Student physical therapists' performance and perceptions of learning management system embedded multimedia instruction for psychomotor skill development

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by

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Abstract

Student physical therapists' performance and perceptions of learning management system embedded multimedia instruction for psychomotor skill development

This research examined the effectiveness of a learning management system (LMS) embedded instructional multimedia on musculoskeletal manual therapy psychomotor learning in physical therapy students. The traditional educational strategy for providing instruction for these psychomotor skills is live demonstration followed by student practice, which requires significant face-to-face class time. By contrast, the framework of this study used Elaboration Theory, which sequences key learning concepts hierarchically from simple to complex. In this study, half of the live demonstration manual therapy skills were replaced by LMS-embedded multimedia instruction. The skill demonstration was the simple component of the sequence increasing available classroom time for complex lessons.

After obtaining ethical approval from the University of St. Augustine for Health Sciences (USAHS) and the University of Liverpool, the study was conducted using a census sample. Two groups of students in the USAHS Doctor of Physical Therapy program were asked to participate in a fifteen-week study. Cohort one had 54 students, and cohort two had 59 students that agreed to participate. A mixed-methods sequential explanatory design was utilized. Two practical examinations given during the course measured student performance on psychomotor skills acquisition and compared the live demonstration and the LMS-embedded multimedia instruction. Two cohorts allowed for a balanced cross-over design for the practical examination comparison. At the end of the course, a questionnaire was administered, which was followed by a focus group discussion to assess the perceived student experience.

The mean scores on the practical examination were compared using a one-way repeated measures ANOVA. The results for the upper extremity manual therapy skills comparison demonstrate that the live demonstration instruction examination scores were slightly higher than the LMS-embedded multimedia instruction. While the differences were statistically significant, the partial eta squared value is small. The results of the lower extremity manual therapy skills comparison demonstrate that the live demonstration examination scores were slightly lower than the LMS-embedded multimedia instruction. However, the difference between these means is not statistically significant. These findings reveal similar outcomes for both instructional strategies on psychomotor examination tests.

The questionnaire showed that most of the students found the LMS-embedded multimedia instruction useful for review of skills and that it facilitated learning. The focus group discussions highlighted that the videos standardized expectations and made a review and practical examination preparation easier. The group further noted the importance of maintaining the allocated classroom time for practice and instructor feedback for these skills.

The findings of this study provide support for the use of educational technology in the application of Elaboration Theory to facilitate a student-centered classroom and provide time to train doctoral students in higher-order thinking such as the utilization of these psychomotor skills through case scenarios and problem-based learning.

Key Words

Educational technology, learning management system, multimedia, psychomotor learning, musculoskeletal manual therapy, physical therapy education

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This research process was a long journey, and similar to all meaningful ventures, the road was challenging at times. In retrospect, the difficulties that appeared to be hurdles enhanced my learning. I aim to use these lessons with future projects, which will hopefully engage my students and further refine their educational outcomes.

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I want to dedicate this manuscript to my children Katherine Rose (12) and Courtney May (10). I hope that you see the value in lifelong learning and pursuit of one's goals. I know that you can both achieve greatness. Follow your dreams.

Chapter 1: Introduction

Chapter One introduces the framework for this thesis in four sections. The first section describes the study's context, while the second considers the purpose of the study and benchmark research questions. The third and fourth sections offer an overview of the research approach and define applicable terminology, respectively. Subsequent chapters expand the literature review, further delineate methodology, as well as proffer and analyze study results and discuss the learning gained from this research.

1.1 Context

The use of technology in higher education continues to evolve and expand. Increasingly, educators are employing technology to transition traditional brick-and-mortar classrooms into modified learning spaces (Brooks, 2010) and blended-learning models (Tucker, 2013). Eighty-seven percent of academic faculty believe that educational technology improves student learning (Epper & Bates, 2001). These beliefs, however, are based on somewhat limited data. The 'best practices' related to the use of these technologies requires supportive research. This study endeavors to add to the body of knowledge associated with the efficacy of educational technology and higher education while also recognizing the importance of incorporating student preferences.

In a systematic review and meta-analysis of educational technology for health care professionals using Internet-based learning, some improved learning outcomes (Cook, Garside, Levinson, Dupras, & Montori, 2010). That said, other studies report that educational technology can impede student learning. Psychomotor learning among nursing students exhibited poorer outcomes using computer-assisted instruction (CAI) in the form of a CD-ROM video compared to live demonstration for blood pressure assessment (Bauer, Geront, & Huynh, 2001). These counterintuitive outcomes emphasize the need for continued study. Moreover, the type of educational technology used and instructional methods require specific definition. A large heterogeneity exists in educational technology studies, which limits direct comparisons and evidence syntheses (Cook, Garside, Levinson, Dupras, & Montori, 2010). Section 1.4 defines the terminology and instructional strategies used in this study.

Burbules and Callister (2000) state that the effectiveness of educational technology is dependent on the purpose and implementation. Moreover, the majority of educational technology literature has focused on the cognitive and affective domains of learning. Limited studies are available for the psychomotor domain (Papasterigiou, Pollatou, Theofylaktou, & Karadimou, 2014). Specific to physical therapy education, technology research for all learning domains is minimal despite its increased interest and use (Veneri & Gannotti, 2014). A systematic review demonstrated the availability of only 22 studies related to educational technology in this field of study (Macznik, Riberiro, & Baxter, 2015). While the use of technology in physical therapy education has increased over time, the cognitive learning domain is the most commonly assessed. The prevailing theme of multimedia instruction versus lecture comparison yields similar results for this learning domain in both the short and long term assessments (Adams, 2013; Barker, 1988; Bayliss & Warden, 2011; Campbell & Kohli, 1970; Ford, Mazzone, & Taylor, 2005; Jones, Dean, & Hui-Chan, 2010; Maring, Costello, & Plack, 2008; Plack, 2000; Smith, Jones, Cavanaugh, Venn, & Wilson, 2006; Thompson, 1987; Willett, Sharp, & Smith, 2008). That said, additional research is needed, especially for the psychomotor learning domain.

Psychomotor skills are essential for the practice of physical therapy. The Commission on Accreditation in Physical Therapy Education (CAPTE) has regular individual testing and evaluation of student performance of psychomotor skills as a required element (CAPTE, 2015).

The American Physical Therapy Association has included the assessment of joint integrity and mobility as psychomotor skills in which entry-level physical therapy graduates must demonstrate competency (APTA, 2010). These techniques are useful for the examination and treatment of patients, especially those with musculoskeletal conditions. The traditional instructional strategy for these skills is live demonstration followed by student practice. This study examines the use of learning management system (LMS) embedded instructional multimedia as the primary instructional strategy for teaching musculoskeletal psychomotor skills and assists in filling gaps in the literature.

An additional consideration for increasing the use of technology in physical therapy education is expanding the number of graduates in the field. According to the Bureau of Labor Statistics (2020), 247,700 physical therapists are working in the USA (Bureau of Labor Statistics, U.S. Department of Labor, 2020). Demand for physical therapists in the USA is projected to increase by 36 percent between 2012 and 2022 (Bureau of Labor Statistics, United States Department of Labor, 2014). The current entry-level qualification for a physical therapist is a professional doctorate. Potential students apply to programs after completion of an undergraduate degree and prerequisite coursework. The average length of the Doctor of Physical Therapy (DPT) curriculum is 123.8 weeks, with 88 weeks of didactic education and 35.8 weeks of supervised clinical experience. Additionally, the mean cohort size is 45 students (CAPTE, 2020).

The CAPTE (2020) reports that the USA has 255 accredited programs that offer a DPT degree; moreover, 54 institutions are currently developing programs. The increase in the number of programs links with the projected job market demand. This growth in student numbers necessitates a corresponding need for additional faculty. However, achieving adequate staffing in academic medicine is difficult (Lowenstein, Fernandez, & Crane, 2007). Commonly cited justification for the faculty shortfall include low salary compared to clinical work, limited professional opportunities, and difficulty balancing work and family responsibilities (Cropsey, Masho, Shiang, Sikka, & Kornstein, 2008; Radtka, 1993). Current open faculty positions for DPT programs is 166, representing 65 percent of schools; additionally, 48 new full-time faculty assignments are projected this year (CAPTE, 2020). The mismatch of student enrollment and available faculty requires more efficient educational strategies to meet societal demands. A technological solution could assist in enhancing educational efficiency, and thus, research about the best practices for its use is necessary.

This study was performed at the University of St. Augustine for Health Sciences (USAHS), which has a rich history in manual therapy. The Institute of Physical Therapy was established in 1979 by Stanley Paris (USAHS, 2020). During this time, the entry-level qualification for physical therapists in the USA was a bachelor's degree. The Institute offered a Master of Science in Orthopaedic Physical Therapy with a manual therapy emphasis for licensed physical therapists. When the entry-level qualification moved to a graduate level, a Master of Physical Therapy program was created. In 1997, the Institute changed its name to the USAHS to match its evolution, which now included other disciplines (USAHS, 2020). The university transitioned the entry-level physical therapy degree to a DPT in 2001 (USAHS, 2020).

The USAHS is the largest physical therapy program in the USA comprised of five campuses in three states: California, Florida, and Texas. The length of the DPT curriculum matches the mean program duration at 123.8 weeks. The size of the cohort is 65 students, which is larger than the mean; additionally, each campus enrolls three cohorts annually. This model increases the number of annual graduates compared to traditional institutions with once yearly enrollment. Given the larger class sizes and the number of cohorts, instructional efficiency is paramount. Throughout the university's growth and expansion, an emphasis has remained regarding an expectation of high-quality manual therapy skills of the school's graduates. Given the university's history, it is fitting that this study investigating different instructional strategies for manual therapy takes place at this institution.

1.2 Study Purpose and Guiding Research Questions

This study was conducted at the USAHS. The university's course outline for the DPT's program's clinical courses allocates three to four hours per week. Specific to the clinical course involved in this study, 57 percent of the face-to-face laboratory time with faculty is dedicated to the instruction and practice of manual therapy psychomotor skills. Moreover, a similar instructional strategy is utilized throughout the DPT curriculum. The significant time required to demonstrate these rudimentary, but necessary, psychomotor skills materially limits higher-level learning activities. Utilizing learning LMS-embedded instructional multimedia could function as the introduction of these skills, thus freeing class time for supplementary and equally necessary learning activities, including the application of these psychomotor skills through case scenarios and problem-based learning. Furthermore, this resource not only allows students to advance at their pace but provides opportunities for ongoing review by the instructor.

As previously mentioned, a paucity of literature exists regarding the use of educational technology as a primary instructional strategy for psychomotor skill development in physical therapy education. The majority of the available articles report no statistical difference in student performance using multimedia instruction compared to the traditional teaching strategy (Barker, 1988; Ford, Mazzone, & Taylor, 2005; Moore & Smith, 2012; Smith, Jones, Cavanaugh, Venn, & Wilson, 2006). However, van Duijn, Swanick, and Donald (2014) found improved performance in 25 percent of the skills for the face-to-face group. Given the limited number of studies, the effectiveness of multimedia instruction as a primary instructional strategy for psychomotor skill development needs further examination within the context of DPT education.

Research questions.

The focus of this study is to determine the effectiveness of LMS-embedded multimedia as the primary instructional strategy for psychomotor musculoskeletal manual skills development. Additionally, the perceptions of physical therapy students toward the use of this instructional strategy are explored. Thus, three research questions guide the study:

1. What is the difference in learning outcomes between LMS-embedded multimedia versus live demonstration as an instructional strategy for manual therapy psychomotor skills in physical therapy education?
2. How does LMS-embedded instructional multimedia affect psychomotor skill performance?
3. What is the student perception for using LMS-embedded instructional multimedia?

These questions were investigated using student scores on psychomotor examinations, as well as reactions and feedback garnered via a questionnaire. A qualitative analysis of the open-ended questions comprising the questionnaire was performed and augmented by follow up focus group discussions. A methodological overview is presented in the next section.

1.3 Research Approach

This research study utilized a mixed-methods explanatory design and a census sample. Students at the San Marcos, California campus of the USAHS enrolled in the course entitled PHT 5134C (Musculoskeletal III: Advanced Extremity Examination, Evaluation, and

Manipulation) were invited to participate in the study. The above-cited course instructs students in a range of manual therapy psychomotor skills for the appendicular skeleton. This study compares two different instructional strategies for these skills.

The study's initial component was a crossover approach with two sequences and twelve periods, which is balanced in uniformity. The sequence and period allocation are further discussed in Chapter Three. Live demonstration and LMS-embedded instructional multimedia were employed to instruct students in the application of psychomotor manual therapy skills for six body regions. Student performance on two psychomotor examinations compared outcomes for each instructional strategy.

A questionnaire was administered following the psychomotor performance examination to compare student perceptions of the learning strategy. Although the questionnaire has not been validated, it has been used in prior studies that investigated the use of educational technology in physical therapy education. In addition to gathering student perceptions about the learning strategy, the results of the questionnaire helped to refine the quantitative analysis.

The study's second component was qualitative analysis. Toward that end, the focus group discussion was conducted to measure the understanding of student perceptions. Qualitative analysis of the focus group provides a basis for interpreting the findings of the study's quantitative elements.

1.4 Terminology

The following definitions apply to each instructional strategy utilized in the study:

The **live demonstration** involves the instructor's performance of a psychomotor skill in front of the students in a classroom setting. Following the instruction, the students practiced the skills in pairs. Faculty oversight and feedback are provided during this practice time. The sequence, faculty demonstration, study practice, and faculty oversight and feedback are repeated for each of the subsequent manual therapy techniques. This pedagogical strategy is the usual and customary approach adopted for psychomotor instruction at the USAHS.

The **LMS-embedded multimedia instruction** employed a flipped-classroom approach using a video of the course instructor performing the applicable skill. This study uses the web-based instructional configurations definitions from Cook, Garside, Levinson, Dupras, and Montori (2010) for LMS and multimedia:

- LMS is a software platform that offers tools for site security and user identification, posting course resources, online discussions, and testing.
- Multimedia comes in different content forms such as text, sound, still images, animations, or video.

Each technique was filmed, and this video was embedded in Blackboard, the LMS available at USAHS. Each video was accompanied by text describing the technique. Participants were required to view the videos in advance of the face-to-face class time. With this approach, the instructor did not perform live demonstrations of these techniques. However, the procedure used in the live demonstration approach—student pairing and practice and instructor observation with feedback—continued to be followed.

