materials.
3. Use of technical media.
4. Provision of two-way communication.
5. Possibility of occasional seminars.
6. Participation in the most industrial form of education. (Moore & Kearsley, 1996)

Keegan (1986) further defined four generally accepted definitions of distance education as proposed by Holmberg, Peters, Moore, and Dohmen. This definition became one of the most widely cited when referencing distance education (Moore & Kearsley, 1996). The use of the transactional theory in reference to distance education has provided the framework for distance education programs as well as established pedagogy for which to structure distance learning environments.

The theory for distance education introduced by Moore in 1972 was intended to be general and applicable to all forms of distance education and came to be known as the, "Theory of Transactional Distance" (Moore & Kearsley, 1996). This theory stated that distance education meant educational activity and learner were separated by space and included the effect of distance on instruction. The term "transaction" as included in the theory was derived and developed by Dewey, Boyd and Apps (Boyd & Apps, 1980; Moore & Kearsley, 1996). Boyd and Apps (1980) stated, “The transaction that we call distance education is the interplay between people who are teachers and learners, in environments that have the special characteristics of being separate from one another, and a consequent set of special teaching and learning behaviors.” This theory assumes distance education is pedagogy and not the idea of physical or temporal distance that separates instructor and learner. The transactional distance is both a psychological and communications space of potential misunderstanding between instructor and learner (Moore & Kearsley, 1996). Moore’s theory noted the need for structure, dialogue, and learner autonomy to be key elements in successful distance education delivery (Gorsky & Caspi, 2005).

The theory of transactional distance as stated by Moore did not receive unanimous acceptance, however it did provide a needed framework for defining and understanding distance education in a general sense (Falloon, 2011; Gorsky & Caspi, 2005). Moore (1997) in relation to his prior work indicated the importance of understanding the need for frequent and meaningful dialogue when teaching at a distance. Moore’s theory noted dialogue and transactional distance to be inversely proportional. Dialogue included both quantity and quality of interaction between instructor and student. (Gorskey & Caspi, 2005). Saba & Shearer, 2005 and Bunker, Gayol, Nti & Reidell, 1996, both concluded that as dialogue increased, transactional distance decreased in studies conducted to prove transactional theory concepts (Gorskey & Caspi, 2005). These studies did have limitations in regard to the reliability and validity of the instrument used and learner participation. Gorsky and Caspi (2005) did conclude in their analysis of transactional distance theory that, “Transactional distance theory was accepted philosophically and logically since its core proposition (as the amount of dialogue increases, transactional distance decreases) has high face validity and seems both obvious as well as intuitively correct.” Saba (1988) continued studies on the theory of transactional distance by using computer simulation to understand the use of telecommunications in distance education. This beginning laid the groundwork for transactional theory describing distance education and its effect on the ever-changing world of teaching. The theory established the relationship of teaching and learning, as well as defined the variables of the course, the learner, and the instruction (Moore & Kearsley, 1996). The need to address variance in learning style, as well as the evident need for teacher student interaction, also was included.

Concerns with instructor/ student contact and interaction are common to assuring quality education occurs at a distance. Falloon (2011) in research conducted utilizing virtual classrooms, noted students found communications tools embedded into the virtual classroom format to increased sense of confidence in ability to ask questions and improved direct interaction capabilities. This study was conducted to build on Moore's transactional distance theory specific to student needs when related to interaction and distance education. The study concluded that virtual classrooms did have purposes for collaboration and a means by which to engage students. The need for quality dialogue remained questionable from Falloon's (2011) results.

As with face-to-face courses, defining course structure is vital to the development process. Every course should consist of learning objectives, illustrations, forms of assessment, and other content based information. These common elements need careful structure and precise detail when presented at a distance. Moore and Kearsley (1996) "Since structure expresses the rigidity or flexibility of the course's educational objectives, teaching strategies, and evaluation methods, it describes the extent to which course components can accommodate or be responsive to each learner's individual needs." Moore included in his theoretical framework of distance education that recognition is needed to not only consider teaching variables but also to consider the variance in learners. This variance will include the type of learner within the course according to various learning styles presented by Dunn and Dunn (1979) and Gardner (1999). The variance would also include learning ability, age, life experience and college experience to name but a few. Their work lead Moore to further employ a descriptive theory of distance education that laid the framework for a collaborative relationship between the teacher and learner and expressed the need for highly structured courses with interactive methods as a main component. This basis of the theory of distance education suggests the importance of interaction in the process of learning and may increase when physical separation becomes a part of the equation. Anderson (2008) discusses that a concern for online environments is the issue of how interaction is accomplished and how it is managed. The need for interaction in distance learning courses is apparent. The effectiveness of the methods used to incorporate interaction is a key component to its success (Crawley et al., 2009; Lee & Rha, 2009). Moore's (1973) work was followed by others seeking to refine the theory and needs of distance education.

Transformative learning is also relevant to distance education. This theoretical idea removes the educator from teaching memorization and transforms them to teaching learners to think. The role of the educator then becomes one of fostering critical thinking activities and supporting the learners (Cranton, 1994). The student engages in a process of examining, questioning, validating, and revising their own experiences and perceptions (Cranton, 1994). This theory is beneficial to the concepts of distance education as well as to Allied Health professions requiring critical thinking skills necessary to practice in respective disciplines. The transformation theory incorporates constructivism as a prominent thought as to how people learn (Anderson, 2008). The theory of constructivism is closely linked to distance education foundations and frames the research in this study.

According to Anderson (2008), the theory of constructivism surfaced as a leader in the world of non-traditional instruction. This theory claims that learners interpret information from the world based upon their personal reality and after processing and interpreting information it is then personalized into knowledge (Cooper, 1993; Wilson, 1997). Distance learning provides an area in which to infuse constructivist principles (Tam, 2000). The theory of constructivism notes that learners learn best when the information can be applied for personal meaning and stresses that the learner learns best when actively engaged (The Constructivist Theory, n.d.). This idea of active engagement relevant to dialogue between instructor and student parallels the theory of transactional distance. Constructivist learning experiences should not be impacted by virtue or physical location (Tam, 2000).

A seemingly strong reason that constructivism has gained support as a leading theory amongst virtual educators/learners is the connection to active rather than passive learners (Anderson, 2008). Non-traditional learning should be an active process and involve collaborative initiatives. Additionally, learners in non-traditional environments tend to be more in control of the learning process. This control by the learner aligns with constructivism. While other theories lend themselves to non-traditional learning environments, constructivism encompasses the ever changing world of education. Kowalczyk (2014), supports this theory for radiologic sciences by noting that for online courses to be successful, the learning environment is to be student centered and engaging.

The constructivist theory can be traced back to the ideas of John Dewey. Dewey believed education was best presented in an atmosphere centered on learning by doing (Gutek, 2005). Dewey’s theory emphasized a curriculum that was experience -based by which problems of life served as a primary teacher. Dewey's theory encompassed experiments and a hands-on approach to the teaching and learning process. While termed experimentalism rather than constructivism the roots of these theories are common. Dewey stressed that education depended on action and that knowledge would emerge from situations in which students could draw from experience (Learning Theory). Dewey's ideas for experimentalist teaching include incorporation of collaborative group projects, inquiry methods, and process-based learning activities (Gutek, 2005). Each of these teaching methods parallels with the ideas of constructivism and are commonly used in Allied Health fields.

When discussing the constructivist approach it should be noted that both Piaget and Vygotsky supported a constructivist view. Their approaches however differed in that Vygotsky took a social approach to the basis of the constructivism theory of learning (Powell & Kalina, 2009). According to Powell and Kalina (2009), Vygotsky is noted as the founding father of the social constructivism theory. Vygotsky's theory stressed the interaction with others essential to the learning process. Central to Vygotsky's theory of constructivism is the need of social interaction for learning to occur. Vygotsky believed social learning was followed by development (Learning-Theories, 2015). This concept was in opposition to that of Piaget who believed development to precede learning. Vygotsky focused on connections in a social context and believed interaction to be the basis of learning (Luis, 2013). Piaget however detailed a more individualized approach in his learning theory, (Jonassen, 1991). The use of experimentation and observation to gain personal understanding shaped Piaget's belief of meaningful learning (Mayes & DeFreitas, 2007). Whether social constructivism or individualistic the learner remains central to each theory and instructors become facilitators of active learning environments. Additionally both constructivist theories support learners learning through interaction and collaboration (Brandon & All, 2010; Learning-Theories, 2015; Tam, 2000).

The social constructivist theory as detailed by Vygotsky includes the need of socio-cultural environments as a critical part of cognitive development. This theory emphasized the role of social interaction and instruction (Blake & Pope, 2008). The central theme to Vygotsky's theory was that learning is dependent on outside social forces. Social life is the fundamental basis for the learning process (Blake & Pope, 2008). Similar to the beliefs of Dewey, Vygotsky also noted group work, cooperative learning, and problem solving activities to be central methods for teaching (Blake & Pope, 2008; Gutek, 2005). While the social constructivist theory as detailed by Vygotsky was devised for development in children, it can be both adapted and applied to traditional and non-traditional college students (Bohonos, 2013).

The influence of Piaget to framing constructivist ideas is significant to its development and acceptance in education (Mayes & DeFreitas, 2007). Piaget believed development to occur from intellectual activity rather than recitation followed by absorption of information (Piaget, 1970). Piaget's constructivist theory was an individualized approach based on learners needing to be active in the learning process. Instructors who utilize constructivist theory encourage student activity, questioning, and promotion of life-long learning (Brandon & All, 2010). The instructor becomes one of a coach who prompts critical thinking and helps students to develop their own understanding of the subject. Activity based learning environments provide authentic learning activities embedded into the instructional process. These areas may be coined training environments, practice fields, or learning communities and are characterized by real situations (Mayes & DeFreitas, 2007). Tam (2010), details that constructivist education has been described as an apprenticeship in which teachers model, guide and direct students. Despite the term used for the learning environment the basic characteristic includes a practical or real situation to meet learner outcomes. It is for this reason that Piaget's idea of constructivism is used for the theoretical framework of this study. Clinical situations warrant the need for students to work independently in healthcare environments. While interaction with fellow students, instructors, and patients certainly plays a large role in the clinical learning process, independent evaluation of patients and use of equipment are necessary to become competent in the field.

The basic theoretical concept of constructivism is active learning. The roots of this theory can be traced back to cognitive and social psychology (Brandon & All, 2010). Many educational theorists are known to support the theory of constructivism include the cognitive theories as detailed by Piaget (1970), social interaction by Vygotsky (Blake & Pope, 2008), as well as the concepts relevant to adult learning as framed by Knowles (1979). Each of these theorists are relevant to the theories connecting distance education. The concepts as presented by Piaget (1970) include student engagement and active learning. These concepts are necessary for students in clinical settings to learn practical skills. The ideas of Piaget and an individualized approach as well as that of Vygotsky and social needs complement one another in order to meet needs of clinical education.

Knowles (1979), details more the learner needing to be self-directed and part of the learning process. Distance education formats built on these ideas can provide meaningful learning for students. According to Knowles (1979) adults need to be part of the process, have structure and build on life experience. The constructivist theory encourages each of these aspects. Distance learning formats traditionally attracted adult learners for sake of flexibility in scheduling. Due to this perception incorporating techniques to meet adult learning needs are necessary for any distance education format.

Distance learning and constructivist views merge well due to the learner in both theories bringing their own experiences into the learning process (Tam, 2000). While the instructor and learner are at a distance from one another constructivist learning environments can be built requiring collaboration, and application of personal meaning to assignments. According to Tam (2000), “there is no doubt that constructivism and the use of new technologies will help transform significantly the way distance education should be conducted.” Decades later the ideas presented by Dewey, Piaget, Vygotsky, Moore, and Knowles can be seen to have merged into an ever evolving constructive distance education platform.

Supporting Literature

Health care professions build on the constructivist theory for educational practices. The need to learn in a clinical setting and acquire practical skills is essential to success in Allied Health programs. The constructivism learning theory is one theory supported in nursing education as well as other simulation-based practices (Gaberson & Oermann, 2010). The use of meaningful reflection and linking knowledge to a collaborative learning activity are processes common to nursing education (Brandon & All, 2010). Constructivism helps to improve critical reasoning, and develop the ability to adapt to various situations. These processes are necessary in both nursing and other health care programs.

The constructivist theory includes a personal approach to the learning process. Constructivism stresses learning through observation, processing and interpretation of information (Anderson, 2008). Basic building blocks to constructivism include understanding to be gained from an active process and building on that process through activity (Mayes & De Freitas, 2007). According to the JISC e-learning model as presented by Mayes & DeFreitas (2007), the constructivist view of learning can be summarized by the following:

Learning depend on what we already know, or what we can already do.

Learning is self- regulated.

Learning is goal oriented.

Learning is cumulative.

Educators who truly adopt these ideas can strive to build learning activities and environments to foster the constructivist view of the educational process.

In research conducted in the field of dental hygiene education as related to distance learning, Olmsted (2010) notes the principles of constructivism to provide the pedagogical basis for distance learning delivery. As with other Allied Health fields Olmsted (2010) notes the sharing experiences through interactions strengthens the ability of the learner to apply clinical contexts. This idea is necessary to preparing Allied Health professionals to enter the workforce.

Fydryszewski et al. (2010), echo the ideas presented by Olmsted (2010) as related to phlebotomy delivery by web-based means. Like dental hygiene, phlebotomy is also considered an Allied Health field. Pedagogical strategies for teaching are also founded on the constructivist theory. "Constructivist strategies are learner centered, with the instructor involved as a facilitator and utilizes problem solving approaches as well as strategies where the student helps create learning environment." (Fydryszewski et al., 2010). The application of this theory is of particular necessity in health professions. Constructivism is helpful in the process of nursing education by improvement of critical thinking skills and encouragement of evidence based practice models (Brandon & All, 2010).

The basic belief of constructivists is that students construct their own meaningful learning engagements (Juniu, 2006). The role of the instructor becomes one of a motivator to trigger interest and critical thinking into the topic. The theory of constructivism supports the need for technology to play a role in meeting stated learning outcomes. The constructivism learning theory is supported as a fit for e-learning as it ensures learning from experience to be rooted in the learner (Koohang, Riley & Smith, 2009). The question, however, when dealing with distance education is how effective online forms of teaching can be in creating real life scenarios to support learning.

Despite the theory of learning applicable to non-traditional teaching environments, some things remain constant: learners require motivation, interaction, information, and personal application to achieve competency in their subject area. Feyten and Nutta (1999) in their research that interactive, self-directed learning and higher order thinking can be fostered by technology, but the selection of that technology and the manner in which it is used is critical to realizing the potential benefits. Learners are not the only group that non-traditional learning affects. Instructors require support to learn and integrate new delivery methods. The learner of course is responsible for their learning; the instructor then is responsible for quality learning experiences to foster proactive interaction and learning (Garrison, 1993). The concept of simply adapting a traditional lecture style course to a non-traditional format is not supported by research (Cook, 2007; Martino & Odle, 2008). Non-traditional learning will continue to evolve and as it does, multiple theories of learning will continue to be applicable as well as multiple levels of preparation for faculty involved. Online forms of course delivery require active learning processes and should be designed to allow student engagement. “Faculty development greatly influences the quality of online programs because faculty must feel confident about and competent in using the technology” (Kowalczyk, 2014). Thus teaching in any form of non-traditional forum requires attention to the needs of both the instructor and the student to assure quality delivery.

The task of applying the theory of constructivism where transactional distance exists becomes daunting. Instructors need to create authentic learning environments in order to foster student engagement. Students need to be active learners and experience real life scenarios. These ideas are essential to learning in fields of Allied Health to produce professionals competent in various fields. Turner (2005) states,

> Students cannot learn to interpret, analyze, infer, explain, evaluate and self-regulate by merely memorizing profuse quantities of discipline specific knowledge. Rather educators must provide a learning environment which establishes active participation as the norm in which students learn these new skills.

This statement is certainly applicable to Allied Health professions and supports the ideas of Dewey and Piaget for learning through experimentation and constructive pedagogical foundations.

Distance education is now an integral part of the educational process. In a study conducted by the National Center for Educational Statistics, it was reported that 56% of all degree granting higher education institutions offered distance education courses during 2000–2001. In 2005 this number continued to grow by 25% (Park & Choi, 2009). Learning at a distance has drastically changed the image of higher education in the last decade. Delivery methods through interactive video networking, independent study courses and web-based instruction are among the most common forms of distance learning methodologies. Web-based instruction has been the most common of these methods (Cook, 2007; Lahaie, 2007). Many advantages can be noted for non-traditional methods of instruction such as completed by the MOODLE® format. The advantages include increased accessibility to educational materials, personalized instruction, and standard content (Gagnon, Gagnon, Desmartis & Njoya, 2013).

A key element to successful instruction in any delivery format is that of sufficient interaction between students and teachers (Carey, 2001; Crawley et al., 2009; Lee & Rha, 2009). This issue of interaction becomes especially important in distance courses and demonstrates that regardless of how courses are delivered student involvement is critical. Moore, Thompson, Quigley, Clark, and Goff (1990) and Verduin and Clark (1991) found that distance education courses were most effective when student-student interactions were present and when instructor feedback was timely. The authors noted that while instructor-learner interaction is important, high levels of this type of interaction did not prove to be any more beneficial than moderate response. Mazzolini and Maddison (2003) found that increased instructor posting in online courses did not result in increased student participation. Lee and Rha (2009) learned that as the instructor became more involved, student messages became shorter and more infrequent. The need then exists to provide student-to-student interaction assignments as well as finding the best balance of instructor to student interaction. Teaching at a distance does not afford the reading of body language that traditionally can create a teachable moment. It is necessary for teachers at a distance to provide students with active engagement assignments that can still allow spontaneous teaching moments (Crawley et al., 2009; Kowalczyk, 2014). The use of web-cams or interactive video networking are options available that can provide active participation.

It is reported that a greater percentage of students participating in online courses drop out as compared to students in face-to-face classes (Park & Choi, 2009). The factors for the higher drop-out rate for online courses included individual characteristics, as well as external and internal factors. The individual and external factors were further detailed in the 2009 study by Park and Choi. The individual factors of age, gender, educational background and employment status were not significant causes for online course dropout. External factors including family support, learner motivation and learner satisfaction with the course were found to influence learner decisions to drop online courses. These studies indicate the importance of creating methods to assure valuable and positive learning experiences for students engaged in such coursework. Although some studies cannot prove why students in online courses have higher drop-out rates, Levy (2007), noted that learners are less likely to drop out when they are satisfied with their courses and when they are motivated by the instruction. Park and Choi (2009) stated, "Therefore, an online course needs to be designed in ways to guarantee learners' satisfaction and be relevant to learner needs" (p. 215). Activities to promote an active learning environment, independent of the teaching format, may include experiments, field trips, discussion, concept mapping, interviews, journaling and online tools (Brandon & All, 2010). Each of these can promote interactive learning in either a traditional lecture environment or used in computer management systems such as MOODLE®.

Integration of effective non-traditional teaching methods into courses is not simple. It is necessary to plan and adapt course assignments to be cohesive with the educational delivery method. In their report to the American Society of Radiologic Technologists (ASRT), Martino and Odle (2008) stated that a danger lies in assuming that lecture content can be converted to a new delivery method without attention to revision of content, assessment, technology used, or mode of delivery. Problems arise when traditional teaching methods are simply interchanged with non-traditional delivery. A significant amount of time is needed to assure non-traditional delivery is successful. The need of time compounded with increased workload and new knowledge required of instructors to implement and maintain non-traditional teaching can become a challenge (Anderson, 2008). Well-prepared and planned course delivery is essential to any teaching method. Non-traditional teaching methods can prove to be as effective in meeting educational objectives as traditional face-to-face instruction (Omar et al., 2011). Cook (2007) stated, "Students need to be able to use course delivery tools, but they also need to be able to think beyond these tools, addressing their future online students' needs regardless of platform used to deliver content." The learning needs of students should frame the delivery of educational programs whether in a traditional or non-traditional environment (Feyten & Nutta, 1999). Garrison (1993), states "The goal of all education is to construct meaning through critical and collaborative analysis and consensual understanding."

Although traditional lecture, face-to-face courses lend themselves relatively easily to a non-traditional teaching format, educational areas involving hands-on instruction are not as adaptable (Ward, 2009). Many Allied Health programs include a clinical component as a part of their instructional methods. The basis for many health education programs is learning in practice. Students are often given problem based learning assessments to allow application of knowledge in relevant areas (Fydryszewski et al., 2010; Martino & Odle, 2008; Olmsted, 2010). For most Allied Health professions clinic is a required portion of the educational program (Martino & Odle, 2008; Ward, 2009; Williams, 2006). Students experience hands-on learning in the clinical setting(s). These clinical settings are in addition to the didactic classroom. The more traditional lecture style teaching takes place within the didactic portion of Allied Health programs. The didactic curriculum benefits some students, however the use of lab experiences and visual components are essential to the success of students in Allied Health programs.

Meehan-Andrews (2009) conducted a study in the field of nursing and found that student preference included practical classes and lectures to be the most useful learning experiences. Practical instruction is conducted in a real life scenario or clinical teaching moment. These practical sessions prove to increase student confidence in performance (Meehan-Andrews, 2009).

Other studies indicate that there is no significant difference in face-to-face and online instruction in nursing education programs (Ayars, 2013; Lukman & Krajnc, 2012). Kowalczyk (2014) noted in a study specific to radiologic science educators, that fully online programs in this field are not feasible due to the need for clinical application. Other research notes little evidence in the area of distance learning for health care professionals targeted on the impact relative to student learning outcomes but rather on learner satisfaction with distance learning (Gagnon et al., 2013). The need to assure competence of Allied Health students is essential to the production of graduates in respective fields. This need holds educational programs responsible for quality instruction and provision of skilled entry level health care providers.

The practical application needs of Allied Health education require instruction with real world situations. Koohang et al. (2009) provide research regarding the application of the constructivism theory to e-learning. Their work provides a basis on which real world situations can be adapted to e-learning formats. Instructors provide real world situations to learners in an e-learning assignment and the learners are given the task of goal development and problem solving. The learner was instructed to apply prior experience and knowledge to the provided situation. The learner was then tasked with self-reflection on the experience and to justify the answers they provide to the situation (Koohang et al., 2009). This research details a series of assignments utilized to foster active learning in an online environment. It should be noted that as with other studies in the area of Allied Health didactic education is the focus of application for constructivist and distance learning theories. (Koohang et al., 2009; Kowalczyk, 2014; Martino & Odle, 2008; Olmsted, 2010; Omar et al., 2011).

Radiologic Technology requires clinical instruction. Students in Radiologic Technology need to develop skills that will meet the demands of clinic practice (Ward, 2009). According to the American Registry of Radiologic Technologists (ARRT, 2013) the clinical requirement for radiography involves a demonstration of competency in general patient care activities and radiologic procedures. The term competency as defined by the ARRT is stated as, “performing procedures independently, consistently, and effectively” (ARRT, 2013). The clinical setting is the area where this performance takes place. Replacement of traditional face-to-face clinic performance with non-traditional teaching methods may prove to have unfavorable results as related to student competency.

The effectiveness of clinical education in Radiologic Technology is vital to student competency. The advancement in equipment as well as the complexity of diagnostic procedures in the field requires students to be familiar with an imaging department. The performance of diagnostic procedures in imaging requires real patient interaction to develop competent new graduates (Marshall, 2008). Curricular planning should focus on development of such practical skills. Development of clinical skills shifts from traditional lecture to hands-on activities as a primary teaching strategy. The need for independent critical thinking, procedural adaptation, and student accountability is central to clinical instruction (Marshall, 2008). The thought of students being accountable for their own learning while instructors facilitate activities that will foster critical thinking and learning resonate the constructivist theory. According to Martino & Odle, 2008, “Students are more liked to gain and retain understanding when they construct new concepts based on prior knowledge or experience and incorporate and test their theories and beliefs.” This idea for teaching and learning for students in Radiologic Technology is in line with the constructivist theory. The need for hands-on teaching in order to gain knowledge through experience can also be supported by this context.