The psychomotor learning domain is the primary focus of this study, and the definition and taxonomies are included in the following section. A review of learning domains should discuss Bloom's taxonomy as it was instrumental in the early definitions and remains an important source of information for educators. The original publication focused on the cognitive learning domain and included early work and planning for future work in the affective domain. While the psychomotor domain was documented, the handbook recognized a limitation in secondary schools and colleges in this area and believed that classification of objectives was not useful at this time (Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956).

Psychomotor learning is categorized by progressive physical skill performance. The overarching objective is the physical encoding of information with movement (Wilson, 2019). Building on the early work of Bloom and others, three psychomotor learning domain taxonomies were developed in the 1970's. Each taxonomy has defined levels of psychomotor development, which are illustrated in Table 1.1.

Table 1.1

Summary of the psychomotor learning domain taxonomies

Dave (1970)	
1. Imitate	The observation of a skill and attempts to repeat it
2. Manipulate	Performing the skill following general instructions
3. Precision	The ability to independently perform the skill
4. Articulation	The ability to modify the skill for new situations
5. Naturalization	The ability to perform one or more skills consistently and with ease
Harrow (1972)	
1. Basic-fundamental movements	Locomotion and manipulative movements
2. Perceptual abilities	Kinesthetic, visual, auditory and tactile discrimination, and coordinated movements
3. Physical abilities	Endurance, strength, flexibility, and agility
4. Skilled movements	Simple, compound, and complex adaptive skills
5. Nondiscursive communication	Expressive and interpretive movement
Simpson (1972)	
1. Perception	The ability to use sensory cues to guide physical activity
2. Set	The readiness to act where the learner demonstrates awareness needed to perform the skill.
3. Guided response	The ability to imitate complex skills
4. Mechanism	The ability to perform a complex motor skill
5. Complex overt response	The ability to perform complex motor skills correctly.
6. Adaptation	The learner can modify the skill to fit a new situation.
7. Origination	The ability to develop an original skill that replaces the original

All of these frameworks classify observation, imitation, practice, and habit as progressive learning stages (Thoirs & Coffee, 2012). Dawson (1998) developed another psychomotor taxonomy and described four stages: observation, refinement, consolidation, and mastery. This newer framework aligns with professions that require manual dexterity, including laboratory practice and surgery (Cooper & Higgins, 2014).

Applying Dawson's framework to this study, the observation stage is achieved through both the live demonstration and LMS-embedded multimedia instruction. Both instructional strategies provide students with a preview of the expected outcome. This difference in the primary instruction during the observation phase is a centerpiece to this study. The student pairing and practice with instructor observation and feedback represents the refinement stage. For this study, the amount of face-to-face time allocated for student practice of these skills was the same. These laboratory sessions were fixed and occurred twice weekly for ninety minutes.

Consolidation occurs when the student can perform manual therapy skills correctly over time. Two practical examinations assessed the student's skill performance with the first one occurring at the midway point and second at the end of the semester. The grading rubric checklist for those examinations is available in Appendix A. The USAHS's grading criteria require a minimum of 80 percent on clinically related practical examinations to achieve a passing grade; additionally, the student must meet 100 percent competency for all safety requirements (USAHS, 2019).

Mastery of these techniques occurs during the student's fieldwork through practice on real patients under the supervision of a clinical instructor and continues throughout their clinical practice. The physical therapy education programmatic accrediting body, CAPTE, does not have a set standard number of laboratory practice hours. That said, students are expected to be safe and competent with these skills before clinical fieldwork begins. The consolidation stage assessment is one measure of student readiness. This study examines psychomotor skill acquisition from the observation through the consolidation stages of Dawson's taxonomy.

While this study does not extend into the mastery stage of psychomotor learning, a brief discussion of this phase is warranted. The amount of deliberate practice to become an expert was popularized by Malcom Gladwell (2008) in his book "Outliers: The Story of Success" as 10,000 hours. Expert skill performance has been linked with deliberate practice and reported in the literature for mathematics (Webb, 1975), music (Sosniak, 1985), and sports (French & Thomas, 1987). Additionally, Feltovich, Johnson, Moller, and Swanson (1984) linked a positive relationship for diagnostic expertise in medicine. Ericsson, Krampe, and Tesch-Romer (1993) published a theoretical framework for the acquisition of expert performance. These authors state that deliberate practice extends over at least ten years and requires optimization of resource, motivation, and effort constraints (Ericsson, Krampe, & Tesch-Romer, 1993). That said, all available evidence does not support their assertion that performances differences are largely due to deliberate practice.

A recent meta-analysis concluded that deliberate practice is important; however, the volume of practice did not account for all performance variance. Specifically, deliberate practice explained 26 percent of the variance in performance for games, 21 percent for music, 18 percent for sports, four percent for education, and under one percent for professions (Macnamara, Hambrick, & Oswald, 2014). Certainly, studies that investigate individual and situational factors related to deliberate practice will further explain performance variance, but these questions are beyond the scope of this thesis. Moreover, this framework does not tell us how long it takes for the novice to achieve entry-level competence.

1.5 Thesis Structure

The remainder of the thesis consists of four chapters. Chapter Two presents a literature review with an emphasis on educational technology within physical therapy education. Particular attention is given to a review of psychomotor skills instruction for other medical disciplines. Also, the framework for skill instruction is found in Chapter Two. Chapter Three discusses the relevant methodology. The collected data results and the analytical framework are presented in Chapter Four. The concluding Chapter Five tenders a review of the study's findings in relation to the literature, and a discussion of the implications of the use of multimedia for psychomotor skills instruction with students engaged in the discipline of physical therapy.

Chapter 2: Literature Review

The available literature evaluating the use of multimedia instruction within physical therapy education is limited, especially pertaining to psychomotor learning. This chapter presents a five-part examination of the use of educational technology in higher education as well as users' perceptions. The first section reviews five decades of physical therapy education studies related to psychomotor skill acquisition using educational technology. Also, postbaccalaureate healthcare professions are included as the age, degree level, and intent of the skills are similar. In the few instances that undergraduate degree studies are reviewed, their inclusion was due to similarity of skills, specifically joint accessory techniques. The second section reports on the perceptions of students enrolled in healthcare degree programs regarding multimedia instruction. As expected, the type of multimedia varied as technology advanced. Thirty-five-millimeter projector slides were the format used in the early studies. Over time, the technology transitioned to CD-ROM and interactive DVD multimedia. The more recent articles reflected the use of online resources such as LMS multimedia and mobile device applications. The third section discusses gaps in the literature and frames this study's necessity, and the fourth and fifth sections describe the framework for the psychomotor skill instruction, Elaboration Theory, and summarizes Chapter 2, respectively.

2.1 Educational Technology Use for Psychomotor Skill Development in Physical Therapy Education and Other Healthcare Professions

The earliest educational technology study of physical therapy student instruction was performed nearly fifty years ago. Campbell and Kohli (1970) studied an audio-tutorial approach to goniometry in forty physical therapy students. Participants were randomly assigned to a conventional instruction group or the experimental audio-tutorial group. The conventional instruction group received live demonstration and dedicated laboratory practice. The experimental group listened to audio recordings that were linked with 35-millimeter projector slides illustrating the range of motion measurement techniques under consideration. Both cognitive and psychomotor skill acquisition were assessed. The results indicated similar outcomes for each group in both the cognitive and psychomotor assessments; however, the authors noted increased instructor efficiency using this educational technology (Campbell & Kohli, 1970).

The available technology used in the 1970s differs from the audio and video recordings available today and hinders direct comparison. That said, this study is the first to investigate audio instruction with projector slides in physical therapy education for psychomotor skill development and provides historical context. The number of participants in the experimental group was 20, and several tests were not used because the wrong extremity was measured, further decreasing the sample. This small sample impacts the study's power.

Moreover, the goniometric measurement for a joint range of motion assessment is a basic skill, and only three skills were compared. To that end, it is difficult to use this study as a reference point for the more complex joint accessory assessments, especially with the limited number of participants and skills. The study's population was also younger than current physical therapy students. The age variance is most likely due to the entry-level qualification being credential or bachelor's degree in the 1970s as opposed to the current professional doctorate.

Nearly twenty years passed before the next educational technology study for psychomotor skill acquisition was performed for physical therapy education. Barker (1988) studied the effectiveness of interactive videodisc compared to lecture-demonstration instruction on the topic of sliding board transfers. To my knowledge, this study is the first one to examine video capture technology and the psychomotor domain of learning in physical therapy education.

Forty-five physical therapy students were randomly assigned to one of three groups: videodisc instruction, lecture-demonstration, and a control group that did not receive any instruction. Of note, the videodisc was not available for viewing outside of the class instructional time. Pretest, posttest, and a four-week delayed posttest written examination scores were compared. The videodisc and lecture-demonstration groups were also graded on their performance of a sliding board transfer immediately after instruction and four weeks later. Similar to Campbell and Kohli (1970), no differences in written examination scores or the psychomotor performance domain were noted between the videodisc instruction and live demonstration groups (Barker, 1988).

Differences in the study population are similar to Campbell and Kohli (1970) regarding the degree program and participant age. The entry-level qualification for a physical therapist during this time was a bachelor's degree, and the reported average age of the participants was 18.6 years old, which makes the Barker (1988) study population younger than current physical therapy students. Limitations include the experimental group, which was small (n=15), and only one simplistic psychomotor skill was studied. Despite these limitations, this study provides some early evidence for using video instruction for basic psychomotor skills instruction for physical therapy students.

Toth-Cohen (1995) examined the use of multimedia software instruction in applied anatomy and kinesiology classes for 86 occupational therapy students at two universities. The software was available on a desktop computer at each institution. A control group utilized textbook instruction for the same material. Examination scores were compared. In one of the two experimental groups, higher test scores were observed using the multimedia. This study postulated that improved learning outcomes might be achieved using multimedia when compared to textbook instruction. That said, the small sample size and narrow grade range demonstrate a low post-hoc power analysis. The study design did not include live demonstrations, so a comparison to this instructional strategy cannot be performed.

Basic surgical skills training using CD-ROM multimedia and simulated tissue models were studied for 72 medical students (Kneebone & ApSimon, 2001). This study used animations and video demonstrations to teach ellipse excision and wound closure in groups of 12 with instructor feedback. Each student also attended a self-directed learning session. Observation and group interviews were combined with performance assessments. The psychomotor assessments produced an acceptable performance of the skills, and a one month follow up revealed no significant decline. These findings extend the comparable learning outcomes using instructional multimedia reported by Barker (1988) and Campbell and Kohli (1970) to the postbaccalaureate student population. However, the results of the Objective Structured Assessment of Technical Skills were not listed in the article or compared to a control group. Thus, a direct comparison of instructional multimedia and live demonstration cannot be made. It should also be noted that this study investigated a small number of skills using multimedia instruction.

Howerton, Enrique, Ludlow, and Tyndall (2004) compared CAI in the form of an interactive CD, and face-to-face demonstration for 75 dentistry students enrolled in a radiology course. Three groups of students were randomly assigned to instructional multimedia, lecture instruction, and both multimedia and lecture instruction groups. Pre and posttests compared learning outcomes. No statistical difference in student learning outcomes was reported, which is similar to other studies (Barker, 1988; Campbell & Kohli, 1970). Moreover, this degree program is a postbaccalaureate level. The findings agree with Kneebone and ApSimon (2001) concerning the development of psychomotor skills development using multimedia for this student population. The limitations of small sample size and narrow grade distribution reveal a low post-hoc power analysis, which affects the generalization of these findings.

Sanddal, et al. (2004) performed a randomized, prospective, multisite comparison of pediatric prehospital training methods for 140 emergency medical responders from 12 sites. While this study was not conducted in a university setting, it examines the use of multimedia instruction for psychomotor skill development over 12 months for the adult learner. The training was either an interactive CD-ROM or standard classroom instruction using a train-the-trainer model. Written, practical performance, and combined scores compared the two groups. No differences were noted in the written examinations between groups. The performance and combined scores were higher in the CD-ROM group. This finding contrasts Barker (1988), Campbell and Kohli (1970), and Howerton, Enrique, Ludlow, and Tyndall (2004), who all reported similar outcomes between live demonstration and multimedia instruction. The authors concluded that CD-ROM training shows promise for improving performance. This study had a high attrition rate, which may affect the results. Additionally, several of the control group sites had additional local pediatric training not affiliated with the study, further impacting the posttest scores.

Ford, Mazzone, and Taylor (2005) compared classroom demonstration, CAI, and self-study with a textbook. Two cohorts of physical therapy students participated in the study representing 43 total participants. The students were randomly assigned to one of the following four groups: CAI, live demonstration, textbook, and control. The CAI used in this study was a digitally captured audio and video segment. The students viewed the skill performance on a desktop computer for two 25-minute instructional sessions, and the students did not have access to these videos outside of this time. Student performance of orthopaedic special tests was assessed after instruction using one of the three methods. Both written and practical examination scores were compared for each group. Results were similar for the class demonstration and CAI groups supporting earlier studies (Barker, 1988; Campbell & Kohli, 1970; Howerton, Enrique, Ludlow, & Tyndall, 2004). Additionally, students taught using both instructional strategies achieved higher performance scores than students in the self-study group using a textbook. The authors noted a benefit to the self-paced and repeated exposure to the content (Ford, Mazzone, & Taylor, 2005).

Again, this study had limitations regarding the number of assessed skills and small experimental group (n=11). That said, a more complex psychomotor skill was investigated, which builds on the basic skills from the previous studies. Specifically, the Clunk Test relates to accessory mobility assessment of the shoulder. Unfortunately, the three other skills were not explicitly reported. Additionally, the available class time for student practice with instructor feedback was not defined for either group.

The entry-level qualification in 2005 was a DPT, and the average age of the students in the Ford, Mazzone, and Taylor (2005) study was 21.8 years. This average is older than both the Campbell and Kohli (1970) and Barker (1988) studies reflecting the increased requirements of an undergraduate degree before enrolling in a DPT program. It should be noted that currently, the average age for physical therapy students at the time of admission is 23 years (Physical Therapist Centralized Application Service, 2019). The difference in the entry-level qualification and increasing student age may impact the transferability of these early studies to today's physical therapy students.

Xeroulis, et al. (2007) investigated computer-based video instruction for basic surgical techniques, including suturing and instrument knot-tying in a group of 60 medical students. The students performed a pre-test, were assigned to live demonstration or computer-based video instruction groups, and reassessed with an immediate and one-month follow-up posttest. No difference in the rate of student learning was noted between the groups, which is consistent with Barker (1988), Campbell and Kohli (1970), Ford, Mazzone, and Taylor (2005), and Howerton, Enrique, Ludlow, and Tyndall (2004). This study further supports Howerton, Enrique, Ludlow, and Tyndall (2004) and Kneebone and ApSimon (2001) report of comparable findings for the postbaccalaureate student population. These researchers concluded that computer-based video instruction could improve faculty efficiency and augment basic surgical skill training. The study examined a small number of techniques over a short duration and doesn't answer the question concerning the long-term use of multimedia instruction for psychomotor skill development.

The effectiveness of online video use for teaching clinical skills was studied by Kelly, Lyng, McGrath, and Cannon (2009). Fourteen of 204 students volunteered for the assessment part of the study. These students were randomly assigned to the control and experimental groups. The control was taught three skills, peak flow meter, incentive spirometry use, and pulse oximetry, using lecturer demonstration followed by practice. This group did not have access to the videos that were used to teach the experimental group these same three skills. The experimental group had access to the videos throughout the study and could view the material as many times as they wanted. Additionally, this group had the same classroom time allocated for practice. Performance outcomes were assessed one week after the instruction in an OSCE format, and student knowledge was tested using a multiple-choice posttest. The results indicated no difference in skill performance or knowledge between the groups. This study adds to evidence of similar learning outcomes for instructional multimedia and live demonstration in physical therapy education. That said, the sample size was small, and only 6.8 percent of the class volunteered to participate in the study. This selection bias could impact the results.

Others have reported similar learning outcomes for using video instruction and live demonstrations in physical therapy education. Smith, Jones, Cavanaugh, Venn, and Wilson (2006) examined the effectiveness of instructional multimedia in the performance of clinical orthopaedic techniques for the knee and ankle. This study had 46 participants from two physical therapist programs. Students were randomly assigned to the experimental and control groups. The experimental group received an instructional CD-ROM illustrating the knee and ankle skills. Students then augmented the multimedia instruction with laboratory class time for practice and instructor feedback. Live demonstration and practice with instructor feedback served as instruction for students in the control group. Written and practical examination scores for these groups were compared. Each instructional strategy demonstrated equal effectiveness, indicating CD-ROM multimedia instruction as a viable alternative to traditional methods (Smith, Cavanaugh, Jones, Venn, & Wilson, 2006).

This study expanded the use of video as the primary instructional strategy for psychomotor skills development in physical therapy education. The number of skills taught using the CD-ROM multimedia included 43 techniques for the ankle, foot, and knee body regions. This total is considerably larger than previous studies that examined one to four skills. The duration that students used multimedia instruction increased to five weeks representing one-third of the semester, which is the most extended study length to date. Moreover, the complexity of the techniques was at a higher level than previous studies and included joint accessory mobility assessments.

The cross-over design of this study allowed for a larger experimental group sample size of 48 participants. The participants' age resembles current physical therapy students with the mean age of 24.69 and 25.13 years for groups one and two, respectively. However, the voluntary participation rate of 57.69 percent is a limitation. Group one had 24 of 30 students agree to participate, and 21 of 48 students in group two volunteered. Additionally, nine participants withdrew from the study before completion. The number of students that opted out of the study participation and high attrition rate are limitations.

Arroyo-Morales, et al. (2012) researched the cognitive and psychomotor learning for ultrasound imaging and palpation to the knee. Forty-six physical therapy students were divided into two groups. One group was provided with an e-learning supplement, including a video of the technique and a self-assessment questionnaire, while the other group served as the control. A structured, objective clinical examination, and multiple-choice questionnaire were used to compare the groups. No difference between the groups was noted regarding the theoretical knowledge. However, the group that utilized educational technology required less time to palpate and achieved higher scores for positioning and managing the ultrasound probe (Arroyo-Morales, et al., 2012). The authors concluded that e-learning supplements are an effective educational strategy for palpation and ultrasound skill acquisition of physical therapy students.

In a similar study related to palpation and ultrasound imaging skills to the lumbar spine, Cantarero-Villanueva, et al. (2012) reported higher performance scores for students in the group taught using educational technology versus the control group strategy. Seventy-four physical therapy students were randomly assigned to the two groups. The e-learning group received online access to a musculoskeletal palpation and ultrasound assessment website, and the control group was provided with documents and books on the topic. Both groups received the same classroom instruction on these topics. The groups were compared using an OSCE style assessment for palpation and ultrasound imaging skills. The e-learning group's OSCE scores were significantly higher, and the group required less time to complete the test. The authors concluded that e-learning, when used as an adjunctive tool, reinforces the acquisition of skills needed to perform palpation and ultrasound imaging of the lumbar spine in physical therapy students (Cantarero-Villanueva, et al., 2012). Of note, this study's findings concerning higher scores with multimedia instruction over the textbook correlated with the results of Ford, Mazzone, and Taylor (2005).

Both the Arroyo-Morales, et al. (2012) and Cantarero-Villanueva, et al. (2012) studies were conducted at the University of Granada in Spain. Some differences exist between the USA and Spain regarding physical therapists or physiotherapists' education. The DPT degree is the entry-level qualification in the USA, while Spain has a bachelor's degree standard (World Physiotherapy, 2019). This difference accounts for the younger age of the University of Granada students, which was 21.5 and 20.17 years in these two studies. Similar to Campbell and Kohli (1970) and Barker (1988), the transferability of these findings are challenged with the younger age and degree differences compared to current physical therapy students in the USA. Also, these articles reported on a single body region with the classroom and e-supplemental instruction occurring within a three week period. Cantaero-Villanueva, et al. (2012) further indicate that the novelty of teaching strategy could have positively influenced the results. This possibility may impact student learning when extending for a longer duration within the term or curriculum.

Preston et al. (2012) also examined the use of online video clips and supportive text resources to enhance physical therapy students' performance on a neurological skills practical examination. Experimental and control groups were formed from the 59 participants. In addition to the traditional teaching strategy, the experimental group received online access to videos and text of the techniques. Higher practical examination scores were noted for students in the group using education technology. The authors further reported that the improvement in scores was primarily linked with the students' rationale for the practical skill and effective performance, which may be reflective of improved clinical reasoning and skill performance (Preston, et al., 2012). The described results support those of Arroyo-Morales, et al. (2012) and Cantarero-Villanueva, et al. (2012). Moreover, the students considered the online resources to be a valuable learning tool, as indicated by survey responses.

The experimental group had more participants than most of the previously reviewed articles at 35, and the age average of 25 years is closely aligned with current DPT students. However, this sample size was small for statistical analysis. The authors report that 162 participants were necessary for adequate power. Another limitation is that the practical examination proctors were not blinded to the instructional strategy. Examiner bias could impact the study results. This study's findings reinforce the presumed hypothesis that online video clips, when used as an adjunct to traditional teaching strategies, enhance student learning outcomes. However, a comparison of means did not reveal a statistical difference between groups. While the use of supplemental instructional multimedia is not the focus of this thesis, the Arroyo-Morales, et al. (2012), Cantarero-Villanueva, et al. (2012) and Preston, et al. (2012) articles are the first to examine internet-based video instruction for physical therapy education. Moreover, these articles provide insight into the impact of video instruction that is available outside of the classroom.

Moore and Smith (2012) investigated the effects of video podcasting on psychomotor and cognitive performance, attitudes, and study behavior of 33 student physical therapists over three weeks. Sixteen video podcasts were created, illustrating eight transfer techniques and eight gait training techniques. In a crossover design, half of the students were instructed on transfer skills using lecture and live demonstration, while the other half used both lecture and video demonstration. The assignment of live demonstration or video demonstration was reversed in the gait training skills. The podcasts were available to the participants throughout the study and could be viewed on their personal computers and appropriate hand-held devices. The students were assessed using a written post-test and scenario-based practical post-test format for psychomotor skills. The results of the study revealed similar scores for each learning strategy. These findings are consistent with Barker (1988), Campbell and Kohl (1970), Ford, Mazzone, and Taylor (2005), Howerton, Enrique, Ludlow, and Tyndall (2004), Kelly, Lyng, McGrath, and Cannon, 2009, Smith, Cavanaugh, Jones, Venn, and Wilson (2006), and Xeroulis, et al. (2007). The author's concluded that podcasting appears to be a reasonable alternative to live demonstration for instructing physical therapy students in basic transfer and gait training skills (Moore & Smith, 2012).

Limitations of this study include the sample size, which, when coupled with the small difference in mean scores, demonstrates low power. Additionally, the grades on these examinations were not included in the final course grade. The authors state that this decision was due to local Institutional Review Board recommendations. Exclusion of the tests from course grading could have an impact on participant motivation and affect the results. The two examiners were blinded to the instructional strategy; however, inter-rater reliability was not established.

Sole, Schneiders, Hebert-Losier, and Perry (2013) examined the effect of DVD multimedia for psychomotor musculoskeletal manual skills. Their study utilized this technology as a learning resource to augment the live classroom demonstration. Eighty-one physical therapy students participated in the study. The faculty noted similar skill performance in this cohort of students. This claim is speculative, as performance scores were not reported. If the scores were similar, this finding differs from Arroyo-Morales, et al. (2012), Cantarero-Villanueva, et al. (2012), and Preston, et al. (2012) who reported higher scores when the instructional multimedia was used to supplement in-person instruction. The authors' key points included that the DVD provided a greater consistency of teaching between laboratory groups (Sole, Schneiders, Hebert-Losier, & Perry, 2013).

Student learning of cervical spine examination and treatment psychomotor skills were compared using LMS-embedded online video instruction versus face-to-face instruction (van Duijn, Swanick, & Donald, 2014). Fifty-three Master of Science in Physical Therapy students participated in this crossover study. The average participant age was 29 years. Student performance on four skills compared the instructional strategies and found no statistically significant differences, with one exception. The face-to-face group earned higher marks on one of the four skills, albeit with a small effect size at 0.12. This finding contrasts the theme of similar outcomes between instructional multimedia and live demonstration. The difference might be secondary to the complexity of this specific joint accessory psychomotor skills that benefited from a live demonstration. The authors reported that the cumulative effect of utilizing both instructional strategies was apparent with improved performance for both groups after the crossover. The study concluded that online video could enhance traditional classroom instruction for psychomotor skill development in physical therapy students (van Duijn, Swanick, & Donald, 2014).

The effectiveness of mobile learning for psychomotor skill acquisition was compared to the face-to-face environment for 74 undergraduate athletic training students (Davie, Martin, Cuppett, & Lebsack, 2015). While this study's population was younger, mean of 19 years old, compared to the typical DPT student, it was included in the review for similar skill instruction. Participants were randomly assigned to either a face-to-face instruction demonstration group or video instruction available on mobile devices for three skills. The valgus stress test for the knee, middle trapezius manual muscle test, and goniometric measurement of active ankle dorsiflexion skills were compared using examination scores. Although the results revealed no differences in the instructional strategy for the manual muscle test or goniometry, the face-to-face group scored higher for the knee valgus stress test. The authors concluded that mobile video instruction is an effective teaching strategy, but its use as a supplement to face-to-face instruction might be the best implementation strategy. The authors dismissed the higher performance of the joint assessment skill for the face-to-face instructional group, which was statistically significant. This technique is more complicated than the other two involved in the study. The post-hoc power analysis for this finding was strong. This finding supports van Duijn, Swanick, and Donald (2014), who reported higher performance in the live demonstration groups for select skills. A limitation of the study was the use of two examiners with low inter-rater reliability.

In one of the larger studies, Lazinski (2017) examined the psychomotor and affective learning domains for 123 physical therapy students from three successive cohorts. A palpation course changed from face-to-face instruction to a hybrid learning model. Seventy-five percent of the course was taught online in the new format. Student performance on practical examinations, online engagement rates, and student course evaluations was measured. The practical examination scores were comparable amongst the three cohorts. This finding indicates that multimedia instruction can have similar learning outcomes compared to live demonstrations for psychomotor skill development over a longer duration. The study concluded that satisfactory learning for psychomotor skills could be achieved using a hybrid delivery model with significantly less face-to-face instruction (Lazinski, 2017). Study limitations included the use of non-blinded graders regarding the course instruction. Additionally, multiple graders were used without established inter-rater reliability. Post-hoc power cannot be calculated with the data provided in the article affecting the generalizability of the findings. Moreover, the complexity level of palpation skills is basic when compared to joint assessment and treatment techniques.

The psychomotor learning domain was examined in 18 studies. Comparable psychomotor student performance was noted in 12 of them (Barker, 1988; Campbell & Kohli, 1970; Howerton, Enrique, Ludlow, & Tyndall, 2004; Ford, Mazzone, & Taylor, 2005; Kelly, Lyng, McGrath, & Cannon, 2009; Kneebone & ApSimon, 2001; Lazinski, 2017; Moore & Smith, 2012; Sanddal, et al., 2004; Smith, Jones, Cavanaugh, Venn, & Wilson, 2006; Sole, Schneiders, Hebert-Losier, & Perry, 2013; Xeroulis, et al., 2007). Moreover, three studies demonstrated improved student psychomotor performance using multimedia instruction (Arroyo-Morales, et al., 2012; Cantarero-Villanueva, et al., 2012; Preston, et al., 2012). These three studies used multimedia as a supplement to regular course instruction. In contrast, Sole, Schneiders, Hebert-Losier, and Perry, 2013 reported similar outcomes between instructional strategies when multimedia was used as a supplement.

When the multimedia instruction was used a the primary instructional strategy, the majority of the studies revealed no statistical difference in student performance (Barker, 1988; Ford, Mazzone, & Taylor, 2005; Moore & Smith, 2012; Smith, Jones, Cavanaugh, Venn, &

Wilson, 2006). However, two studies found improved performance in select skills for the face-to-face group compared to multimedia instruction.