Incorporation of teaching with technology in the clinical area has been sparse in Radiologic Technology associate degree programs. The instruction in the clinical area is vital to the success of radiographers. The use of virtual technology for simulation such as that used with flight simulation has been introduced in the field (Martino & Odle, 2008). An advantage to this type of instruction is that of performing procedures without the fear of harming patients (Martino & Odle, 2008). The disadvantage however comes with the high cost of virtual simulation laboratories. It should be noted that simultaneous training with various teaching modalities coupled with collaboration can increase interaction and improve conceptual learning in the Radiologic Sciences. The lack of patient interaction and real life practice is however compromised. When using non-traditional teaching methods in Radiologic Technology faculty development is necessary to assure activities are formulated that engage students (Kowalczyk, 2014). The area of faculty development in the Radiologic Sciences as well as other professions has been found to jeopardize quality online instruction (Kowalczyk, 2014; Olmsted, 2010; Omar et al., 2011). Kowalczyk (2014) found 58% or Radiologic Technology educators to feel inadequately prepared to use online technology. The study also found 35% of the respondents to have concern for the student engagement in online learning (Kowalczyk, 2014). The standards for accreditation for programs of Radiologic Technology require educational delivery at a distance to be reported and assessed for quality (JRCERT, 2011).

The Joint Review Commission for Education in Radiologic Technology (JRCERT) utilizes standards for accreditation of Radiologic Technology programs. In order to assure student competency, the standards require a practice based curriculum as well as a detailed assessment plan of the curriculum. A list of the standards used in this study can be found in Appendix A. Standards 3.2 and 5.1 were used in this research because they are necessary to assure that student learning outcomes are stated, taught, and assessed to provide proof of student competency. The programmatic SLOs of the Radiologic Technology program used for this study are included in Appendix B. The SLOs for this research were selected based on the need of clinical performance relative to competency of graduate students. Student learning outcomes for any Allied Health program will be specific to the profession as well to accrediting agencies by which programs must provide assessment data.

Due to the debate in the success of non-traditional educational delivery, the ASRT formulated a task force on new educational delivery methods to address the changing face of higher education and detail educational delivery methods utilized within programs of Radiologic Technology (Martino & Odle, 2008). Non-traditional delivery methods identified by this group included e-learning, simulation, various distance education methods, online instruction, hybrid courses, computer- aided education, and use of portable devices (Martino & Odle, 2008). Many of these methods have been successfully integrated into programs of Radiologic Technology and according to Martino and Odle (2008), the students' learning outcomes from non-traditional versus traditional settings has shown no significant differences. This finding led the ASRT task force to note that greater detail in the comparison of traditional and non-traditional learning was needed. The study by Martino and Odle (2008) suggested that students in online courses miss the interaction available in a traditional classroom environment. Thus conclusive data is needed in this area.

In their research of new technologies being used in the teaching and learning environments of health education in the UK, Moule et al. (2011) found that e-learning will remain on the edges of educational delivery in nursing and health sciences. However their conclusions also state that the use of e-learning will augment face-to-face teaching to provide additional information. Williams (2006) stated in his study, "More research needs to be conducted to evaluate the effect of educational level on the effectiveness of distance education in Allied Health science fields." Thus it should be clear that to assure effective student outcomes in Allied Health education there is a need for additional research.

Non-traditional learning environments remain a part of the educational arena from the past, present, and will likely increase in the future. Innovative ways to deliver education continue to emerge. Although this trend is prevalent in all areas of educational delivery, programs of Radiologic Technology are experiencing widespread use of technology to teach the required curriculum (Martino & Odle, 2008). Moule et al. (2011) found e-learning to be on the edges of educational delivery in nursing and health sciences. However their conclusions also state that the use of e-learning will augment face-to-face teaching to provide additional information. Kowalczyk (2014) states that, "Because for the need for clinical application of course content inherent in radiologic science education, fully online educational programs are not feasible." This conclusion supports the need for face-to-face instruction to remain in the clinical portion of these health science programs.

Summary

Distance education has become a vital part of the higher education experience. Allied Health programs including physical and respiratory therapies, dental hygiene, nursing and Radiologic Technology are certainly realizing this trend (Gagnon et al., 2013; MacKinnon, 2004; Martino & Odle, 2008; Moule et al., 2011; Olmsted, 2010; Strickland, 2007). The need for students to be prepared for the work force necessitates quality teaching methodologies. Studies have indicated that non-traditional means of instruction are as effective as face-to-face methods (Alonso & Blaquez, 2009; Gagnon et al., 2013; Martino & Odle, 2008; Olmsted, 2010).

Research does not typically include the clinical aspect of training for students in the field of Radiologic Technology or other Allied Health fields. The need for effective clinical experiences is vital to student competence. The need to assess varied teaching methodologies for practical application in Allied Health fields is present.

Assurance of effective clinical experiences is questionable concerning the use of complete online instruction for acquisition of clinic skills. The theoretical basis for critical thinking skills is essential to clinical training, and is grounded in constructivist thought. Both the views of Piaget and Vygotsky can be noted as essential and complementary to the clinical learning experience. Active participation of learners for problem solving and critical thinking are fundamental to practical assessment in clinical environments. Simpson and Courtney (2002), define clinical judgment as critical thinking in a clinical area. These skills are necessary to provide a broad outlook on a situation requiring creative solution and multiple pathways for successful completion (Simpson and Courtney, 2002). A student engages in a decision making process that incorporates critical thinking in order to produce a sound clinical decision. "Critical thinking becomes a daily experience, not an experience saved for the clinical practice setting" (Simpson & Courtney, 2002). The need of critical thinking skills in Radiologic Technology necessitates teaching methodologies that will provide instruction of such skills. When non-traditional platforms such as MOODLE® are used for instruction of material requiring critical thinking assessment, assurance of quality is central to the production of competent students. It should be noted that quality instruction is not limited to non-traditional formats, but rather all instructional methods should produce students demonstrating competency of critical thinking outcomes.

The methods in which the technology is used will drive the quality of educational program(s). It should be noted however that when non-traditional teaching formats are used it is important to focus on student engagement and to use pedagogy that supports innovation and creativity (Carey, 2001; Crawley et al., 2009; Kowalczyk, 2014; Lee & Rha, 2009).
Martino and Odle (2008) stated that a danger lies in assuming that lecture content can be converted to a new delivery method without attention to revision of content, assessment, technology used, or mode of delivery. This basis of the theory of distance education suggests the importance of interaction to the process of learning. Anderson (2008) discusses that a concern for online environments is the issue of how interaction is accomplished and how it is managed. Problems arise when traditional teaching methods are simply interchanged with non-traditional delivery. This problem is non discipline specific and should be considered when any change in teaching formats are incorporated. Clinical assessments rely on interaction with patients and face-to-face exchange. Teaching in complete non-traditional methods cannot replace the interaction gained in real life clinic experiences. The learning that takes place in a clinical active process would be difficult to replace with non-traditional, online lab experiences. Such experiences do not involve face-to-face communication, assessment of body language or accurate trauma assessment. The challenge then exists to find methods of instruction independent of the teaching format that includes interaction, critical thinking, and proven demonstration of competency for specific student learning outcomes.

CHAPTER THREE: METHODS

Design

The researcher used a quantitative/quasi-experimental approach. The use of a quantitative study permits the author to examine variables to determine if a relationship between the stated variables exists. The independent variable serves as the hypothesized occurrence (Gall, Gall & Borg, 2010). The dependent variable is an effect from another variable. The quasi-experimental study incorporates the nonrandom selection of participants (Creswell, 2009; Gall et al., 2010; Howell, 2008). This design approximates the conditions of the true experiment in a setting that does not allow for random assignment of participants to treatment and control conditions and is convenient and less disruptive to the participants and researcher (Creswell, 2009). The comparison of the course delivery format to graded assessments linking specified student learning outcomes is the emphasis of the study. The graded assessments provide the independent variable for the study. The dependent variable is the type of delivery format used. This design allows the researcher to establish a relationship between two such variables (Creswell, 2009; Howell, 2008). Student learning outcomes for comparison were selected based upon those taught in both face-to-face and non-traditional formats. The learning outcomes selected require a level of competency equal to that achieved in a laboratory or clinical setting. The scores of the assessment on these objectives are included in the statistical analysis to determine if a significant difference exists in the traditional versus non-traditional instruction.

The SLOs used include student evaluation of image quality and student performance of proper patient care during medical imaging procedures involving trauma situations. The imaging procedures selected require student knowledge of basic human anatomy and physiology. The ability to radiographically demonstrate anatomic structures where trauma is involved may vary from a normal imaging routine. Proper patient positioning in correlation with medical imaging equipment for the production of a diagnostic image is imperative to all examinations. Student problem solving skills and independent thinking while performing medical imaging examinations specific to trauma situations will be included in the assessments. Clinical evaluation requirements include more than one anatomic area to be assessed for trauma competency. The trauma assessments used for this study included the area of trauma upper extremity, lower extremity, and shoulder. The assignment for the trauma critical thinking assessment along with the grading rubric is available in Appendix C and the practical evaluation assessment tool is located in Appendix D.

Research Question(s)

RQ1: Is there a difference in the written and practical assessment scores of non-traditional students using MOODLE® as the delivery system as compared to traditional students being instructed in lecture and lab delivery formats?

Null Hypothesis(es)

Null hypothesis (H_{01}): There will be no significant difference in the results of each of the three practical examinations (trauma upper extremity, trauma lower extremity, and trauma shoulder), for the students taught in the non-traditional course delivery format and those taught by traditional delivery.

Null hypothesis (H_{02}): There will be no significant difference in written trauma critical thinking assessment results for students taught in the non-traditional course delivery format and those taught by traditional delivery.

Participants and Setting

The participants for this study were in the second year, third semester of an associate degree Radiologic Technology program. The setting for this research was an associate degree program of Radiologic Technology at a 4-year state funded college in the southeastern United States. The college in which the program is located is in a small rural area in the southeastern United States. Students are selectively admitted into the restricted enrollment program. Students take courses that include face-to-face instruction as well as web-based and web enhanced courses. The courses chosen for this study included those with face-to-face instruction methods from a prior semester and MOODLE® instruction methods during the current term. The student learning outcomes selected were those that demonstrate clinical competence in accordance with the JRCERT and ASRT standards and guidelines.

The degrees awarded at the college include associate degrees in Allied Health programs and Engineering as well as bachelor degrees in Business, Education, Arts and Sciences, Nursing, Imaging Science and Engineering. A convenience sampling, which involves using participants available and easily accessible to the researcher was used (Johnson lectures, 2010). The purposive sampling, includes a population with specific characteristics (Johnson lectures, 2010). The purpose is that the sample includes those enrolled in a Radiologic Technology program which is the focus of the study. The sample also includes students who have completed two semesters of the program.

All students in the study were enrolled in Radiographic Procedures II and a clinical component in their respective semester of study. A total of 33 students was included in the study. The face-to-face cohort consisted of 20 students while the participation in the MOODLE® instructional format consisted of 13 students. The difference in numbers is due to the number of students enrolled in the program for the particular semester. Due to attrition the non-traditional delivery group had fewer participants. The study was intended to include a minimum of twenty-five participants per cohort; however, this number in each group was not met due to program attrition rates. The participants utilized for face-to-face instruction were from a prior semester and are compared to data from a current semester in which instruction was provided in the MOODLE® format. The researcher, upon Liberty University Institutional Review Board approval, informed students in the sections of the courses identified for the study and provided an overview to the students of the research to be conducted. Demographic information including age, ethnicity, gender, and level of education is reported in narrative and tabular form. Descriptive statistics of this information includes the percentage of male versus female students, the average age, and a summary of the educational levels found within the group. The form used to gather this data can be found in Appendix E.

The sample by gender of the non-traditional (MOODLE) delivery included 12 females and one male. The age range for this cohort varied from 18–32 years with the mean age of 22.167 years. Additionally within this sample 12 were of Caucasian race and one African-American. The data collected did not note other races to be included within the group. The sample groups were also asked level of education to include highest level being high school diploma or GED, any form of certification, Associate Degree, Bachelor’s Degree, or Master’s level or beyond. The data revealed no participants to hold certifications, or to have education beyond the associate level.

The data collected for the face-to-face cohort included 19 females and one male. The age range for this cohort varied from 18–37 years with the mean age of 24.263 years. This sample consisted of 19 students of the Caucasian race and one American Indian. The data collected did not note other races to be included within the group. The sample was also asked level of education to include highest level being high school diploma or GED, any form of certification, Associate Degree, Bachelor's Degree, or Master's level or beyond. The data revealed no participants to hold certifications, or to have education beyond the associate level.

In addition to basic demographic information, students were asked to state which learning format they felt best met their learning style needs as well as which was best suited for students in Radiologic Technology. The options given for response included face-to-face with lecture only, face-to-face with MOODLE® enhancement, or instruction via MOODLE® only. The data gathered from this survey is noted in Tables 2 and 3. The MOODLE® cohort consisted of 13 participants stating the best format suited for students in Radiologic Technology to be face-to-face. The type of instruction that best met individual learning styles included four stating face-to-face only, nine face-to-face with MOODLE® enhancement and zero MOODLE® only.

The 18 students within the face-to-face cohort stated the teaching format best suited for students in Radiologic Technology to be face-to-face only, one non-traditional delivery only and one no response. The type of instruction to best meet individual learning styles of this group included four stating face-to-face only, 14 face-to-face with MOODLE® enhancement, and two MOODLE® only.

Table 2

Preferred Student Learning Format Class of 2013/2015 Moodle® Cohort

Teaching Format Best for Students in Radiologic Technology		Type Instruction that Best Suits Learning Style(s)	
Face to Face	100%	Face to face lecture only	N = 4 30.769%
Non-traditional	0%	Face to face MOODLE® enhanced	N = 9 69.231%

		MOODLE® only	N = 0 0%

Table 3

Preferred Student Learning Format Class of 2012/2014 Face-to-Face Cohort

Teaching Format Best for Students in Radiologic Technology		Type Instruction that Best Suits Learning Style(s)	
Face to Face	N = 18 90.000%	Face to face lecture only	N = 4 20.0%
Non-traditional	N = 1 5.0%	Face to face MOODLE® enhanced	N = 14 70.0%
No Response	N = 1 5.0%	MOODLE® only	N = 2 10.0%

Instrumentation

This study utilized student assessment tool(s) used to establish competency of the SLOs included in this study. The JRCERT standards were utilized to provide the basis for which programmatic SLOs are formulated. These standards are requirements for accreditation purposes and are utilized by all Radiologic Technology programs accredited by the agency. The grades of the written critical assessment for trauma radiography and the graded practical exam for trauma procedures including shoulder and upper and lower extremity from each delivery method are statistically presented. The instrument used for written critical assessment of trauma radiography was developed by the program faculty. The assessment includes a rubric for grading that was selected from the Association of American College and Universities (AAC&U) value rubric for critical thinking assessment. This rubric was reworded to include specific language for Radiologic Technology and is used by the college in the study for institutional assessment. This rubric includes four goals each with a four point scale with four being exceptional and one not meeting the standard. The rubric was developed in conjunction with the research conducted in production of the valid assessment of learning in undergraduate education (VALUE) development project (Rhodes, 2010). The VALUE rubrics have been used in a number of settings and have proven validity demonstrating rich evidence of student learning in meeting accountability demands (Rhodes, 2010). The rubric for critical thinking was tested by faculty at over 100 colleges. The VALUE rubric was tested for reliability using a multi-rater kappa range from -1 to 1, where -1 indicates perfect disagreement beyond chance and +1 indicates perfect agreement beyond chance and a score of zero indicating perfect agreement (Association of American Colleges and Universities, 2011). According to the research conducted the kappa statistic is based upon actual scores whereas the percentage of agreement is based only on actual scores without consideration of the probability of chance. The results of the analysis for the critical thinking VALUE rubric indicate a Kappa score of 0.52 with 64% percentage of agreement when using 4 categories (American Colleges and Universities, 2011). This demonstrates a greater level of agreement than disagreement and indicates a one third of the scores to have perfect agreement. Among the VALUE rubrics tested for reliability, the critical thinking rubric had the highest degree of agreement and reliability (American Colleges and Universities, 2011).

In addition to the written critical thinking assessment the competency performance evaluation tool for clinical assessment of radiographic procedure(s) was used. This tool is used by the program in the study and was approved by the JRCERT for use in the field. The tool includes three subsections including patient rapport and awareness, image production, and image quality. Each subsection contains a series of questions specific to the area being evaluated. The questions within the subsection is weighted according to the impact on the finished radiograph.

While this tool is not standard for all programs of Radiologic Technology it is reviewed on an annual basis by the faculty and as needed by the accrediting agency for purposes of appropriateness of use. The tool utilizes a Yes/No or Not applicable format for clinical grading which is tabulated by the clinical instructor for assignment of a numeric grade. The tool was developed in 1994 and is annually reviewed by the program to evaluate effectiveness (Student Handbook, 2013). In addition to the faculty review process, the tool is included in accreditation visits for review by the JRCERT as scheduled for re-accreditation visits. Studies conducted in the area of Radiologic Technology as well as Physical Therapy education note that there is no universally accepted tool for assessment of clinic skills (Gosnell, 2010; Jette et al., 2014). A variety of methods are used to evaluate students in Allied Health programs and standard assessments are not readily available.

Assessment tools are necessary in clinical settings to provide students with an evaluation of their performance. Clinical or practical evaluation tools aid in assessing the students development of knowledge, skills and interactions necessary to becoming competent healthcare professionals (Gaberson & Oermann, 2010; Jette et al., 2014; Snodgrass, Ashby, Onyango, Russell, & Rivett, 2014). Due to the variance in skills needed in Allied Health fields there are few similarities in tools used for assessment (Jette et al., 2014). Standardized tools are not readily available in fields such as physical therapy, Radiologic Technology, or nursing for practical evaluation. There is a tremendous void in the area of clinical performance assessment evaluations. Tools for assessment of practical skills take on many forms. A tool for performance-based assessment is needed in Radiologic Technology in order to assess student demonstration of performance of radiographic examinations. The tool used for this study has been accepted by the program faculty, the college assessment director and the JRCERT and is specific to the Radiologic Technology program utilized by the researcher. The reliability of the tool has proven to be a limitation of the study due to the inconsistencies produced when grading takes place by different evaluators.

The tool utilized for acquisition of the written assessment data was provided to students in both the face to face and MOODLE® group two weeks prior to the required due date. The grading rubric as formulated from the AAC&U critical thinking valid assessment learning rubric was also provided to the students. The tool utilized for the practical assessment data is provided to students upon entry into the clinical portion of the program in the second semester of the student's instruction. These practical assessment tools are utilized as students complete required clinical competency exams as required by the JRCERT. Faculty who administered both the written critical thinking assessment as well as clinical faculty granted permission for use of the assessments for the research. Graded assessments were provided at the end of the term with student identifications removed for use by the researcher.

Other instruments used for data collection included a demographic survey to gather information including age, gender, educational level, and ethnicity. An emailed survey to both student groups related to preference in delivery method specific to Radiologic Technology and basis of personal learning style was also conducted. This survey tool can be viewed in Appendix F.

Procedures

The researcher obtained Liberty University Institutional Review Board (IRB) approval to conduct the research. This approval was provided to the institution in which the participants were located. Liberty University IRB approval also included informing students in each cohort of the courses identified for the study and provided an overview to the students of the research to be conducted. Students were notified in a face-to-face meeting by the researcher in each group. The researcher's selection of SLOs was based on those used to establish competency levels for clinical and/or laboratory procedures specific to trauma radiography. These SLOs were determined by discussion with program faculty in a group setting in a programmatic faculty meeting. The exact research was further discussed with the faculty directly involved with the assessment of the selected SLOs. This discussion included which assessments would be needed by the researcher as well as the removal of identifying factors for students in each group.

The students were divided into traditional and non-traditional teaching environments. These groups were from two semesters of study both in the same academic term. The faculty member(s) instructing each group distributed an email to the group explaining the use of their graded assessment(s) for the purposes of the research. The sample included students across an academic year. Those students in the traditional group were instructed in a clinic or lab setting to meet the student learning outcomes necessary for completion of the practical assessment work. The students also attended didactic courses to meet SLOs related to the written assignment. The non-traditional group was given instruction via the MOODLE® course management system. This group received instruction only in the MOODLE® system to meet SLOs for both the practical and written assessment. The same assessment for grading of each objective was used in each group.

The assessments were provided by the faculty member to the researcher at the completion of a 16 week term. The graded assessments were statistically compared to see if a difference existed between course delivery and student learning outcomes. The grades for the critical thinking and written assessment related to trauma radiography were statistically analyzed via

Microsoft Excel MegaStat software. The procedural materials used for data collection are included in the appendices.

Data Analysis

Statistical analysis included *t-test* evaluation. The *t-test* evaluation for demonstration of significant differences within data assessed was conducted to show the variance between test scores within the two teaching formats (Creswell, 2009). The *t-test* was used to test the null hypothesis when computing difference in the mean test scores (Patten, 2005). For this study a series of *t-test(s)* were performed in order to evaluate any difference in written and practical assessment tools within each form of delivery. The scores on assessments for the specified student learning outcomes requiring clinical and laboratory knowledge taught in non-traditional and traditional formats were assessed for the mean and standard deviation. The *t-test* was performed to determine if a significant difference exists between graded practical examinations including selected trauma assessments and written assessments in each delivery format. The graded assessments provide the independent variable for the study. The dependent variable is the type of delivery format used.

Student learning outcomes for comparison were selected based upon those taught in both face-to-face and non-traditional formats. The learning outcomes selected require a level of competency equal to that achieved in a laboratory or clinical setting. The scores of the assessment on these objectives are included in the statistical analysis to determine if a significant difference exists in the traditional versus non-traditional instruction. The trauma practical assessment scores including upper extremity, lower extremity and shoulder, for students in each delivery format were statistically analyzed to establish if a significant difference was found between the non-traditional and traditional groups. Due to different trauma exams being performed within the given semester an assessment for the areas of trauma shoulder, trauma upper extremity and trauma lower extremity were included. The same analysis was conducted for written assessments for students in each delivery format. An analysis of descriptive statistics was included to demonstrate the demographics of the sample population including age range, sex, learning style preference and level of education. Programmatic course objectives are identified in specific Radiologic Technology courses that contain both a traditional and non-traditional teaching component. Instructional methods included lecture, traditional and online discussion, PowerPoint presentation and demonstration both in traditional and non-traditional delivery.

CHAPTER FOUR: FINDINGS

Research Question

RQ1: Is there a difference in the written and practical assessment scores of non-traditional students using MOODLE® as the delivery format as compared to traditional students being instructed in lecture and lab delivery formats?

Null Hypotheses

Null hypothesis (H_{01}): There will be no significant difference in the results of each of the three practical examinations (trauma upper extremity, trauma lower extremity, and trauma shoulder), for the students taught in the non-traditional course delivery format and those taught by traditional delivery.

Null hypothesis (H_{02}): There will be no significant difference in written trauma critical assessment results for students taught in the non-traditional course delivery format and those taught by traditional delivery.

Descriptive Statistics

The sample populations for each group included a total of 33 students. Group #1 consisted of 13 students taught in the non-traditional format utilizing MOODLE® as the mode of delivery. Group #2 consisted of 20 students taught in the traditional lecture style format as the mode of delivery. The mean scores for the critical thinking written assignment were 83.792% for the MOODLE® group in contrast to 91.450% for the face-to-face group. The mean scores for all practical assessments were 99.586% for the MOODLE® group as compared to 98.563% for the face-to-face group. The number of graded assessments vary for each trauma category due to the fact that each student is required to be graded on each area. During the course of the 16-week term the number of participants who were assessed varied due to the number of each examination that was available at the scheduled time for each participant's rotation. The trauma upper extremity mean value was 99.400% for the MOODLE® group and 99.116% for the face-to-face group. Similarly the trauma lower extremity mean score was 98.733 for the MOODLE® group and 98.400 for the face-to-face group. The trauma shoulder scores had calculated mean scores of 99.517 for the MOODLE® group and 98.172 for the face-to-face group. The variance noted in this group was far less than that of the written assignment scores. Tables 4 and 5 provide the data for each group and each assessment.