Van Duijn, Swanick, and Donald (2014) reported higher marks for 25 percent of the joint accessory mobility skills tested. In this study, the Cervical Natural Apophysial Glide was performed better by students who received live demonstration instruction. This particular technique is more complex insofar as the number of steps required to complete the skill. Higher marks on a joint assessment skill were also reported by Davie, Martin, Cuppett, and Lebsack (2015). While these authors reported similar outcomes for the three skills examined in this study, one skill received higher marks for the face-to-face group. Specifically, the valgus stress test of the knee had statistically significant improved performance. This technique is more complicated than the manual muscle test and goniometric measurement also investigated.

An argument could be made that the complexity of skills may impact the results. Further analysis of these studies specific to the orthopaedic examination revealed similar results. Five studies meet these criteria, and three report comparable learning outcomes (Ford, Mazzone, & Taylor, 2005; Smith, Jones, Cavanaugh, Venn, & Wilson, 2006; Sole, Schneiders, Hebert-Losier, & Perry, 2013). The van Duijn, Swanick, and Donald (2014) and Davie, Martin, Cuppett, and Lebsack (2015) studies report a higher score for the live demonstration group; however, this finding was only noted for one skill in each study.

The general theme from these studies is that instructional multimedia is comparable to live demonstration when used as the primary instructional strategy for psychomotor skill acquisition. Moreover, it is conceivable that when used as an adjunct to traditional instruction that the psychomotor performance can be improved. That said, not all of the studies reached this conclusion, and some evidence suggests that more complex psychomotor skills benefit from live demonstration instruction. Given the small sample size, the limited number of techniques examined, the short duration of most of the studies, questions regarding the use of instructional multimedia for a higher volume of skills over an entire course semester remain. The specific gaps in the literature will be discussed in detail in Chapter 2.3. While a comparison of test scores is essential when assessing instructional course design, analysis of the learner's experience should also be considered. The next section will review the available literature regarding physical therapy students and other selected healthcare professions' perceptions related to multimedia instruction.

2.2 Student Perceptions of Educational Technology Use in Physical Therapy Education and Other Healthcare Professions

Thompson (1987) investigated the effectiveness of text-based CAI versus written instruction between two groups of physical therapist assistant students on the topic of respiration. Participants accessed the technology while on campus during a 20-minute session. As reported in Chapter 2.1, the skill performance between groups was similar. Learning style and attitude towards computers were also studied. All 20 participants completed a Kolb Learning Style Inventory and a computer attitude survey. No statistically significant correlation for learning style inventory was found. One computer attitude survey question, "I like working on computers," was linked to increased retention in text-based CAI group participants. This article is the first reference in physical therapy education literature to discuss student attitudes towards the use of multimedia.

Toth-Cohen (1995) examined the use of multimedia software instruction installed on a desktop computer in applied anatomy and kinesiology classes for 86 occupational therapy students at two universities. Higher test scores were reported for one of the multimedia instruction experimental groups. An attitude questionnaire was also administered to the participants, and both experimental groups noted a more positive attitude toward multimedia instruction. The visual multimedia was reported as both interesting and helpful, and the ability to self-pace and review were highlighted benefits. The open-ended survey responses identified technical issues, including slow software speed and unfamiliarity with working with computers. While this reference is dated, the questionnaire has been used in other studies (Smith, Cavanaugh, & Moore, 2011) to measure student and instructor attitudes related to technology as an instructional strategy in physical therapy education. Given the historical use of the questionnaire on this topic, a modified version was used in this research project. However, the questionnaire results will allow for consistent comparison over time.

Kneebone and ApSimon (2001) used CD-ROM multimedia instruction in the form of animations and video demonstrations for basic surgical skills training for 72 medical students. Each student also attended a self-directed learning session. Observation and group interviews were combined with performance assessments. The interviews revealed an overall positive perception of multimedia use for both students and instructors. Similar to Toth-Cohen (1995), the learners liked the imaging and ability to view the skill repeatedly. Moreover, the instructors enjoyed the time to tailor the instruction to each student during the feedback period.

Osborn and Tentinger (2003) performed a pilot study assessing the usefulness of digital video in a musculoskeletal physical therapy course. Edited videos were incorporated into a Microsoft Office PowerPoint presentation on the topics of orthopedic special tests. The videos were played several times during the face-to-face laboratory session. Study participants were also provided with a CD-ROM containing the videos that could be utilized off-campus for self-study. After course completion, the participants were involved in a six-week clinical affiliation, and upon return from this fieldwork, they completed a survey regarding the videos. The majority of students reported positive feedback utilizing the video clips of the special tests. All respondents reported that classroom video use was a benefit with an average rating of 4.6 on the five-point Likert-scale. That said, the article did not further clarify how the students used the videos for practical and written examination preparation. A perception of helpfulness regarding watching the videos during the clinical rotation was also reported with an average Likert-scale rating of 4.13 out of five. These authors concluded that the video clips are a useful adjunct to instruction for physical therapy students. Technological limitations were noted for both classroom projection and accessing the videos on the takeaway CD-ROM. These findings support Toth-Cohen's (1995) ascertain that some students will experience barriers using instructional multimedia.

Hayward (2004) examined student experiences and perceived learning, as defined by the student's reported knowledge gain, through integrated web-enhanced instruction in a research methods course. While this study does not measure psychomotor learning, it provides insight into this population's perception of using LMS. Fifty-seven physical therapy students participated in the study. The course materials were uploaded to the Blackboard LMS, and discussion board postings, chat room transcripts, and reflective papers were analyzed. Student behavior, communication feature use, student perspectives, and barriers were identified as thematic categories through qualitative analysis. The results demonstrated that this educational strategy could potentially foster deeper thinking about assignments and provide opportunities for peer comparison. The listed barriers to LMS use include technical and nontechnical issues. The technological limitations were similar to Toth-Cohen (1995) and Osborn and Tentinger (2003) with computer access, slow processing speed, and outdated software as barriers. Additionally, unreliable or no internet connectivity was reported. Nontechnical barriers included lack of immediate feedback, a preference for face-to-face instruction, and difficulty communicating feelings on a discussion board. One limitation of the qualitative analysis was the use of additional coders. While this practice is generally a good way to decrease bias, the two additional coders in this study were graduate physical therapy students who were working with the primary researcher. This relationship could affect the analysis based on perceived expectations.

Howerton, Enrique, Ludlow, and Tyndall (2004) compared CAI, in the form of an interactive CD, and face-to-face demonstration for 75 dentistry students enrolled in a radiology course. Three groups of students were randomly assigned to instructional multimedia, lecture instruction, and both multimedia and lecture instruction groups. Pre and posttest compared learning outcomes and reported earlier. Student perceptions were also examined through a survey and directly compared the interactive CD to PowerPoint lecture format. Ninety-two percent of respondents agreed or strongly agreed that the multimedia was advantageous compared to the lecture. Moreover, 64 percent of respondents indicated a preference for the multimedia instruction over lecture. The authors reported that convenience was the primary determinate for this finding. These findings differ from Hayward (2004) that discussed a preference for face-to-face instruction with several noted barriers, including technology issues and lack of immediate feedback for multimedia instruction. However, these technical barriers were not reported by Howerton, Enrique, Ludlow, and Tyndall (2004). The nontechnical barrier of lack of immediate feedback was present but did not alter the preference for multimedia instruction.

Willett, Sharp, and Smith (2008) compared teaching methods for two cohorts of physical therapy students totaling 28 participants enrolled in a neuroscience course. The study compared LMS-embedded multimedia to classroom lectures using a randomized cross-over design. Examination scores, study time, and student opinions were compared. Their results did not reveal any statistically significant differences between groups in examination scores at the immediate and three-week posttests. Students did not show a preference for either instructional strategy. That said, 33 percent of cohort one and 15 percent of cohort two did not want to participate. The number of students opting out study participation is noteworthy. The authors also reported that many additional study participants would have preferred LMS-embedded multimedia as a supplement to class instruction rather than as the primary teaching strategy. This sentiment links with a theme from Hayward (2004) regarding a preference for face-to-face instruction for some students. A cost analysis for each instructional strategy was also reported. The lecture-based learning was more cost-effective; however, the high costs of multimedia development are expected to decrease after the initial expenses.

Maring, Costello, and Plack (2008) compared traditional lecture and distance learning for physical therapy students enrolled in a pathophysiology course. The study had 96 participants. Half of the course was instructed in a traditional classroom, and the other half of the course was instructed in a distance mode using LMS. The instructional strategy alternated each week. Scores on two multiple-choice examinations compared the instructional approach. The results indicated higher scores on the material presented in the distance format. The participants also completed a survey. Consistent with Toth-Cohen (1995) and Kneebone and ApSimon (2001), the self-paced and convenient distance learning delivery were the positive findings. Despite the higher test scores and stated benefits of LMS distance learning, the authors reported a student preference for the traditional classroom format. This finding supports those Hayward (2004) and Willett, Sharp, and Smith (2008). These three articles oppose the view of Howerton, Enrique, Ludlow, and Tyndall (2004), who found a preference for multimedia instruction. The most notable reasons for face-to-face preference was the ability to ask questions and discuss real-life examples.

Jones, Dean, and Hui-Chan (2010) compared outcomes between video-linked, web-based, and classroom tutorials for physical therapy students in Canada and Hong Kong. The 72 participants were divided into three groups: video-linked tutorials in combination with web-based tutorials, web-based only tutorials, and conventional classroom tutorials. Scores on a short-answer standardized quiz compared the groups. The students' preferences were also analyzed using an open-ended questionnaire. No differences were noted in mean scores amongst the three groups; however, one institution had a lower grade for the web-based tutorial for one of the studied topics. The qualitative analysis revealed that some students liked the independent method of web-based learning. This finding is consistent with studies regarding multimedia instruction (Howerton, Enrique, Ludlow, & Tyndall, 2004; Kneebone & ApSimon, 2001; Maring, Costello, & Plack, 2008). That said, more students reported that they missed the instructor's reinforcement. The inability to ask questions and receive immediate feedback on skill performance is a recurring statement for participants who prefer face-to-face instruction (Hayward, 2004; Howerton, Enrique, Ludlow, & Tyndall, 2004; Maring, Costello, & Plack, 2008). Also, students who preferred classroom teaching were less confident using the structured video-linked format. The authors concluded that video-linked and web-based instructional strategies have comparable learning outcomes for physical therapy students learning intensive care techniques (Jones, Dean, & Hui-Chan, 2010).

Bayliss and Warden (2011) studied test performance in different cognitive domains and preferences for the mode of instruction between traditional lecture-based and a hybrid model of instruction. Sixty-five physical therapy students enrolled in a cardiopulmonary course participated in the study. Half of the class was taught using each instructional strategy, and the end of term examination compared results. The results revealed similar outcomes on questions assessing knowledge, but the hybrid model scored better on test questions within the higher cognitive domains of comprehension, analysis, and evaluation. This improvement may be from the hybrid model's pedagogical approach that combined electronic lectures with group problem-solving activities. The participants also completed a survey regarding the preferred mode of instruction. No statistically significant preference for mode of instruction was noted, which is similar to the report from Jones, Dean, and Hui-Chan (2010). Forthy-three percent of participants stated that the traditional lecture-based format was better, while 32 percent reported a preference for hybrid instruction. The authors attributed these preferences to individual learning styles.

Smith, Cavanaugh, and Moore (2011) compared instructional multimedia and live demonstrations for psychomotor learning in physical therapy students. A questionnaire assessed the attitudes toward each instructional strategy for 45 participants. No difference in attitudes was found between the two groups on the Likert scored questionnaire statements. That said, the open-ended questions revealed themes of improved efficiency and autonomy using instructional multimedia, which is a similar finding reported in other studies (Howerton, Enrique, Ludlow, & Tyndall, 2004; Jones, Dean, & Hui-Chan, 2010; Kneebone & ApSimon, 2001; Maring, Costello, & Plack, 2008). The participants further stated that the multimedia had a greater detail of instruction. The authors concluded that multimedia provides an efficient method for psychomotor skill development in physical therapy students.

Adams (2013) compared the student outcomes in a therapeutic modalities course comprised of 64 physical therapy students. The study contrasted hybrid versus traditional classroom. The experimental group received web-enhanced CD-ROM lectures and face-to-face laboratory instruction, while the control group received only face-to-face lecture and laboratory instruction. Upon course completion, the final examination scores and course grades were compared, and the participants also completed a posttest at four-months. The immediate and delayed posttest scoring was similar between the groups. The survey data and focus group interviews were used to gauge participant satisfaction and preferences. A preference for an instructor-centered approach to teaching was noted in participants less satisfied with the CD-ROM multimedia. Specific characteristics for this group included a reliance on rote memorization, requests for step-by-step instructions, and frustration with higher-order thinking and self-reflection practices.

In contrast, participants more satisfied with the CD-ROM multimedia revealed a recognition for class preparedness, an appreciation of active learning exercises, and a request for further learner-centered activities. Adams (2013) concluded that a hybrid format yielded similar results to face-to-face instruction, with higher levels of course satisfaction noted in students with adult learner characteristics. This finding relates to the current DPT population. As previously reported, the evolution of physical therapy education in the USA has experienced a higher entry-level degree qualification. This change corresponds to increased student age.

Boucher, Robertson, Wainner, and Sanders (2013) gauged student and faculty responses to a flipped-classroom approach for delivering musculoskeletal content to physical therapy students over four years. During this period, the amount of online material increased from 20 to 100 percent of the lecture content. Face-to-face classroom instruction remained for review, discussion, problem-solving, clinical reasoning, and laboratory skills. In addition to the survey, course grades and practical examination scores were tracked. Their results showed that course grades and examination scores remained consistent throughout the study. Both the student and faculty responses to the flipped curriculum were positive. The survey question regarding face-to-face lab time is particularly noteworthy. Viewing the multimedia before class allowed for more higher-level clinical reasoning activities and skill practice during these labs. This question received a strongly agree ranking of 4.4 on a five-point Likert scale. Similar to other studies (Hayward, 2004; Howerton, Enrique, Ludlow, & Tyndall, 2004; Osborn & Tentinger, 2003; Toth-Cohen, 1995), some students reported technical difficulties. Specifically, accessing multimedia on mobile devices proved problematic. Despite minor technical challenges, the authors concluded that this instructional delivery model is effective.

Sole, Schneiders, Hebert-Losier, and Perry (2013) examined the effect of DVD multimedia for psychomotor musculoskeletal manual skills. This study utilized the DVD instruction as a learning resource to augment the live classroom demonstration. Eighty-one physical therapy students participated in the study. the faculty noted similar skill performance in this cohort of students. This study also investigated the student experience through a questionnaire and focus group discussions. The students reported increased confidence in their skill application using the multimedia for review of these techniques. Moreover, 94 percent of the survey respondents were favorable to the multimedia DVD. That said, the faculty expressed a concern that not all students used the multimedia for laboratory preparation. This report supports the assertion by Adams (2013) that primary multimedia instruction may have limitations for students with youth-learner characteristics. The author's key points included that students valued the multimedia DVD of manual therapy techniques, and the DVD provided a greater consistency of teaching between laboratory groups (Sole, Schneiders, Hebert-Losier, & Perry, 2013).

Veneri and Gannotti (2014) compared student outcomes in a neurological course completed by 41 physical therapy students. One group received only face-to-face instruction, and the second group experienced both face-to-face and computer-assisted learning modules. These modules included video clips of patient evaluation and treatment activities. Student performance was measured via weekly ten-question quizzes. The study results revealed that the group using computer-assisted learning modules had higher quiz grades by 5.7 percent.

Additionally, the analysis of student perceptions revealed positive themes for this instructional strategy with assistance in critical thinking as a noted benefit. Other positive features included self-pacing and the ability to rewatch the videos, which is consistent with previously discussed articles (Kneebone & ApSimon, 2001; Maring, Costello, & Plack, 2008; Toth-Cohen, 1995). The focus group thematic analysis revealed a recommendation of using computer-assisted learning modules as a supplement to the face-to-face as opposed to the primary instructional strategy.

Hurst (2016) performed a qualitative study of 31 physical therapy student experiences using video podcasts to enhance the learning of clinical skills. The authors gauged participant perceptions using focus group discussions centered on video podcasting and psychomotor skill development. All participants used the video podcast to help with skills acquisition, with practical examination review, repetition, and skill refinement listed as critical features. Clinical reasoning development was not perceived as a benefit of the video podcast. Instead, study participants reported that practice with instructor feedback was necessary to develop this skill. This study agrees with Adams (2013) that the use of instructional multimedia as the primary instructional strategy can increase available face-to-face instruction time for higher-level learning activities.

Lazinski (2017) studied psychomotor and affective learning domains for 123 physical therapy students from three successive cohorts in a course that changed from face-to-face instruction to a hybrid model. As previously reported, the practical examination scores were comparable amongst the three cohorts in this palpation course. This study also examined online engagement rates and student course evaluations. Online engagement analysis revealed that most participants met the criteria. Moreover, the overall student perceptions, based on course evaluations, were generally positive. That said, a small number of participants did not meet the defined engagement criteria. This finding is consistent with Adams (2013) and Sole, Schneiders, Hebert-Losier, and Perry (2013) regarding class preparation. The course evaluation review also revealed that face-to-face instruction was the best part of the course for 25 percent of participants. The study concluded that satisfactory learning for psychomotor skills could be achieved using a hybrid delivery model with significantly less face-to-face instruction (Lazinski, 2017).

Overall, 17 studies investigating students' perceptions of multimedia instruction were analyzed. Several studies conveyed that student perceptions of instructional multimedia are favorable (Hurst, 2016; Kneebone and ApSimon (2001); Lazinski, 2017; Osborn & Tentinger, 2003; Sole, Schneiders, Hebert-Losier, & Perry, 2013; Toth-Cohen, 1995). These articles suggest an appreciation of self-paced course content and access to the multimedia for ongoing review. Further analysis demonstrates several varied positions on how to utilize instructional multimedia best.

Three studies recommend using instructional multimedia as a supplement to traditional classroom lectures (Adams, 2013; Maring, Costello, & Plack, 2008; Veneri & Gannotti, 2014). This approach provides access to multimedia for ongoing review. It also continues to offer preferred face-to-face instruction for select students that was reported by Hayward (2004), Jones, Dean, and Hui-Chan (2010), Maring, Costello, and Plack (2008), and Lazinski (2017). However, using multimedia as a supplement to in-class live demonstration limits the amount of higher-level activities during face-to-face instruction to ensure skill instruction and student practice.

Four studies conveyed no preference for either instructional strategy (Bayliss & Warden, 2011; Smith, Cavanaugh, & Moore, 2011; Thompson, 1987; Willett, Sharp, & Smith, 2008). It should be noted that Thompson (1987) found better student learning outcomes in learners that stated that they liked working with computers. This finding suggests that some students prefer multimedia instruction over live demonstrations. Howerton, Enrique, Ludlow, and Tyndall (2004) support this assertion. Moreover, Sole, Schneiders, Hebert-Losier, and Perry (2013) reported increased student confidence with psychomotor skill performance with multimedia instruction. To that end, these studies support the use of instructional multimedia as a primary instructional strategy. This approach, advocated by Adams (2013) and Hurst (2016), allows for higher-level learning exercises during face-to-face instruction. These studies provide insight regarding the use of instructional multimedia from the students' lens. Chapter 2.3 reviews gaps in the literature and also provides the rationale for this study.

2.3 Gaps in the Literature

The studies reviewed in sections 2.1 and 2.2 generally demonstrate the equal effectiveness of using instructional multimedia for psychomotor skills instruction in healthcare professions education compared to live demonstrations. However, the amount of research remains limited, especially with the small sample sizes and low statistical power of the outcome comparison noted in most studies. Moreover, many of these studies utilized instructional multimedia as a supplement to classroom instruction, and few studies investigated its use as the primary instructional strategy for psychomotor skill acquisition.

For several of the earlier studies, the best available technology was CD-ROM and DVD. In today's classroom environment, LMS has become commonplace for most institutions in the United States of America (edutechnicia, 2017). Despite the increased use, research regarding LMS in physical therapy education is limited across all learning domains (Veneri & Gannotti, 2014). To that end, further studies investigating LMS-embedded instructional multimedia for psychomotor skill development are necessary for the physical therapy education context.

Furthermore, no study has employed or evaluated LMS-embedded instructional multimedia across an entire semester for psychomotor skill development. The majority of studies reported on a small number of techniques over a short period. This study increases the volume of techniques taught using this instructional strategy over a more extended period. It should also be noted that this study examines skills for body regions that have not previously been reported in the literature, including the hip, elbow, wrist, and hand.

The key question regarding the effectiveness of LMS-embedded instructional multimedia for psychomotor skill instruction to physical therapy students remains. Moreover, it is important to investigate student perceptions of the instructional strategy, including the utilized multimedia.

This research will add to the available body of evidence examining and evaluating the use of LMS-embedded instructional multimedia for the psychomotor learning domain. From an originality perspective, the type of multimedia, volume of involved techniques, longer study duration, and inclusion of previously unreported body regions can address current gaps in the literature. Chapter 2.4 will discuss the instructional design employed for psychomotor skill instruction in this study.

2.4 Instructional Design

Elaboration Theory provides the instructional design framework for this research study's psychomotor skills. Supporters of this theory report that learning is enhanced through 'zoom lens' sequencing, which begins with the simple and general concepts, and progresses to the complex and increasingly specific (Hamidi, Khoshbakht, & Abdolmalcki, 2011). Reigeluth (1979) describes the zoom lens as a movie camera. The wide-angle view allows the learner to see the major parts and relationships, representing the starting point. The learner then zooms in to see a portion of the picture in closer detail, including the subparts and interrelationships. This process of zooming in and out continues until the entire picture is examined at the first level of detail, and it is repeated for additional levels of detail.

The sequence progression begins with simple and advances to more complex concepts. The first lesson should epitomize the skill (Reigeluth C. M., 1979). This epitome presents the lesson on an application level with a few constructs (Reigeluth, Merrill, Wilson, & Spiller, 1994). Specific to this study, the psychomotor skills are simple, and the video content of these skills is the epitome. The orientation of the epitome can be conceptual, procedural, or principle. While all three can appear in the epitome, one of the three should be emphasized (Clark, 2011). This study used a primarily procedural epitome orientation, which is defined as a skill or technique (Reigeluth C. M., 1979).

After the initial presentation of the epitome, an elaborative sequence occurs, adding detail and complexity to the content (Reigeluth, Merrill, Wilson, & Spiller, 1994). The primary elaborative sequence relates to the specific details required to perform the manual therapy skill, including patient position, therapist position, limb position, joint alignment, stabilization, manipulating hand, the direction of force, end-feel, and patient response. LMS-embedded multimedia provided the study's participants with the initial presentation of the epitome, which were the psychomotor skills primary instruction. The participants were instructed to view the assigned videos before the associated laboratory class. During the face-to-face instructional time, these psychomotor skills were practiced and refined in response to instructor feedback.

At the end of each elaborative sequence, the instruction is summarized, synthesized, and an expanded epitome is introduced (Reigeluth, Merrill, Wilson, & Spiller, 1994). The course instructor was the 'summarizer' and provided the learner with a concise generality for the elaboration sequence content. Additionally, the course instructor guided the student through case scenarios and problem-based learning exercises, which represents the 'synthesizer' to the epitome. These learning activities integrate the content to facilitate a deeper meaningful understanding (Clark, 2011). Elaboration Theory uses this process to layer until a terminal epitome is reached. The summary, synthesis, and expanded epitomes were presented in the classroom during face-to-face laboratory time for students in this study.

In this study, the psychomotor skills are procedural in nature and represent the simple concept in the elaboration sequence. The use of LMS-embedded multimedia as the primary instructional strategy allows the course instructor to use class time to summarize and synthesize the expanded epitomes. Moreover, the course learning outcomes are reinforced through the instruction of each body region. The spiral nature of the curriculum allows the student to build on previous course content. This progression is similar to the 'spiral curriculum' described by Bruner (1960).

The extension of Bruner's approach through the Elaboration Theory aligns with constructivism (Perswal, 2011). This theory postulates that each learner constructs meaning to new knowledge (Hein, 1991). Additionally, learning is recognized as an active process (Education theory, 2014) with an appreciation for the learner's prior knowledge and life experiences (Evans, Yeung, Markoulakis, & Guilcher, 2014). Recent physical therapy education trends favor a constructivist approach for teaching and learning, including psychomotor skills instruction (Qasem, 2015). Elaboration Theory is recommended for teaching medium to complex content in the cognitive and psychomotor learning domains (Carr-Chellman & Reigeluth, 2009; David, 2014) and algins well with the course content and intended learning outcomes for the course involved in this study.

Chapter 2.5 Summary

Chapter Two reviewed the history of instructional multimedia within the physical therapy context. Given the similar age, degree level, and intent of the psychomotor skills, other healthcare professions were included in the literature review to provide insight on student performance outcomes using multimedia and live demonstrations instructional strategies. An analysis of the student perceptions regarding multimedia instruction was also discussed. This review identified gaps in the literature and highlighted the need for ongoing study, especially for the physical therapy education context. Lastly, Elaboration Theory framed the instructional design for these psychomotor skills. Chapter Three will cover the study's methodology.

Chapter 3: Methodology

Chapter Three describes the study methodology in four parts. First, an overview of the study design is presented. The second section is a description of the study's sample population. The third segment reviews ethical considerations. Lastly, the data analysis processes are outlined.

Chapter 3.1 Study design

This research study used a mixed-methods explanatory design. Mixed-methods research uses both quantitative and qualitative data within the study and integrates them (Creswell, Plano, Gutmann, & Hanson, 2003). This study design is advocated for the assessment of complex interventions with stated benefits of understanding contradictions in the data, reflection on participants' points of view, and to collect rich, comprehensive data (Wisdom & Creswell, 2013). Moreover, Greene and Caracelli (1997) state that mixing different methods strengthens a study. Despite these advantages, mixed methods studies are complex and challenging to perform; additionally, more resources are needed and often require a multidisciplinary team to conduct the research (Wisdom & Creswell, 2013).

This study used a census sample. The population that was invited to participate were students from University of St. Augustine for Health Sciences who were enrolled in PHT 5134C (Musculoskeletal III: Advanced Extremity Examination, Evaluation, and Manipulation) on the San Marcos, California campus. Of note, the primary author teaches this course and the psychomotor skills involved in the study. While this sampling method limits the ability to generalize findings, it does allow for deep insights regarding the study topic (Laerd dissertation, 2012).

A mixed-methods research design was selected for this study to enhance the analysis. The quantitative data comparing test scores are essential for assessing instructional course design.

That said, this information becomes more meaningful with an exploration of the learner's experience (Wisdom & Creswell, 2013). In this study, the qualitative inquiry helps to explain the results of the quantitative data. Furthermore, past research for psychomotor skill acquisition in physical therapy students used a similar methodology (Maring, Costello, & Plack, 2008; Moore & Smith, 2012; Smith, Cavanaugh, & Moore, 2011; Willett, Sharp, & Smith, 2008). Replicating the study with different experimenters and participants aids in establishing reliable and valid study results (Exploreable.com, 2009). An outline of the mixed-methods explanatory design is illustrated in Figure 3.1.

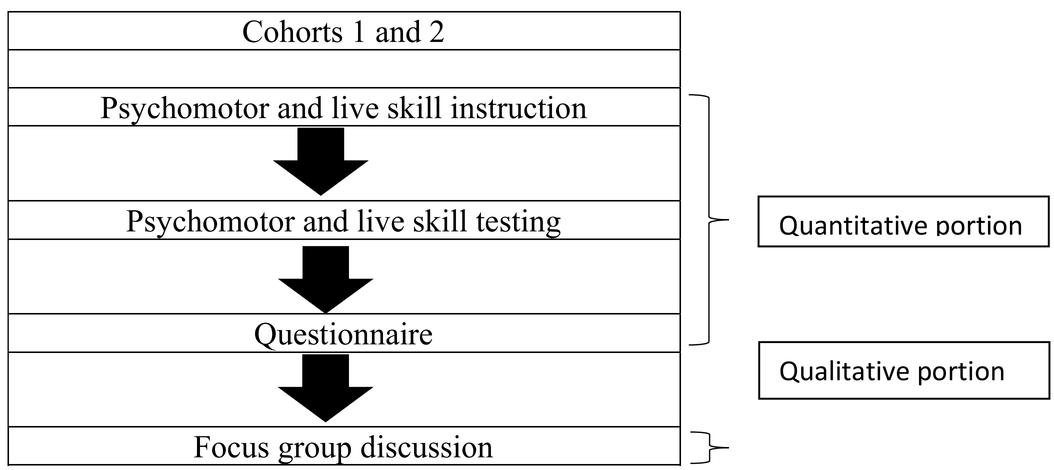

Figure 3.1 Mixed-method explanatory design

This research study design helps to fill gaps in the literature concerning psychomotor skill acquisition using instructional multimedia in physical therapy education. Specifically, the study's duration was the entire 15-week semester, which extends the temporal component of past research and increases the number of skills examined. Moreover, the use of the LMS for this instruction represents an advancement in educational technology within the physical therapy education context.