Table 4

Descriptive statistics – Written Assessment

Group	n	M	SD	t	p=
MOODLE®	13	83.792	9.345	3.09	.0042
Face-to-Face	20	91.450	4.88	3.09	.0042

Table 5

Descriptive Statistics – PRACTICAL ASSESSMENTS

Group	n	M	SD	t	p=
MOODLE®					
Trauma upper extremity	13	99.400	1.071	-0.42	.6761
Trauma Lower Extremity	6	98.733	1.962	-0.25	.8072
Trauma Shoulder	12	99.517	1.129	-1.58	.1262

FACE-TO-FACE	n	M	SD	t	p=
Trauma upper extremity	19	99.116	2.424	-0.42	.6761
Trauma Lower extremity	19	98.400	3.100	-0.25	.8072
Trauma Shoulder	18	98.172	2.794	-1.58	.1262

Results

Null Hypothesis One

A series of *t-test*(s) was conducted between each of the practical trauma examinations. These examinations were conducted in the clinical setting and included a trauma upper extremity, trauma lower extremity and trauma shoulder. The practical examinations encompass the programmatic student learning outcomes including:

- The student will evaluate image quality, applying the knowledge of positioning and technical selection necessary for diagnostic images;
- The student will provide the patient with proper care during medical imaging procedures. This will include knowledge of body mechanics, patient immobilization, basic life support techniques, patient education for examinations, and overall patient care and comfort;
- The student will utilize problem solving skills and exercise independent thinking while performing medical imaging examinations (Student handbook, 2013).

There were no p-values found $< .05$. Thus the data implied no significant difference to be found between the graded practical examinations and course delivery.

Due to each student performing more than one assessment related to trauma radiography each trauma category was evaluated to determine if any pattern was evident for specific examinations. When utilizing the assumption of $p < .05$ it was identified that variance did not exist between examinations. However on the critical thinking written assessment for trauma examination a value of $p < .05$ was found to exist.

The trauma upper extremity practical exam revealed a p value of ($p = .6761$). The trauma lower extremity practical exam indicated, $p = .8072$ and the trauma shoulder practical exam

$p = .1262$. This finding revealed no significant difference to exist between the stated graded practical exams and teaching format. A possible reason for this finding is that the practical graded assessments are graded in a hospital setting by varying staff radiographers rather than a consistent faculty member grading each assessment for all students. This area is certainly one of concern for grade inflation in the clinic area and one to be considered for future study. This finding also shows no significant difference between method of delivery and graded practical exams. This demonstrates no significant difference to exist between graded practical assessment and the course format. The finding supports ($H_{01)}$ in that a significant difference was not found to exist between practical assessment results and course delivery format.

Null Hypothesis Two

Independent *t-test* analyses were conducted between the graded critical thinking assessment(s) for trauma radiography, in each delivery format. This assessment was used to evaluate the programmatic SLOs including: The student will evaluate image quality, applying the knowledge of positioning and technical selection necessary for diagnostic images. The student will demonstrate knowledge of basic human anatomy and physiology, demonstrating the ability to radiographically identify anatomic structures and basic pathologic findings. The student will utilize problem solving skills and exercise independent thinking while performing medical imaging examinations.

A p-value of .0042 was found when using $p < .05$ which is considered to be a significant difference. The average score for the assessment in the face to face group was a 91.450% while the MOODLE® group average was 83.792%. This finding indicates that when using non-traditional teaching methods the graded assessments related to the SLOs previously stated regarding critical thinking for trauma radiography were found to be lower. This finding rejects the (H_{02}) identifying a significant finding between written assessment scores of students taught via non-traditional course delivery and those taught by traditional methods. The *Summary of Findings* table details the specified student learning outcomes as related to programmatic learning objectives and provides the assessment tool(s) utilized in the course(s) for student evaluation. The results provided are an average score of each trauma practical assessment and the critical thinking assessment(s) utilized in both the face-to-face and MOODLE® cohorts. The *p-value* used for comparison is provided. The difference in the average practical scores between the cohorts is 0.634 of a point. As noted previously this narrow margin does not indicate a significant difference to be found between the two teaching formats relative to the practical assessments for the stated trauma exams thus supporting H_{01}. The difference in the average critical thinking assessment scores between the cohorts was equal to 7.66 points. This difference in scores does indicate a significant difference to be found to exist between the two teaching formats in relation to the written assessment(s) for critical thinking. Thus H_{02} is rejected by this finding.

Table 6

Summary of Findings

Programmatic SLOs	Course Name	Learning Objective	Assessment Tool(S)	Results
The student will evaluate image quality, applying the knowledge of positioning and technical selection necessary for diagnostic images	Clinic Radiographic Procedures II Radiographic Procedures II lab	Apply knowledge of anatomy to evaluate radiographic images. Properly evaluate image quality.	Graded competency evaluations for practical performance	**Face-to-Face** Trauma upper extremity Average score – 99.1% Trauma lower extremity Average score – 98.4% Trauma shoulder Average score – 98.2% **MOODLE®** Trauma upper extremity Average score – 99.4% Trauma lower extremity Average score – 98.7% Trauma shoulder Average score – 99.5% $p = .6761$ – Trauma upper extremity $p = .8072$ – Trauma lower extremity $p = .1262$ – Trauma Shoulder
			Critical thinking trauma assignment	**Face-to-Face** Average Score – 91.45% **MOODLE®** Average Score – 83.79% $p = .0042$

Programmatic SLOs	Course Name	Learning Objective	Assessment Tool(S)	Results
The student will provide the patient with proper care during medical imaging procedures. This will include knowledge of body mechanics, patient immobilization, basic life support techniques, patient education for examinations, and	Clinic Radiographic Procedures II & III	Apply patient preparation for imaging procedures and answering questions concerning the procedure and proper explanation.	Graded Competency Evaluations for practical performance	**Face-to-Face** Trauma upper extremity Average score – 99.1% Trauma lower extremity Average score – 98.4% Trauma shoulder Average score – 98.2% **MOODLE®** Trauma upper extremity Average score – 99.4% Trauma lower extremity Average score – 98.7% Trauma shoulder

overall patient care of comfort				Average score – 99.5% *p = .6761* – Trauma upper extremity *p = .8072* – Trauma lower extremity *p = .1262* – Trauma Shoulder
The student will demonstrate knowledge of basic human anatomy and physiology, demonstrating the ability to radiographically identify anatomic structures and basic pathologic findings	Clinic Radiographic Procedures III Radiographic	Apply knowledge learned of anatomy to evaluate radiographic images per exam criteria. Apply knowledge obtained during clinical and class to pathological findings on imaging procedures	Critical thinking trauma assignment	**Face-to-Face** Average Score – 91.45% **MOODLE®** Average Score – 83.79% *p = .0042*

Table 6 Continued

Programmatic SLOs	Course Name	Learning Objective	Assessment Tool(S)	Results
The student will utilize problem solving skills and exercise independent thinking while performing medical imaging examinations	Clinic Radiographic Procedures II & III	Apply observed and taught skills to procedures outside normal positioning.	Graded competency evaluations for practical performance	**Face-to-Face** Trauma upper extremity Average score – 99.1% Trauma lower extremity Average score – 98.4 Trauma shoulder Average score – 98.2 **MOODLE®** Trauma upper extremity Average score – 99.4% Trauma lower extremity Average score – 98.7% Trauma shoulder Average score – 99.5% $p = .6761$ – Trauma upper extremity $p = .8072$ – Trauma lower extremity $p = .1262$ – Trauma Shoulder
			Critical thinking trauma assignment	**Face to Face** Average Score – 91.45% **MOODLE®** Average Score – 83.79% $p = .0042$

Additional Analysis

The results of the *t-test* evaluation of the graded critical thinking trauma assessment tool in each delivery format did not support the null hypothesis (H_{02}) which states, “There will be no statistically significant difference in written trauma critical thinking assessment scores of students taught via non-traditional course delivery and those taught by traditional methods.” The stated hypothesis that a significant difference in written critical thinking assessment scores of students taught via non-traditional course delivery and those taught by traditional methods from this research is supported when using the critical thinking assessment scores. Due to the difference found between the scores for the written assessment between the delivery formats, scores of a written quiz for trauma radiography were reviewed. Similar to the findings found between the critical thinking written assessment, the graded quizzes demonstrated a $p = .000234$. Thus it can be concluded that scores for didactic work were impacted by the delivery format.

Analyses conducted for the practical exam scores for trauma radiography in each delivery format did not reveal a significant difference. This finding is believed to be due to the grading method for the exam and the possible lack of objectivity involved. A summary of these findings including the link to each hypothesis demonstrates *p-value* $< .05$ for all practical assessments and a *p-value* $> .05$ for both the written critical thinking assessment and the quizzes related to trauma radiography. Due to this finding further research in this area is necessary.

Table 7

Statistical Link to Research Questions

Programmatic SLO	Assessment Tool	Statistical Finding *(t-test evaluation)*	Linked Null
The student will evaluate image quality, applying the knowledge of positioning and technical selection necessary for diagnostic images.	Graded competency evaluations for practical performance. Critical thinking trauma assignment. Trauma quizzes.	$p = <.05$ for all practical evaluations $p = .0042$ $p = .000234$	H_{01} H_{02}
The student will provide the patient with proper care during medical imaging procedures. This will include knowledge of body mechanics, patient immobilization, basic life support techniques, patient education for examinations, and overall patient care and comfort.	Graded competency evaluations for practical performance.	$p = <.05$ for all practical evaluations	H_{01}
The student will demonstrate knowledge of basic human anatomy and physiology, demonstrating the ability to radiographically identify anatomic structures and basic pathologic findings.	Critical thinking trauma assignment. Trauma quizzes.	$p = .0042$ $p = .000234$	H_{02}
The student will utilize problem solving skills and exercise independent thinking while performing medical imaging examinations.	Graded competency evaluations for practical performance. Critical thinking trauma assignment.	$p = <.05$ for all practical evaluations $p = .0042$	H_{01} H_{02}

Trauma quizzes.	*p* = *.000234*

CHAPTER FIVE: DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

Discussion

This study was prompted by the need for programs of associate degree Radiologic Technology to have evidence that non-traditional teaching methods are sufficient to meet student learning outcomes pertaining to primary clinic skills. Prior studies conducted by Alonso and Blaquez (2009) and Martino and Odle (2008) found no significant differences to be found in the course delivery method and learning outcomes. This study examined the effectiveness of non-traditional instruction as related to student learning outcomes in associate degree Radiologic Technology programs. The objectives selected are based upon having a clinical component needed for trauma radiography. Students from a prior semester were utilized for the data on traditional teaching methodologies. The MOODLE® instruction was for those students in the current semester of study. Each group of student data was from the third semester of enrollment into the program. This study is important due to the need for hands on teaching in programs of Radiologic Technology to effectively teach clinical outcomes. Student learning outcomes (SLOs) were identified as utilized programmatically for an associate degree program of Radiologic Technology. These SLOs were in accordance with accreditation standards set forth by the Joint Review Commission on Education in Radiologic Technology (JRCERT) and guided by programmatic and course objectives per the American Society of Radiologic Technology (ASRT) curriculum guide.

The use of independent *t-tests* revealed a statistical difference between critical thinking written assessment scores and the course delivery format. This finding rejects the stated null hypothesis related to written trauma critical thinking assessment scores that are linked to the programmatic SLOs and the relationship to teaching format. The finding presents an indicator that student learning outcomes for the program in this research are affected by the teaching format utilized.

A series of independent *t-test*s were also conducted for the trauma practical examinations including upper extremity, lower extremity and shoulder assessments, no significance was found for any of the three categories. This finding indicates the need for future research related to the clinical grading process. The practical evaluations are assessed by clinical instructors and staff which vary between each clinic site and lend to inconsistency in objectivity when grading. In contrast, the critical thinking written assessment was graded by the same faculty member with a standard rubric. The findings of the research did support the null hypothesis stating that a significant difference would not be found between results of the practical assessment(s) for trauma radiography for the traditional and non-traditional teaching format for students in Radiologic Technology. The study confirms the assessment of stated outcomes to be comparable in traditional and non-traditional formats. This finding is supported by other research conducted primarily in the area of didactic instruction (Alonso & Blaquez, 2009; Cook, 2007; Martino & Odle, 2008; Omar et al., 2011; Strickland, 2007).

The research conducted supports the theory of constructivism in which learners learn best by being an active part of the process. According to Anderson (2008), the theory of constructivism has surfaced as a leader in the world of non-traditional instruction. The theory of constructivism notes that learners learn best when the information can be applied for personal meaning. The research conducted supports the need for face-to-face instruction in improving critical thinking scores. This finding is not to say that non-traditional teaching cannot be conducted, it simply becomes necessary to assure instruction facilitates the use of varied methods to meet learning needs. Martino and Odle (2008) stated that a danger lies in assuming that lecture content can be converted to a new delivery method without attention to revision of content, assessment, technology used, or mode of delivery. This basis of the theory of distance education suggests the importance of interaction to the process of learning. Anderson (2008) discusses that a concern for online environments is the issue of how interaction is accomplished and how it is managed. Problems arise when traditional teaching methods are simply interchanged with non-traditional delivery. This problem is one non discipline specific and should be considered when any change in teaching formats are incorporated. Clinical assessments rely on interaction with patients and face-to-face exchange. Teaching in complete non-traditional methods cannot replace the interaction gained in real life clinic experiences.

Conclusions

The results of the research indicate a need to assure non-traditional instructional methods include all aspects of the traditional instructional methods. An area of concern continues to revolve around the interaction which takes place, or does not take place, when instructors and teachers are at a distance. While the idea believed by the researcher that the clinical area would show a significant difference in non-traditional and traditional formats was not supported, a significant difference was demonstrated in the area of critical thinking written assessment scores. These findings may support the need for closer evaluation of the grading procedures for clinic assessment. Clinical grading in most areas of Allied Health do not have consistency in the evaluators. Students are graded by clinical education designees who in many cases are employees of the clinical agency rather than the academic affiliate (Jette et al., 2014). This evaluative process may lead to inconsistencies in the assessment process.

A second area the research indicates as necessary is that of critical thinking assessment of students. Critical thinking skills should be integrated throughout the curriculum and are critical in health care programs. The curricula for nursing, for example, integrates critical thinking as an educational outcome (Simpson & Courtney, 2002). The student learning outcomes indicated for

Radiologic Technology also include assessment of a critical thinking component (Student Handbook, 2013). Due to these requirements instruction for critical thinking skills should assure learning objectives can adequately be met independent of the instructional format.

The research conducted was supportive of the needs of adult learning theory as stated by Knowles (1980) as well as Moore's theory of distance education (Moore, 1997). The need for a constructivist approach to teaching critical thinking skills as well as practical performance skills is also supported by the research. It is believed by the researcher that both the individual approach as well as the social approach to constructivist application can be used in education of Radiologic Technologists. These students must approach each patient interaction independently, however guided group activities as well as lab settings and group discussions will also aid in meeting stated student learning outcomes.

The results of student preference for teaching format in Radiologic Technology suggested 100% of the MOODLE® cohort preferred face-to-face instruction overall, with 90.0% of the face-to-face group preferring face-to-face as the format of choice specific to Radiologic Technology instruction. The demographics were not linked to the proposed hypotheses; however the data collected provides data for Radiologic Technology programs to utilize in assessing curricular needs and course delivery. This information may be useful when planning curricular delivery for overall programmatic success.

Implications

For programs of Radiologic Technology it may be necessary to review practical grading tools for valid and reliable tools as well as to review the method in which practical exams are graded. This study included a program in which practical examinations are graded by clinical instructors rather than a college faculty member. These individuals often have no educational experience and have not been trained with the grading tools or rubrics. In some cases these evaluators are reluctant to give poor grades, or will give a student a "second chance" (Luhanga, Yonge, & Myrick, 2008). Due to this trend, practical grades may not be reflective of a student's true performance ability; whereas, the assessment of the written critical thinking assignment was performed by the same academic faculty for all students.

The study has also shown that for written work, a relationship is found to exist between the grades and the delivery format. The results indicate a $p = .0042$ showing a significant difference between the delivery formats. This finding is not revealed when looking at the *p values* for the practical exams and the delivery format. The lowest *p value* of .1262 was demonstrated with the trauma shoulder exam and certainly does not indicate a significant difference to exist. This finding supports the need to more closely evaluate how practical exams are assessed. The written assessment was graded with a standard rubric with some noted validity. Additionally, the same academic faculty member did the grading for all critical thinking written work. This process was not the case with the practical assessment grading.

The written assessment for critical thinking appears to be closely tied to the mode of instruction. Thus the results would imply the need to assure non-traditional methods of instruction are adequate to meet stated student learning outcomes. Martino and Odle (2008) detail that in Radiologic Technology podcasts, online learning formats, hybrid courses, and computer aided education all have merit and effectiveness when instructing students of Radiologic Technology. Research does however warn that faculty need proper training and support when moving from traditional face to face teaching to incorporation of various technologies (Carey, 2001; Cook, 2007; Feyten & Nutta, 1999; Gibbs, 2004).

Limitations

The study was limited by the small size of the sample population which limits the use of results. Data from a prior semester was used for the traditional instructional setting in an effort to increase the sample size. The setting included only students in a small rural state college in the eastern United States. A large percentage of students at this college are first generation, non-traditional students. The non-traditional students for purposes of this study were considered to be 24 years of age or older and in many cases were in single parent agreements. The student population included approximately 10% transfer students from other colleges/universities. Another implied limitation was that of a nonrandom sample. Since it included only those students in the associate degree program of Radiologic Technology, the results were limited to this area of Allied Health and cannot be generalized to other programs of study or other institutions.

This sampling could be improved by utilizing more than one program of Radiologic Technology. The size of the sample does not provide strong support for either hypothesis presented in the study. The use of restricted enrollment programs limits the sample size. Other limitations to the sample include its non-random selection of participants. The external validity of the study is compromised due to the size of the sample groups. The results may not be applicable to other Allied Health programs and are limited to programs of Radiologic Technology using the same assessment tools and course evaluations tools. The lack of random assignment of the groups used for comparison threaten the internal validity of the findings. Additionally the sample size of the groups varied due to attrition in the MOODLE® cohort.

Other limitations include the practical grading tool and method. The tool utilized in the clinical setting for practical assessment is not a standardized instrument used by other programs of Radiologic Technology. Due to this lack of standardization the reliability of the grading tool limits the results of the study. It was found through the research that standard clinical grading tools are lacking in other Allied Health disciplines as well (Carpenter et al., 2013; Fydryszewski et al., 2010; Lekka et al., 2007; Simpson & Courtney, 2002). While these limitations were not one anticipated by the researcher, it certainly presents areas needing addressed to improve upon assessment of grading methodologies. Student evaluation in the clinical setting also necessitates consistency in grading to avoid objectivity between evaluators. Clinical instructors often vary and staff technologists grade students on real patient performance. This procedure raises a concern of the reliability of the assessment results. Persons involved in the grading process should be well trained in order to produce more consistent results in student evaluation.

Recommendations for Future Research

The onset of this research included a belief by the researcher that clinical objectives should not be taught via non-traditional (online) delivery. The findings of this study demonstrate a need for future research specifically in the area of clinical grading, to be conducted. The need for larger sample sizes is necessary to reproduce a study such as this one seeking to reveal a consistent structure for which assessment could occur. It should be noted that studies relevant to clinical teaching are needed in the field of Radiologic Technology to assure quality radiographers are entering the workplace. Since the clinical area is one in which face-to-face instruction is needed as found in this study as well as by Williams (2006) study of Allied Health programs, it is necessary to assure both teaching methodologies as well as grading procedures produce quality radiographers. Studies are needed to assure staff radiographers understand the grading process in order to reduce inflated grades.

The findings of the study did not find a strong correlation between mode of instruction and the practical graded assessments. These findings paired with the limitations present the need for future research in the area of consistent clinical grading procedures. The research previously found in the area of instructional delivery in programs of Radiologic Technology is related only to didactic courses. A gap is believed to exist for research data related to clinical assessment and grading procedures. This gap is specific to the field of Radiologic Technology however for other Allied Health programs similar findings may be found.

The need for critical thinking application in both written and practical assessment should be explored. As discussed within this text critical thinking skills are imperative to production of competent Radiologic Technologists, as well as other Allied Health professionals. Program officials and faculty should closely review non-traditional teaching methodologies to enhance areas where critical thinking assessment is involved.

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APPENDICES

APPENDIX A: JRCERT Standards (excerpt)

Standards for an Accredited Educational Program in Radiography

Effective January 1, 2011

Adopted by:
The Joint Review Committee on Education in Radiologic Technology - April 2010

Joint Review Committee on Education in Radiologic Technology 20 N. Wacker Drive, Suite 2850 Chicago, IL 60606-3182 312.704.5300 ● (Fax) 312.704.5304 www.jrcert.org The Joint Review Committee on Education in Radiologic Technology (JRCERT) is dedicated to excellence in education and to the quality and safety of patient care through the accreditation of educational programs in the radiologic sciences. The JRCERT is the only agency recognized by the United States Department of Education (USDE) and the Council on Higher Education Accreditation (CHEA) for the accreditation of traditional and distance delivery educational programs in radiography, radiation therapy, magnetic resonance, and medical dosimetry. The JRCERT awards accreditation to programs demonstrating substantial compliance with these **STANDARDS**.

Introductory Statement The Joint Review Committee on Education in Radiologic Technology (JRCERT) **Standards for an Accredited Educational Program in Radiography** are designed to promote academic excellence, patient safety, and quality healthcare. The **STANDARDS** require a program to articulate its purposes; to demonstrate that it has adequate human, physical, and financial resources effectively organized for the accomplishment of its purposes; to document its effectiveness in accomplishing these purposes; and to provide assurance that it can continue to meet accreditation standards. The JRCERT accreditation process offers a means of providing assurance to the public that a program meets specific quality standards. The process helps to maintain program quality and stimulates program improvement through program assessment. There are six (6) standards. Each standard is titled and includes a narrative statement supported by specific objectives. Each objective, in turn, includes the following clarifying elements:

• **Explanation -** provides clarification on the intent and key details of the objective.

• **Required Program Response -** requires the program to provide a brief narrative and/or documentation that demonstrates compliance with the objective.

• **Possible Site Visitor Evaluation Methods -** identifies additional materials that may be examined and personnel who may be interviewed by the site visitors at the time of the on-site evaluation to help determine if the program has met the particular objective. Review of additional materials and/or interviews with listed personnel is at the discretion of the site visit team.

Following each standard, the program must provide a **Summary** that includes the following:

• Major strengths related to the standard
• Major concerns related to the standard
• The program’s plan for addressing each concern identified
• Describe any progress already achieved in addressing each concern
• Describe any constraints in implementing improvements

The submitted narrative response and/or documentation, together with the results of the on-site evaluation conducted by the site visit team, will be used by the JRCERT Board of Directors in determining the program's compliance with the STANDARDS.

Standards for an Accredited Educational Program in Radiography
Table of Contents

Standard Three *Curriculum and Academic Practices*

Standard Three: The program's curriculum and academic practices prepare students for professional practice. Objectives: In support of Standard Three, the program: 3.1 Has a program mission statement that defines its purpose and scope and is periodically reevaluated. 3.2 Provides a well-structured, competency-based curriculum that prepares students to practice in the professional discipline. 3.3 Provides learning opportunities in current and developing imaging and/or therapeutic technologies. 3.4 Assures an appropriate relationship between program length and the subject matter taught for the terminal award offered. 3.5 Measures the length of all didactic and clinical courses in clock hours or credit hours. 3.6 Maintains a master plan of education. 3.7 Provides timely and supportive academic, behavioral, and clinical advisement to students enrolled in the program. 3.8 Documents that the responsibilities of faculty and clinical staff are delineated and performed. 3.9 Evaluates program faculty and clinical instructor performance regularly to assure instructional responsibilities are performed.

3.1 Has a program mission statement that defines its purpose and scope and is periodically reevaluated. ***Explanation:*** The program's mission statement should be consistent with that of its sponsoring institution. The program's mission statement should clearly define the purpose or intent toward which the program's efforts are directed. Periodic evaluation assures that the program's mission statement is effective. *Required Program Response:*
• Provide a copy of the program's mission statement.
• Provide meeting minutes that document periodic reevaluation of the mission statement.