The study's first component utilized a crossover approach. Live demonstration and LMS-embedded instructional multimedia were employed to instruct participants in the application of psychomotor manual therapy skills for six body regions. In total, the study examined 58 manual therapy techniques. Student performance on two psychomotor examinations compared outcomes for each instructional strategy.

This research design allows participants to serve as their own control (Wong, McGrath, & Lo, 2006). Moreover, two cohorts were utilized to allow for uniformity in both the sequence and periods. This balanced design allows for the removal of sequence and period effects in the data analysis (Pennsylvania State University, 2017). The entirety of the manual therapy psychomotor skills for the course's six body regions was divided into two instructional strategies creating the twelve periods. The employed instructional strategy within these sequences and periods is listed in the table below. The technique allocation had equivalent difficulty for each body region grouping. Three experienced faculty members, with advanced training in orthopaedic physical therapy, approved the list of comparable techniques. For example, the cephalic movement of the radius was appointed to the separate instructional strategy from the caudal movement of the radius. Appendix B illustrates the complete list of skills and instructional strategy allocation. Ultimately, all skills were evaluated for both live demonstrations and LMS-embedded instructional multimedia through the cross-over design.

Table 3.1

Crossover Design Sequence and Period Illustration by Body Region

	Ankle/Foot 14 skills 7 in A 7 in B		Knee 12 skills 6 in A 6 in B		Hip 6 skills 3 in A 3 in B		Lower Extremity Exam	Shoulder 12 skills 6 in A 6 in B		Elbow 4 skills 2 in A 2 in B		Wrist/Hand 10 skills 5 in A 5 in B		Upper Extremity Exam
Cohort 1 n=64	A	B	A	B	A	B		A	B	A	B	A	B	
Cohort 2 n=71	B	A	B	A	B	A		B	A	B	A	B	A	

Note. A—live demonstration; B—LMS-embedded instructional multimedia

The live demonstration instruction involved the course instructor performing the psychomotor skill for participants during the face-to-face class time. The grading rubric, available in Appendix A, framed the talking points for each video. Following the demonstration, the participants worked in pairs to practice the skill while course faculty monitored the session and provided real-time feedback. This process of demonstration and practice was repeated for the subsequent techniques.

The LMS-embedded multimedia instruction featured a video of the course instructor performing the skill. Each technique was filmed using a GoPro HERO 4 with an attached microphone to capture the audio. Again, the grading rubric outlined the verbal directions. The same instructor performed all live demonstrations and multimedia instruction. This approach ensured like detail for instructed skills. The produced videos were a short duration based on the recommendation from previous research for psychomotor skill acquisition for physical therapy students (Macznik, Schneiders, Athens, & Sullivan, 2018). In addition to the audio and video instruction, written text was provided for each technique. This multimodel strategy enhances the learning experience (Evans M. F., 2012).

These videos were embedded into standard Blackboard LMS used at the USAHS. Participants were required to view the videos prior to face-to-face class time. The instructor did not perform a live demonstration of these techniques. Again, the participants worked in pairs during the allocated practice time, and instructor feedback on performance was provided in the same manner as the live demonstration instruction. An example of the LMS-embedded multimedia instruction is available through the following link:. All 58 videos are included in Appendix C.

Student performance on two psychomotor examinations was used to compare outcomes for each instructional strategy. These examinations were performed at the end of the instruction for the upper and lower extremities, respectively. Moreover, each student examination tested a technique from both instructional strategies. As previously mentioned, this approach allowed participants to be their own control. The grading rubric checklist is available in Appendix A. An experienced faculty member that did not instruct PHT 5134C (Musculoskeletal III: Advanced Extremity Examination, Evaluation, and Manipulation) during the study's duration conducted the two psychomotor examinations. This examiner was blinded to the instructional strategy employed for the tested techniques. Blinding the examiner decreased the risk of bias with these assessments (Karanicolas, Farrokhyar, & Bhandari, 2010).

A questionnaire was administered following the psychomotor performance examination to compare student perceptions of the teaching strategy. Although the questionnaire has not been validated, it has been used in two prior studies that investigated the use of educational technology in occupational and physical therapy education (Toth-Cohen, 1994; Smith, Joyce, Cavanaugh, & Wilson, 2006). The questionnaire used in these two studies was modified from the earlier versions after consultation with Smith (personal correspondence 1/16/2017 e-mail).

These changes made for a more concise and understandable questionnaire by merging two similarly structured questions.

The modified questionnaire is comprised of seven closed-ended and five open-ended questions. A copy is provided in Appendix C. Study participants used Survey Monkey to complete the questionnaire. The survey was administered by USAHS's Office of Assessment and Institutional Research. This author was provided with anonymous participant data related to survey responses. The seven closed-ended questions were scored on a five-point Likert scale labeled: strongly disagree (1), disagree (2), indifferent (3), agree (4), and strongly agree (5). Descriptive statistics were reported for these questions. The results of the five open-ended questions were analyzed, and this information assisted in selecting the emphasized topic areas of the focus group discussions.

The study's second component was qualitative analysis. A generic qualitative approach was used to describe the physical therapy participants' perceptions about the use of multimedia instruction for psychomotor skill development. This method seeks to understand a phenomenon, process, or perspective of study participants (Caelli, Ray, & Mill, 2003; Merriam, 1998). Moreover, the aim of generic qualitative studies is for a rich description of the phenomenon being studied (Lim, 2011). Neergaard, Olesen, Andersen, and Sondergaard, (2009) further state this approach links well with quantitative data and is especially relevant in mixed-method studies.

Given the homogeneous nature of the sample, individual interviews could quickly achieve saturation, and commonalities rather than differences were of most interest in the context of this study. Toward that end, focus group discussions were conducted to understand student perceptions. The use of focus groups can provide a greater understanding of the study phenomenon (Bradbury-Jones, Sambrook, & Irvine, 2008).

The size of a focus group should range from six to 12 participants, which is an appropriate size to stimulate discussion (Baumgartner, Strong, & Hensley, 2002; Guest, Namey, Taylor, Eley, & McKenna, 2017). This study aimed for eight participants in each of the two focus group sessions. Ideally, qualitative research is conducted using purposeful sampling, where individuals with specific characteristic that are most able to answer the research question are selected. Participants that can best address the question creates an in-depth understanding of the experience (Patton, 2014). This understanding is enhanced by selected individuals that are especially knowledgeable about the phenomenon being studied (Creswell & Plano Clark, 2002). However, the primary researcher, who also performed these focus group sessions, was an instructor of the participants. Given the potential for perceived power influence, the Institutional Review Board (IRB) at the USAHS recommended against purposeful sampling.

Study participants were invited to partake in a focus group session at the end of the study. If more than eight participants volunteered, a random number table generator was to be used to select the focus group members, which is not considered ideal but was what the review board allowed. In the end, all focus group volunteers were included in the discussion. Cohort one had six participants, and cohort two had four participants. While the sampling method and the number of participants were not ideal, these sessions still provide insight into participant perceptions regarding LMS-embedded instructional multimedia as a primary instructional strategy for psychomotor skills. These two limitations are discussed in greater detail in Chapter Five.

The two focus group sessions were conducted using topic areas to facilitate the discussion. The data analysis from the questionnaire responses helped to refine these topic areas. The topic area for these focus group discussions is included in Appendix D. These sessions were audio-recorded and transcribed. Transcriptions were prepared by the primary researcher as a means of becoming immersed in the data. Additionally, moderator field notes were reviewed. The transcribed data were subsequently coded and analyzed through constant comparative analysis. This method allows the researcher to continually sort through the collected data while analyzing and coding the information and reinforcing thematic generation (Kolb, 2012). The focus group transcriptions were reviewed, and significant statements were highlighted. Next, categories or 'units of meaning' were developed, which underpinned thematic development. Moreover, this process of continually comparing the data refines the concepts and relationships, allowing for integration into the explanatory model (Taylor & Bogdan, 1998). Qualitative analysis of these focus group responses provides a basis for interpreting the findings of the study's quantitative elements.

The trustworthiness of the qualitative data analysis used the Lincoln and Guba (1985) framework: Credibility, transferability, confirmability, and dependability. Credibility relates to the 'truth' of the study findings (Cohen & Crabtree, 2006). This study used triangulation and prolonged engagement as techniques to establish credibility. Triangulation refers to the consistency of study findings between different data collection methods. Studies that use multiple methods provide cross-data validity checks and can facilitate a more in-depth understanding (Patton, 1999). This study enlists data collection through the questionnaire and focus group sessions and serves as a means of triangulation.

Prolonged engagement involves the researcher spending sufficient time in the field to understand the phenomenon of interest. The primary researcher had instructed the involved course 17 times over six years before the study began. Additionally, he was the primary faculty for this study's class, and both student cohorts knew him from prior course instruction. The prolonged engagement provides adequate time for rapport development with the participants supporting credibility (Cohen & Crabtree, 2006).

Transferability recounts that the study findings are applicable in another context and describes the phenomenon in sufficient detail (Lincoln & Guba, 1985). This thick description makes relationships explicit (Holloway, 1997). Chapter One outlined the societal, university, and classroom backgrounds for the physical therapy student participants in the study. Moreover, the similarity of findings from other healthcare professions postbaccalaureate students noted in the Chapter Two literature review aligns with potential transferability to these degree programs. The data analysis includes open-ended survey questions and focus group discussions, providing finer details about LMS-embedded instructional multimedia for psychomotor skill development.

Confirmability is the degree of neutrality in the research findings (Lincoln & Guba, 1985). This objectivity safeguards these findings from researcher bias (Cohen & Crabtree, 2006). The reflexivity process assists in situating the researcher's frame of reference (Markham, 2017), which can aid in the identification of potential influencing factors. The triangulation of the study findings through the questionnaire and focus groups also support confirmability. Furthermore, this study employed an audit trail. To that end, the raw data, analysis and synthesis products, and the focus group audio recordings are saved.

Dependability relates to the consistency in the study's findings (Lincoln & Guba, 1985). Audits can help establish dependability and involve a review of the process, findings, interpretations, and conclusions by someone outside of the study (Cohen & Crabtree, 2006). While not an official inquiry audit, the thesis process, and committee members have performed this process throughout the study. Dependability also includes the ability of other researchers to replicate the study (Lincoln & Guba, 1985). Several aspects of this study were inspired by previous research in this domain, including the cross-over approach and questionnaire. These research commonalities illustrate the replication prospect.

Chapter 3.2 Sample

This study was performed at USAHS's DPT program on the San Marcos, California campus. The USAHS admits three cohorts of DPT students annually, allowing the same course to be presented three times each year. Each cohort is approximately 65 students. This admissions process and curricular design provide an adequate sample for this study. The primary author of this study is the lead instructor for PHT 5134C (Musculoskeletal III: Advanced Extremity Examination, Evaluation, and Manipulation), which is the course involved in this study. This course is the third in a sequence of four musculoskeletal classes in the DPT curriculum. This study occurred over consecutive semesters involving the Fall 2017 and Spring 2018 cohorts using census sampling.

Enrollment for the Fall 2017 class was 62 students, and Spring 2018 had a larger cohort of 77 students. Of these students, 55 from cohort one and 59 from cohort two agreed to participate in the study. All students met the inclusion criteria, which was course enrollment. The exclusion criterion was established to control for previous instruction on the tested psychomotor skills. However, the exclusion criteria for repeating the course was not met by any members of these two classes.

Chapter 3.3 Ethical considerations

This research was performed for partial fulfillment for the degree of Doctorate of Education from the University of Liverpool. The study participants were students at the USAHS. Given the study purpose and sample, approval from both institutions was necessary. The IRB from the USAHS and the University of Liverpool's EdD Virtual Programme Research Ethics Committee (VPREC) approved this study. These authorization letters are included in Appendix E and F, respectively. This section discusses the informed consent process, privacy and confidentiality, and justice and beneficence.

Additional gatekeeper authorization was necessary from the USAHS. Permission from the Chief Academic Officer and President of the university was obtained. This approval authorized the use of university resources, including a laboratory room, conference room, video recording equipment, and access to the Blackboard LMS platform. This letter also permitted access to the fifth term DPT student cohorts for the Fall 2017 and Spring 2018 terms and authorized participation in the study. A copy of this letter is attached as Appendix G.

Since this study involved students, the USAHS's IRB required that the primary investigator complete training involving human subjects research. This author completed a basic course in human subject research through Loma Linda University in January of 2009, and this training was updated in June of 2017, through the National Institute of Health (NIH) course protecting human research participants.

As previously mentioned, the study was approved by both universities. The review process was similar for each institution. A key feature was the informed consent requirement. Each participant signed and returned the informed consent form before the study began. A copy of the letter is available in Appendix H. It should be noted that participation in the study was voluntary. Moreover, all participants had the right to withdraw from the study at any time without explanation. There were no repercussions for opting out of participating or withdrawing from the study. To ensure this stipulation, an outside examiner was used for testing. In other words, this study's researcher did not perform any of the psychomotor examinations for the students in these cohorts. Moreover, this group of students completed their didactic coursework at the end of this term, and they advanced to their fieldwork training. To that end, the students knew that no penalty in grade or matriculation could occur.

Privacy and confidentiality are important ethical considerations, and this study included efforts to ensure that this principle was met. The participant grading sheets are protected by the Family Educational Rights and Privacy Act (FERPA), and these documents are securely stored at the university in accordance with the regulation of student records policy. Additionally, the questionnaire was voluntary, and the results were anonymous. The USAHS's Office of Assessment and Institutional Research Senior Data Scientist compiled the Survey Monkey Data and ensured anonymity. A copy of the letter regarding confidentiality and password protected storage is available in Appendix I. Furthermore, the focus group session selection was voluntary, allowing participants a choice in their level of involvement in these discussions. Each focus group participant was assigned a unique code, and no names were used for the audio file transcription.

Since the study used current instructional strategies employed by the university, this study posed no additional risk to study participants. Moreover, students in PHT 5134C had already passed a course within the musculoskeletal curriculum, which includes basic psychomotor techniques and precautions. This previous course instruction mitigates any preexisting risk associated with learning these skills. Moreover, the University of Liverpool and the USAHS review and approval process noted minimal risk for participants. It should be noted that safeguards were in place to report any harm or discomfort that may have occurred as a result of study participation. The contact information for the principal investigator and the USAHS's IRB chair were both listed on the informed consent document to discuss questions and report any issue.

Chapter 3.4 Data Analysis.

The quantitative aspect of this study has two components. The first measure is the psychomotor examination score. The examination data were compared using a one-way repeated measures ANOVA. This statistical test is an extension of the dependent t-test and is used when participants are subjected to more than one condition, and the response to each condition is compared (Laerd Statistics, 2018). The psychomotor test scores represent the dependent variable and are measured on a continuous scale. This data was collected at the midway point and end of the semester for both cohorts. During these time points, participants were assessed on one skill from each instructional strategy. The independent variable is the instructional strategy with live demonstration and LMS-embedded multimedia representing the related groups. The Mauchly's Test ensured that no assumptions were violated. Descriptive statistics for the psychomotor examination scores are also provided. The second measure is the electronically administered questionnaire. The questionnaire's seven closed-ended questions were scored on a Likert scale, and descriptive statistics are reported for these questions.

The results of the five open-ended questions assisted in identifying topic areas that should be emphasized during the focus group discussions. Also, these results provided insight into the need to add other topic areas. Participant responses to the survey were analyzed for themes and are reported. The focus group for cohort one had six participants, and cohort two's focus group had four participants. The primary researcher performed the transcription to become immersed in the data. The transcribed data were subsequently coded and analyzed through constant comparative analysis. The focus group transcription was reviewed in detail, and statements were highlighted. Next, these statements were categorized into clusters or units of meaning, which in turn were compiled to generate the themes. A process of constant comparison was used to ensure that statements were categorized appropriately. Qualitative analysis of these focus group responses provides an additional perspective when interpreting the quantitative findings.

Chapter 3.5 Summary

Chapter Three discussed the study's methodology. The study design, sample, ethical considerations, and data analysis processes were detailed. The next chapter presents the data collected and the results of this study.

Chapter 4: Results

Chapter Four presents the study's data in four sections. The first section reports the practical examination score comparison for the live demonstration and LMS-embedded instructional multimedia groups. This data includes scoring for both lower and upper extremity examinations. The second section presents the Likert question data from the questionnaire, and the third section highlights themes from the open-ended questions. The analysis of focus group discussions is presented in section four.

4.1 Psychomotor testing data

Each participant completed two practical examinations over the study's duration. A lower extremity assessment was performed at the midway point, and an upper extremity assessment was performed at the end of the 15-week course. Each student was evaluated on a live demonstration technique and LMS-embedded multimedia instruction technique for both the lower and upper extremity practical examinations. The selected psychomotor techniques that the participants performed were chosen using a random number generator. All the techniques were assigned to both learning groups. The grade means for the live demonstration and LMS-embedded multimedia instruction for each participant was calculated, and these means were compared for the lower and upper extremities using a one-way repeated measures ANOVA. The results for the lower and upper extremities are below, including calculations for all participants and each of the two cohorts.

Lower extremity.

A histogram for the live demonstration lower extremity grade means is illustrated in Figure 4.1. The LMS-embedded instructional multimedia lower extremity grade means are shown in Figure 4.2. Both reveal a narrow range restriction. The lower extremity descriptive statistics and one-way repeated measures ANOVA for both groups are represented below in Tables 4.1 and 4.2, respectively. The one-way repeated measures ANOVA was used to compare subject scores for the lower extremity components of the course. The participants' mean total score for the live demonstration learning condition was slightly smaller than the mean total score for the LMS-embedded condition. The difference between these means is not statistically significant F (1,112) = 0.05, p = .832. The partial eta squared value is indistinguishable from zero.

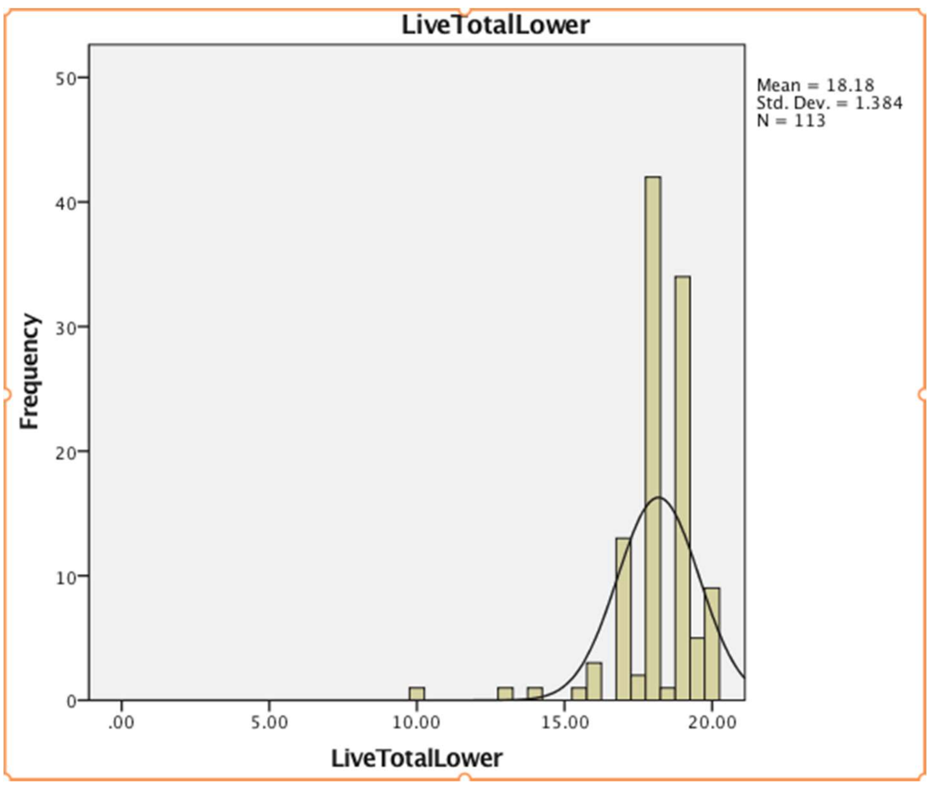

Figure 4.1 Histogram of lower extremity live demonstration grade means

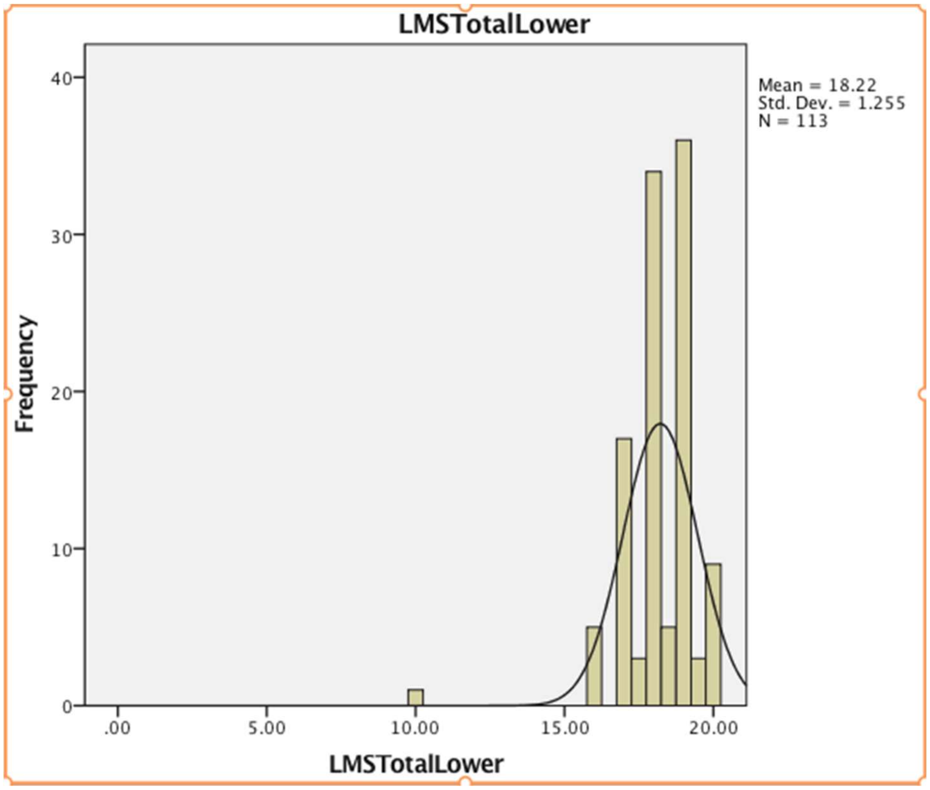

Figure 4.2 Histogram of lower extremity LMS-embedded multimedia grade means

Table 4.1

Descriptive Statistics for Lower Extremity Total Score for Both Cohorts

	Mean	Std. Deviation	N
Live Total Lower	18.18	1.38	113
LMS Total Lower	18.22	1.26	113

Table 4.2

Repeated Measures ANOVA for Within-Subject Comparison (Live versus LMS)

Model	SS	*df*	MS	*F*	*p.*	η^{p2}
Within Treatments	.71	1	8.37	.05	.832	.000
Error	175.93	112	1.57			

The comparisons outlined above are for both cohort one and cohort two. The descriptive statistics for individual cohorts are reported in Table 4.3 below. For cohort one, there is a slight performance advantage for LMS-embedded multimedia over the live demonstration learning condition, but this effect is swapped in cohort two. The differences between the means are very small, and there is no reason to suspect a cohort effect.

Table 4.3

Descriptive Statistics for Both Cohorts Lower Extremity Psychomotor Examination Scores

	Mean	Std. Deviation	N
Cohort 1 Live Total Lower	18.14	1.60	54
Cohort 1 LMS Total Lower	18.29	1.54	54
Cohort 2 Live Total Lower	18.22	1.16	59
Cohort 2 LMS Total Lower	18.15	.93	59

The psychomotor examination results for the six body regions were also compared. The three lower extremity body regions data is shown first, and the three upper extremity body regions data is presented in the next section. Forty-nine participants were tested on knee techniques. The descriptive statistics and one-way repeated measures ANOVA data for the knee body region are shown in Tables 4.4 and 4.5, respectively.

Table 4.4

Descriptive Statistics for the Knee

	Mean	Std. Deviation	N
Live Total Lower	18.34	.85	49
LMS Total Lower	18.27	.99	49

Table 4.5

Repeated Measures ANOVA for Within-Subject Comparison (Live Versus LMS) for the Knee

Model	SS	*df*	MS	*F*	*p.*	η^{p2}
Within Treatments	.13	1	.13	.18	.672	.004
Error	33.00	48	.69			

The participants' mean total score for the live demonstration learning condition was slightly larger than the mean total score for the LMS-embedded condition. The difference between these means is not statistically significant F (1,48) = 0.18, p = .672. The partial eta squared value is .004.

Forty-eight participants were tested in foot and ankle body region skills. The descriptive statistics and the one-way repeated measures ANOVA are presented in Table 4.6 and 4.7.

Table 4.6

Descriptive Statistics for the Foot and Ankle

	Mean	Std. Deviation	N
Live Total Lower	18.14	1.76	48
LMS Total Lower	18.45	.95	48

Table 4.7

Repeated Measures ANOVA for within-subject comparison (live versus LMS) for the Foot and Ankle

Model	SS	*df*	MS	*F*	*p.*	η^{p2}
Within Treatments	2.34	1	2.34	1.21	.277	.025
Error	90.91	47	1.93			

Participants' mean total score for the live demonstration learning condition was slightly lower than the mean total score for the LMS-embedded condition. The difference between these means is not statistically significant F (1,47) = 1.21, p = .277. The partial eta squared value is .025.

The hip body region was tested for 16 participants. Table 4.8 lists the descriptive statistics, and Table 4.9 shows the one-way repeated measures ANOVA data.

Table 4.8

Descriptive Statistics for the Hip

	Mean	Std. Deviation	N
Live Total Lower	17.84	1.46	16
LMS Total Lower	17.38	2.19	16

Table 4.9

Repeated Measures ANOVA for within-subject comparison (live versus LMS) for the Hip

Model	SS	*df*	MS	*F*	*p.*	η^{p2}
Within Treatments	1.76	1	1.76	.55	.469	.035
Error	47.87	15	3.11			

Participants' mean total score for the live demonstration learning condition was slightly larger than the mean total score for the LMS-embedded condition. The difference between these means is not statistically significant F (1,15) = 0.55, p = .469. The partial eta squared value is .035.

Each of the lower extremity body regions demonstrated similar results to the cumulative data. The differences between the group means are small, and the p value range was .277 to .672. These values reveal no statistical difference in the mean examination scores between the two instructional strategies.

Upper extremity.

Once again, one-way repeated measures ANOVA was used to compare subject scores for the upper extremity components of the course. Histograms of the live demonstration and LMS-embedded multimedia examination scores for the upper extremity are illustrated in Figures 4.3 and 4.4. Again, a narrow range restriction is noted. The descriptive statistics are found in Table 4.10 below.