3.2 Provides a well-structured, competency-based curriculum that prepares students to practice in the professional discipline. ***Explanation:*** The well-structured curriculum must be comprehensive, appropriately sequenced, include current information, and provide for evaluation of student achievement. A competency-based curriculum allows for effective student learning by providing a knowledge foundation prior to performance of procedures. Continual refinement of the competencies achieved is necessary so that students can demonstrate enhanced performance in a variety of situations and patient conditions. In essence, competency-based education is an ongoing process, not an end product. Programs must follow a JRCERT-adopted curriculum. An adopted curriculum is defined as:

- the latest American Society of Radiologic Technologists professional curriculum and/or
- another professional curriculum adopted by the JRCERT Board of Directors following review and recommendation by the JRCERT Standards Committee. Use of a standard curriculum promotes consistency in radiography education and prepares the student to practice in the professional discipline. At a minimum, the curriculum should promote qualities that are necessary for students/graduates to practice competently, make good decisions, assess situations, provide appropriate patient care, communicate effectively, and keep abreast of current advancements within the profession. Expansion of the curricular content beyond the minimum is at the discretion of the program.

The program must submit the latest curriculum analysis grid (available at www.jrcert.org). ***Required Program Response:***

- Describe how the program's curriculum is structured.
- Describe the program's competency-based system.
- Submit current curriculum analysis grid.
- Describe how the program's curriculum is delivered, including the method of delivery for distance education courses.
- Identify which courses, if any, are offered via distance education.
- Describe alternative learning options, if applicable (e.g., part-time, evening and/or weekend curricular track).

3.3 Provides learning opportunities in current and developing imaging and/or therapeutic technologies. ***Explanation:*** The program must provide learning opportunities in current and developing imaging and/or therapeutic technologies. It is the program's prerogative to decide which technologies should be included in the didactic and/or clinical curriculum. Programs are not required to offer clinical rotations in developing imaging and/or therapeutic technologies; however, these clinical rotations are strongly encouraged to enhance student learning. ***Required Program Response:*** Describe how the program provides opportunities in developing technologies in the didactic and/or clinical curriculum.

3.4 Assures an appropriate relationship between program length and the subject matter taught for the terminal award offered. ***Explanation:*** Program length must be consistent with the terminal award. The JRCERT defines program length as the duration of the program, which may be stated as total academic or calendar year(s), total semesters, trimesters, or quarters. ***Required Program Response:*** Describe the relationship between the program length and the terminal award offered.

3.5 Measures the length of all didactic and clinical courses in clock hours or credit hours.
Explanation: Defining the length of didactic and clinical courses facilitates student transfer of credit and the awarding of financial aid. The formula for calculating assigned clock/credit hours must be consistently applied for all didactic and all clinical courses, respectively. ***Required Program Response:***

- Describe the method used to award credit hours for lecture, laboratory and clinical courses.
- Provide a copy of the program's policies and procedures for determining credit hours and an example of how such policy has been applied to the program's coursework.
- Provide a list of all didactic and clinical courses with corresponding clock or credit hours.

3.6 Maintains a master plan of education. ***Explanation:*** A master plan provides an overview of the program and allows for continuity among, and documentation of, all aspects of the program. In the event of new faculty and/or leadership to the program, the master plan provides the information needed to understand the program and its operations. The plan should be evaluated annually, updated, and must include the following:
• Course syllabi (didactic and clinical courses) and
• Program policies and procedures.

While there is no prescribed format for the master plan, the component parts should be identified and readily available. If the components are not housed together, the program must list the location of each component. If the program chooses to use an electronic format, the components must be accessible by all program faculty. ***Required Program Response:***
• Identify the location of the component parts of the master plan of education.
• Provide a Table of Contents for the program's master plan.

3.7 Provides timely and supportive academic, behavioral, and clinical advisement to students enrolled in the program. ***Explanation:*** Appropriate advisement promotes student achievement. Student advisement should be formative, summative, and must be shared with students in a timely manner. Programs are encouraged to develop written advisement procedures. ***Required Program Response:***
• Describe procedures for advisement.
• Provide sample records of student advisement.

Summary for Standard Three 1. List the major strengths of **Standard Three**, in order of importance. 2. List the major concerns of **Standard Three**, in order of importance. 3. Provide the program's plan for addressing each concern identified. 4. Describe any progress already achieved in addressing each concern. 5. Describe any constraints in implementing improvements.

Standard Five ***Assessment***
Standard Five: The program develops and implements a system of planning and evaluation of student learning and program effectiveness outcomes in support of its mission. Objectives: In support of Standard Five, the program: Student Learning 5.1 Develops an assessment plan that, at a minimum, measures the program's student learning outcomes in relation to the following goals: clinical competence, critical thinking, professionalism, and communication skills. Program Effectiveness 5.2 Documents the following program effectiveness data:
• Five-year average credentialing examination pass rate of not less than 75 percent at first attempt,
• Five-year average job placement rate of not less than 75 percent within six months of graduation,
• Annual program completion rate,
• Graduate satisfaction, and
• Employer satisfaction.
5.3 Makes available to the general public program effectiveness data (credentialing examination pass rate, job placement rate, and program completion rate) on an annual basis. Analysis and Actions 5.4 Analyzes and shares student learning outcome data and program effectiveness data to foster continuous program improvement. 5.5 Periodically evaluates its assessment plan to assure continuous program improvement.

5.1 Develops an assessment plan that, at a minimum, measures the program's student learning outcomes in relation to the following goals: clinical competence, critical thinking, professionalism, and communication skills. ***Explanation:*** Assessment is the systematic collection, review, and use of information to improve student learning and educational quality. An assessment plan helps assure continuous improvement and accountability. Minimally, the plan must include a separate goal in relation to each of the following: clinical competence, critical thinking, professionalism, and communication skills. The plan must include student learning outcomes, measurement tools, benchmarks, and identify timeframes and parties responsible for data collection.
For additional information regarding assessment, please refer to www.jrcert.org. ***Required Program Response:*** Provide a copy of the program's current assessment plan.

5.2 Documents the following program effectiveness data:
• Five-year average credentialing examination pass rate of not less than 75 percent at first attempt,
• Five-year average job placement rate of not less than 75 percent within six months of graduation,
• Annual program completion rate,
• Graduate satisfaction, and
• Employer satisfaction.

Explanation: Credentialing examination, job placement, and program completion data must be reported annually on JRCERT Program Effectiveness Data (PED) form. Graduate and employer satisfaction data must be collected as part of the program's assessment process. Credentialing examination pass rate is defined as the number of graduates who pass, on first attempt, the American Registry of Radiologic Technologists certification examination or an unrestricted state licensing examination compared with the number of graduates who take the examination. Job placement rate is defined as the number of graduates employed in the radiologic sciences compared to the number of graduates actively seeking employment in the radiologic sciences. Program completion rate is calculated by dividing the number of students who complete the program within a cohort by the number who enrolled in the cohort initially and subsequently (for example, transfer students or re-admits). Students who leave or do not graduate on time for any reason, such as medical leave, personal choice, or course failure, are considered as not completing the program with the original cohort. *# of graduates in the cohort PCR =*
____ *# of students initially enrolled in cohort + # of transfer students or re-admits* Graduate and employer satisfaction may be measured through a variety of methods. The methods and timeframes for collection of the graduate and employer satisfaction data are the prerogative of the program. ***Required Program Response:***
• Provide a copy of the program's current PED form.
• Provide outcome data in relation to graduate and employer satisfaction.

5.3 Makes available to the general public program effectiveness data (credentialing examination pass rate, job placement rate, and program completion rate) on an annual basis. ***Explanation:*** Program accountability is enhanced by making its effectiveness data available to the program's communities of interest and the general public. The JRCERT will post five-year average credentialing examination pass rate, five-year average job placement rate, and annual program completion rate at www.jrcert.org. The program must publish the JRCERT URL (www.jrcert.org) to allow the public access to this data. ***Required Program Response:*** Provide samples of publications that document the availability of program effectiveness data via the JRCERT URL address.

5.4 Analyzes and shares student learning outcome data and program effectiveness data to foster continuous program improvement. ***Explanation:*** Analysis of student learning outcome data and program effectiveness data allows the program to identify strengths and areas for improvement to bring about systematic program improvement. This analysis also provides a means of accountability to communities of interest. It is the program's prerogative to determine its communities of interest. The analysis must be reviewed with the program's communities of interest. One method to accomplish this would be the development of an assessment committee. The composition of the assessment committee may be the program's advisory committee or a separate committee that focuses on the assessment process. The committee should be used to provide feedback on student achievement and assist the program with strategies for improving its effectiveness. This review should occur at least annually and must be formally documented.
For additional information regarding assessment, please refer to www.jrcert.org. ***Required Program Response:***

• Describe how the program analyzes student learning outcome data and program effectiveness data to identify areas for program improvement.
• Describe how the program shares its student learning outcome data and program effectiveness data with its communities of interest.
• Describe examples of changes that have resulted from the analysis of student learning outcome data and program effectiveness data and discuss how these changes have led to program improvement.
• Provide a copy of the program's actual student learning outcome data since the last accreditation award. This data may be documented on previous assessment plans or on a separate document.
• Provide documentation that student learning outcome data and program effectiveness data has been shared with communities of interest.

5.5 Periodically evaluates its assessment plan to assure continuous program improvement. ***Explanation:*** Identifying and implementing needed improvements in the assessment plan leads to programmatic improvement and renewal. As part of the assessment cycle, the program should review its assessment plan to assure that assessment measures are adequate and that the assessment process is effective in measuring student learning outcomes. At a minimum, this evaluation must occur at least every two years and be documented in meeting minutes.
For additional information regarding assessment, please refer to www.jrcert.org. ***Required Program Response:***

• Describe how this evaluation has occurred.
• Provide documentation that the plan is evaluated at least once every two years.

Summary for Standard Five 1. List the major strengths of **Standard Five**, in order of importance. 2. List the major concerns of **Standard Five**, in order of importance. 3. Provide the program's plan for addressing each concern identified. 4. Describe any progress already achieved in addressing each concern. 5. Describe any constraints in implementing improvements.64 Radiography

The JRCERT grants permission for the use of the standards to be published onto the Liberty University Digital Commons dissertation portal for the research conducted by Angela M. Lambert.

Chief Executive Officer

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JRCERT

Excellence in Education

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APPENDIX B: Program of Radiologic Technology Student Learning Outcomes

1. The student will utilize effective communication skills when interacting with the patient and other members of the health care team, demonstrating knowledge of both communication and critical thinking skills necessary to the profession.
2. The student will demonstrate ethical and professional behavior, practicing within the code of ethics and scope of practice for the profession.
3. The student will understand the function of medical image processing with demonstration of knowledge concerning various forms of image processing and determine the proper departmental sequence for proper filing or a completed image.
4. The student will evaluate image quality, applying the knowledge of positioning and technical selection necessary for diagnostic images.
5. The student will provide the patient with proper care during medical imaging procedures. This will include knowledge of body mechanics, patient immobilization, basic life support techniques, patient education for examinations, and overall patient care of comfort.
6. The student will demonstrate the proper methods of radiation protection and exposure selection with regard to the patient, the equipment, other personnel, and to oneself.
7. The student will demonstrate knowledge of basic human anatomy and physiology, demonstrating the ability to radiographically identify anatomic structures and basic pathologic findings.
8. The student will properly position the patient in correlation with medical imaging equipment for the production of a diagnostic image.

9. The student will demonstrate knowledge of radiation physics, understanding the basic operation and maintenance of radiographic equipment and the interactions of x-ray with matter.
10. The student will utilize problem solving skills and exercise independent thinking while performing medical imaging examinations.

Student handbook for radiologic technology students (2013).

You have permission to use the materials contained within the student handbook for Radiologic Technology including the Standards of the JRCERT for your research and publication as needed.

Program Director/Associate Professor

Radiologic Technology Programs

Bluefield State College

APPENDIX C: Critical Thinking (Trauma) Assessment

Critical Thinking Lab Assessment/Rubric

You have been provided a scenario and you will have a photo of that situation and will need to answer the following as completely as possible.

What positions/ projections must you do?

Specifically how you would go about achieving them? (Keeping in mind that Trauma usually requires something other than routine positioning)

CR entrance/ angulation (if any)
Basic Technical Factors
Breathing instructions (if any)
Don’t forget Radiation Protection criteria

IR size/ Placement
SID
And Marker Placement

Additionally you need to review the Trauma ppt. slides prior to completing this assignment.

CRITICAL THINKING ASSESSMENT – Grading Rubric

Goal #1 – Safety

	Exceptional (4 pts)	**Proficient; Meets Standards** (3 pts)	**Needs Improvement** (2 pts)	**Does Not Meet Standards** (1 pt)
Students will practice radiation protection (1, 50%)	The student discussed appropriate radiation protection measures 100% of the time.	The student discussed appropriate radiation protection measures 75% of the time.	The student discussed appropriate radiation protection measures 50% of the time.	The student does not discuss appropriate radiation protection measures.
Students initiate appropriate measures in an emergency situation. (1, 50%)	Student recognizes an emergency situation and includes appropriate measures to safely discharge the emergency situation.	Student recognizes an emergency situation but barely includes the appropriate measures to safely discharge the emergency situation.	Student recognizes an emergency situation but does not include appropriate measures to safely discharge the emergency situation.	Student is unable to recognize an emergency situation.

Goal #2 – Entry-level Technical Skills

	Exceptional (4 pts)	**Proficient; meets standards** (3 pts)	**Needs Improvement** (2 pts)	**Does not meet standards** (1 pt**)**
Students will provide clear instructions and explanation of examination. (1, 25%)	The student explained in detail about procedure needed	The student explained the procedure but neglected to inform of small none treating details.	The student Attempted to explain but neglected to inform of significant safety details.	The student does not give the appropriate explanation
Students will demonstrate proper positioning skills (1, 25%)	The student positions the patient correctly and utilizes anatomic landmarks while assessing and considering patient condition	The student positions the patient correctly but does not utilize anatomic landmarks.	The student positions the patient by utilizing anatomic landmarks, but neglects to position correctly.	The student does not position the patient correctly.
Students will demonstrate proper tube/part/film alignment. (1, 25%)	The student aligns the x-ray tube, centers the central ray and employs accurate angles.	The student aligns the x-ray tube, center the central ray, but misaligned the object.	The student aligns object, but misaligned the x-ray tube or the central ray.	The student does not align the x-ray tube, center the central ray or employ accurate angles.
Students will position patients efficiently and accurately. (1, 25%)	The student performs positioning efficiently and accurately.	The student performs positioning adequately	The student performs positioning efficiently, but lacks accuracy.	The student does not perform positioning efficiently or accurately.

Goal #3 – Radiographic Evaluation and Critical Thinking

	Exceptional (4 pts)	**Proficient; meets standards** (3 pts)	**Needs Improvement** (2 pts)	**Does not meet standards** **(**1 pt)
Students will evaluate radiographs in order to obtain quality films. (1, 33%)	The student will evaluate radiographs for quality including density, contrast, artifacts, and positioning. The student will be able to explain what changes need to be made, if any.	The student will evaluate radiographs for quality including density, contrast, artifacts, and positioning. The student is not able to explain what changes need to be made, if any.	The student will evaluate radiographs for quality including density, contrast, artifacts, and positioning. The student is not able to recognize poor quality.	The student does not have an understanding of what constitutes a quality radiograph.
Students will determine what technical factors are to be set including proper breathing techniques based on patients body habitus and/or trauma related injury.(1, 33%)	The student evaluates the patient properly and selects the most appropriate technical factors. The student explains why the option selected is the most appropriate.	The student uses relevant criteria to select the most appropriate option but does not completely explain why the option selected is the most appropriate.	The student selects technical factors that are not appropriate given the criteria.	The student does not have an understanding of technical factors.
Students will perform non routine examinations. (1, 33%)	The student selects the solution that is the most effective for overcoming the obstacle or constraint and accurately explains why it is the most effective of the possible solutions.	The student selects the solution that is the most effective for overcoming the obstacle or constraint but does not completely explain why it is the most effective of the possible solutions.	The student selects a solution that overcomes the obstacle or constraint but is not the most effective solution given the options.	The student selects a solution that does not overcome the obstacle or constraint.

Goal #4 – Communication

	Exceptional (4 pts)	**Proficient; Meets Standard** (3 pts)	**Needs Improvement** (2 pts)	**Does Not Meet Standard** (1 pt)
Students will demonstrate effective written communication . (1, 100%)	Uses effective written skills, (organization, content, presentation, formatting, and stylistic choices) that clearly convey meaning using language and conventions appropriate to the radiology discipline	Uses effective written skills (organization, content, presentation, formatting, and stylistic choices) that is generally clear but not does not reflect a clear grasp of the language and conventions of the radiology discipline .	Uses writing skills (organization, content, presentation, formatting, and stylistic choices) with an attempt to use the language and conventions of the radiology discipline, but fails to clearly convey meaning.	Does not use effective writing skills (organization, content, presentation, formatting, and stylistic choices).

APPENDIX D: Competency (Practical) Performance Evaluation –Criteria for Grading

Student Name ______________________ Date: __________ ID#_________

Clinic Ed Center: _________

Procedure: ___________________________ Pediatric: Yes ______ No _____

Final Grade: __________

Competency Completed: Day_____ Evening_____ Weekend_____

Projection(s): A: ____________ B: ____________ C: ____________

D: ____________ E: _____________

The criteria for grading should reflect only the objectives that the student completes. The space to the right of each performance objective should be marked as Y for yes, N for no, or N/S for not applicable. The clinical instructor will then take this criteria and place a numerical grade with it. This is designed to be an objective evaluation of the student's performance in the clinical setting.

I. Performance Evaluation (Patient Care) – 15%
Room Preparation

1. Verify that equipment is operational (33%)
2. Provide a clean and orderly work area (33%)
3. Obtain appropriate supplies for examination (34%)

Identify Patient and Self:

1. Identify Procedure(s) to be performed:*(30%)
2. Identify patient's name and age. (20%)
3. Identify patient location and mode of transportation (20%)
4. Select the correct patient.* (40%)

Assistance to Patient

1. Transport patient to appropriate imaging area (10%)
2. Verify if patient is properly prepared for exam (10%)
3. Maintain proper patient dignity and modesty/
   proper gowning and covering of patient (30%)
4. Provide assistance to radiographic table based on patient condition. (30%)
5. Dismiss patient properly. (20%)

Explanation of Procedure and Patient Rapport and Awareness:

1. The student instructs the patient in detail about procedure (15%)
2. Communicate with patient in a concerned professional manner, using effective non-verbal and verbal communication (posture, eye contact and facial expression) as well as appropriate listening skills. (15%)
3. Apply Universal/Standard precautions as established by the CDC and initiates proper measures in an emergency or difficult patient situation. (15%)
4. Provide proper instruction for moving and breathing. (15%)
5. Check patient's condition at regular intervals and provide for patient security if the patient is left alone in the radiographic room. (20%)
6. Acquire appropriate clinical patient history relating to the procedure(s) to include pathological conditions and/or possibility of pregnancy. (20%).

II. Performance Evaluation (Image Production) (85%)

Equipment Utilization	A	B	C	D	E
1. Maneuver the radiographic equipment utilizing the appropriate controls and locks. (20%)					
2. Selects and utilizes the proper image receptor and/or accessory equipment. (20%)					
3. Manipulate the image receptor as appropriate for accurate imaging (portrait or landscape, Bucky or Table Top). (20%)					
4. Uses immobilization devices as needed. (10%)					
5. Measure the patient and/or uses a technique chart. Asks technologist if unsure due to patient body habitus.(5%)					
6. Selects appropriate exposure factors considering patient condition and body habitus. (15%)					
7. Uses equipment so as to not exceed recommended safety guidelines. (10%)					
Positioning Skills	**A**	**B**	**C**	**D**	**E**
1. Position the patient. (15%)					
2. Position the anatomical area of interest. (25%)					
3. Correct placement of CR. (15%)					
4. Set the correct tube angle. (15%)					
5. Set the correct SID and OID. (15%)					
6. Projection is performed in a timely and efficient manner. (15%)					

Image Quality	A	B	C	D	E
1. Proper alignment of IR, tube and part. (15%)					
2. Patient aligned correctly. (15%)					
3. Proper use of appropriate markers. (Right, Left, Accessory) (15%)					
4. Patient information, exposure parameters and date identified. (10%)					
5. Image displays proper contrast, density, positioning, and no artifacts. (15%)					
6. Demonstrates ability to distinguish between acceptable/unacceptable images and can explain what changes need to be made if repeat necessary. (15%)					
7. Identifies anatomical structures and evaluates image for positioning evaluation criteria. (15%)					
Radiation Protection	A	B	C	D	E
1. Evidence of collimation when applicable. (20%)					
2. Provides gonadal shielding to patient and other involved in procedure for radiation protection, when applicable. * (40%)					
3. Projection repeated. (20%)					
4. Demonstrates ability to make adjustment for repeats. Demonstrates ability to make adjustment for repeats. (20%)					

***If these are not properly completed the students will be required to repeat the exam and this will be a failure.** OR/PORT

++ These apply to Computed Radiography. Specific guidelines for CR include the following: **Equipment Utilization** #3: Image receptor placed properly; #4: measurement for tomography only; #6: evaluate exposure index number for proper technique **Positioning Skills** #3: CR to center of image receptor **Image Quality** #1& #2: are critical for optimal image quality; #5: image processed under the correct parameters and/or technique **Radiation Protection** #3: this will include processing image receptor plates after exposure of the patient

Evaluator Comments:

____

____

____

Evaluator Signature:

____ **Date:**________________________

Student Comments:

____
____
____
____

Student Signature:

____ Date:___________________________

Moh/11-94 (effective date) Revision: 1-95/6-07/6-08/4-09/4-13

Student handbook for radiologic technology students (2013).

APPENDIX E: Demographic Data Sample

Overview of Research Study and Data Collection

This research is being conducted to identify if a relationship exists between non-traditional teaching methods and the results of student learning outcomes. The purpose of the research is to explore this relationship between non-traditional and traditional delivery and the level of competency obtained by associate degree Radiologic Technology students in each format.

The data gathered will be analyzed to demonstrate the correlation between course delivery format and graded outcomes.

In order to gather data for this research your graded assessment on clinical competency for trauma radiography as well as your trauma assignment and quiz will be used. All student identifying information will be removed from the assessments. The data collection will not affect your grade in the class.

To provide a summary of the demographics for students in this study please complete the information below and return to your instructor of this course.

DEMOGRAPHICS SURVEY

Age _____ 18 – 22 years

_____ 23 – 27 years

_____ 28 – 32 years

_____ 33 – 37 years

_____ 38 – 42 years

_____ above 43 years of age

Race/Ethniciy _____ Caucasian

_____ African American

_____ Asian/Pacific Islander

_____ Native/American Indian

_____ Hispanic/Latino

_____ Other (please specify)

Gender _____ Female

_____ Male

Education Level _____ High School diploma/GED

_____ Some college credit/no degree

_____ Vocational or technical training/certification(s)

_____ Associate degree

_____ Bachelor's Degree

_____ Other (please specify)

APPENDIX F: Emailed Survey Form

In regard to Student Learning which format do you feel best meets the needs of students in Radiologic Technology: _________________ face to face ____________________ online

Which type of instruction do you feel most meets your learning style:

Face to face with lecture only __________________

Face to face enhanced with MOODLE® __________________

Instruction only via MOODLE® __________________

APPENDIX G: IRB Approval Letter

LIBERTY UNIVERSITY.
INSTITUTIONAL REVIEW BOARD

February 11, 2014

Angela M. Lambert
IRB Exemption 1777.021114: The Correlation of Instructional Delivery and the Assessed Results of Student Learning Outcomes in Programs of Associate Degree Radiologic Technology

Dear Angela,

The Liberty University Institutional Review Board has reviewed your application in accordance with the Office for Human Research Protections (OHRP) and Food and Drug Administration (FDA) regulations and finds your study to be exempt from further IRB review. This means you may begin your research with the data safeguarding methods mentioned in your approved application, and that no further IRB oversight is required.

Your study falls under exemption category 46.101 (b)(2, 4), which identifies specific situations in which human participants research is exempt from the policy set forth in 45 CFR 46:

> (2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless:
> (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.
>
> (4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available or if the information is recorded by the investigator in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects.

Please note that this exemption only applies to your current research application, and that any changes to your protocol must be reported to the Liberty IRB for verification of continued exemption status. You may report these changes by submitting a change in protocol form or a new application to the IRB and referencing the above IRB Exemption number.

If you have any questions about this exemption, or need assistance in determining whether possible changes to your protocol would change your exemption status, please email us at irb@liberty.edu.

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