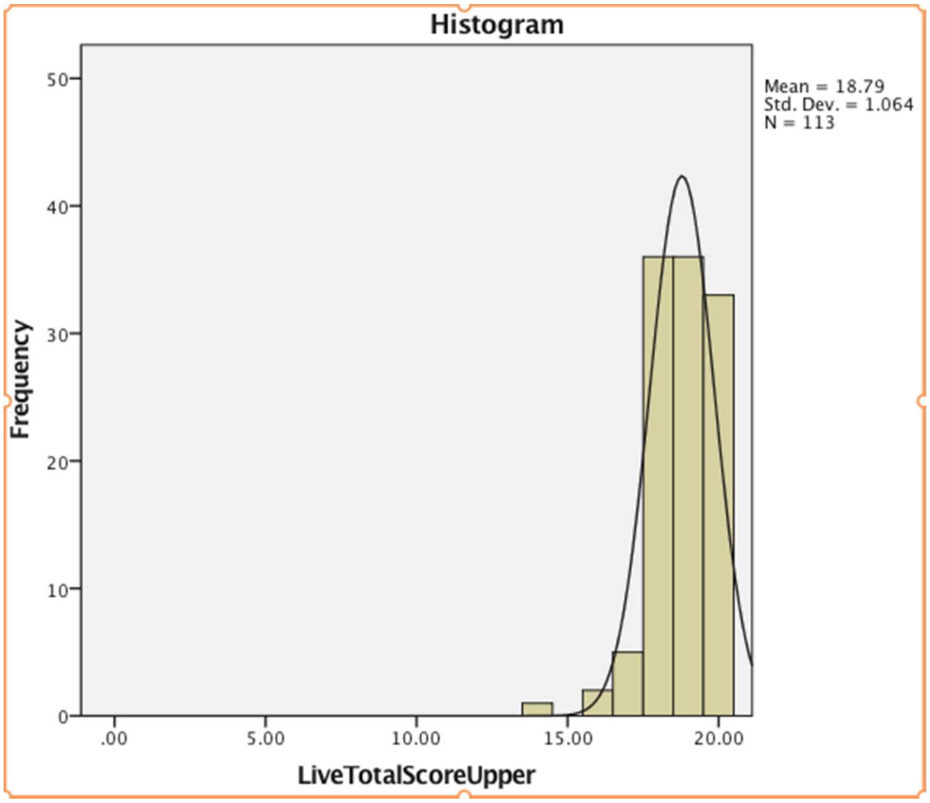

Figure 4.3 Histogram of upper extremity live demonstration multimedia grade means

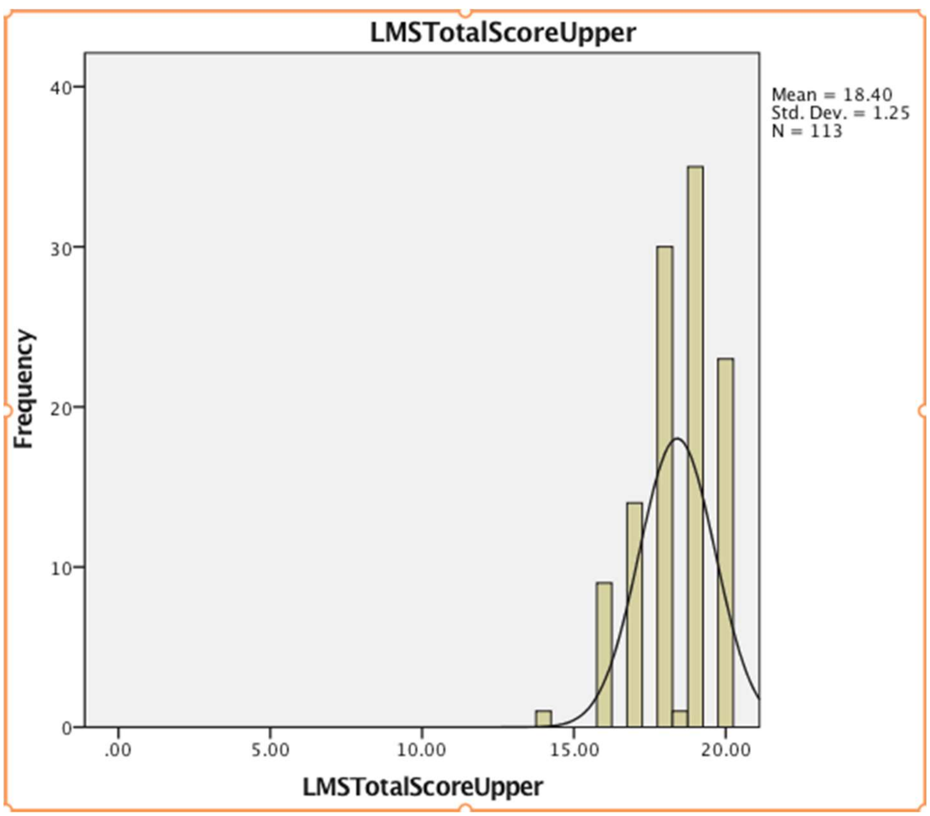

Figure 4.4 Histogram of upper extremity LMS-embedded multimedia grade means

Table 4.10

Descriptive Statistics for Upper Extremity Total Score

	Mean	Standard Deviation	N
Live Demonstration	18.79	1.06	113
LMS	18.40	1.25	113

Table 4.11 illustrates the repeated measures ANOVA for within-subject comparison for the upper extremity. Participants' mean total score for the live demonstration instruction was slightly larger than the mean total score for the LMS condition. The difference between these means is statistically significant F (1,112) = 6.86, p = .010. The partial eta squared value is quite small (.058).

Table 4.11

Repeated Measures ANOVA for within-subject comparison (live versus LMS)

Model	SS	*df*	MS	*F*	*p.*	η^{p2}
Within Treatments	8.37	1	8.37	6.86	.010	.058
Error	136.75	112	1.22			

The comparisons outlined above are for both cohort one and cohort two. The descriptive statistics for individual cohorts are reported in Table 4.12 below. The same slight advantage for the live demonstration over the LMS-embedded multimedia learning holds in both cohort groups. There is no reason to believe that there is a cohort effect present.

Table 4.12

Descriptive Statistics for Both Cohorts Upper Extremity Psychomotor Examination Scores

	Mean	Std. Deviation	N
Cohort 1 Live Total Score	18.85	1.23	54
Cohort 1 LMS Total Score	18.71	1.12	54
Cohort 2 Live Total Score	18.73	1.01	59
Cohort 2 LMS Total Score	18.12	1.30	59

The data analysis for each of the upper extremity body regions is presented below. Twenty-one participants were tested in the elbow body region skills. Table 4.13 shows the descriptive statistics, and the one-way repeated measures ANOVA data is listed in Table 4.14.

Table 4.13

Descriptive Statistics for the Elbow

	Mean	Std. Deviation	N
Live Total Lower	18.57	1.36	21
LMS Total Lower	18.19	1.33	21

Table 4.14

Repeated Measures ANOVA for within-subject comparison (live versus LMS) for the Elbow

Model	SS	*df*	MS	*F*	*p.*	η_{p}^{2}
Within Treatments	1.52	1	1.52	.84	.372	.04
Error	36.48	20	1.82			

Participants' mean total score for the live demonstration learning condition was slightly larger than the mean total score for the LMS-embedded condition. The difference between these means is not statistically significant F (1,20) = 0.84, p = .372. The partial eta squared value is .04.

Forty participants were tested on the shoulder body region. The descriptive statistics are shown in Table 4.15. Also, the one-way repeated measures ANOVA is shown in Table 4.16.

Table 4.15

Descriptive Statistics for the Shoulder

	Mean	Std. Deviation	N
Live Total Lower	18.85	.92	40
LMS Total Lower	18.48	1.11	40

Table 4.16

Repeated Measures ANOVA for within-subject comparison (live versus LMS) for the Shoulder

Model	SS	*df*	MS	*F*	*p.*	η^{p2}
Within Treatments	2.81	1	2.81	3.26	.079	.077
Error	33.69	39	.86			

Participants' mean total score for the live demonstration learning condition was slightly larger than the mean total score for the LMS-embedded condition. The difference between these means is not statistically significant F (1,39) = 3.25, p = .079. The partial eta squared value is .077.

The wrist and hand body region was tested in 52 participants. The descriptive statistics and one-way repeated measures ANOVA are presented in Table 4.17 and 4.18, respectively.

Table 4.17

Descriptive Statistics for the Wrist and Hand

	Mean	Std. Deviation	N
Live Total Lower	18.82	1.04	52
LMS Total Lower	18.43	1.33	52

Table 4.18

Repeated Measures ANOVA for within-subject comparison (live versus LMS) for Wrist and Hand

Model	SS	*df*	MS	*F*	*p.*	η_p^2
Within Treatments	4.04	1	4.04	3.10	.085	.057
Error	66.58	51	1.31			

Participants' mean total score for the live demonstration learning condition was slightly larger than the mean total score for the LMS-embedded condition. The difference between these means is not statistically significant F (1,51) = 3.10, p = .085. The partial eta squared value is .057.

Similar to the lower extremity, the analysis of each of the upper extremity body regions revealed no statistical difference between examination means testing scores. The p value ranged from .079 to .372. That said, the cumulative upper extremity data differed from the lower extremity data. While the lower extremity body regions did not show a difference between examination testing means, the upper extremity data revealed a larger score for the live demonstration group. This difference was statistically significant with a p value of .010. In other words, student performance was better for the live demonstration group on upper extremity techniques when all three body regions were combined for analysis, but no difference was noted for the lower extremity.

4.2 Quantitative questionnaire data

The second measure was the questionnaire, which was administered electronically through the online software, SurveyMonkey. The survey aim was to gauge student perceptions of using LMS-embedded instructional multimedia as a primary instructional strategy for psychomotor skills. As previously mentioned, the procedure employed for the questionnaire ensures anonymous data. The questionnaire included both closed and open-ended questions. The descriptive statistics for the seven closed-ended Likert scale questions are provided below.

The open-ended questions were analyzed for themes, and this information is presented in section 4.3. The participants were segregated into two cohorts. Cohort one consisted of 54 participants, and 42 completed the questionnaire representing a response rate of 77.78 percent. Cohort two had a similar response rate of 77.9 percent, with 46 of 59 participants completing the questionnaire.

Clarity of the instructions.

The first question asked if the instructions for using the LMS-embedded instructional multimedia (online video) were clear. Most participants agreed or strongly agreed with the statement representing 92.85 percent and 93.48 percent for cohorts one and two, respectively. Two participants in both cohorts, 4.76 percent and 4.35 percent of each sample, answered indifferently to the statement. One participant, less than 3 percent of the sample, in each cohort strongly disagreed with the statement. Table 4.19 illustrates the aggregate data, and Figure 4.5 displays this data graphically. While most participants reported that the instructions for using the LMS-embedded videos were clear, a small percentage of participants stated that the instructions were unclear.

Table 4.19

Question 1: The Instructions for Using the LMS-Embedded Instructional Multimedia (Online Video) Were Clear

Answer Choices	Cohort 1		Cohort 2		Total	
Strongly disagree (1)	2.38%	1	2.17%	1	2.27%	2
Disagree (2)	0.00%	0	0.00%	0	0.00%	0
Indifferent (3)	4.76%	2	4.35%	2	4.54%	4
Agree (4)	33.33%	14	43.48	20	38.63%	34
Strongly agree (5)	59.52%	25	50.00%	23	54.54%	48
Answered	100%	42	100%	46	100%	88
Skipped	0.00%	0	0.00%	0	0.00%	0

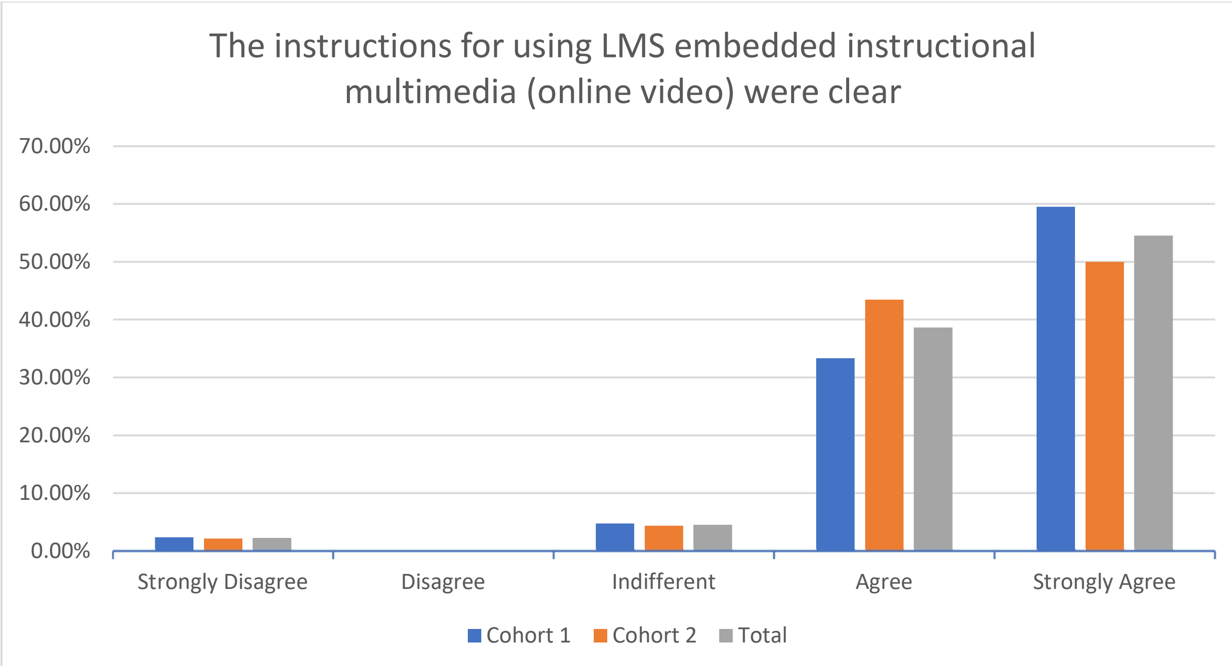

Figure 4.5 Question one results

Useful review of material.

The second question inquired if the program served as a useful review of material that was previously learned. Table 4.20 illustrates the aggregate data, and Figure 4.6 graphically illustrated this data graphically. One student in cohort two did not answer this question. Both cohorts had a similar outcome, with 88 percent answering agree or strongly agree. Four participants in cohort one, 9.52 percent of the sample, and one participant in cohort two, 2.22 percent of the sample, answered indifferently to the statement. One participant, 2.38 percent of the sample, in cohort one disagreed with the statement, and four participants, 8.88 percent of the sample, either disagreed or strongly disagreed with the statement. Most of the participants found the LMS-embedded multimedia useful for a review of previously learned material. That said, some participants did not find it useful. Interestingly, cohort two had a higher percentage of participants, 8.88 percent, that didn't find this method of learning helpful compared to cohort one, 2.38 percent.

Table 4.20

Question 2: This program served as a useful review of material I previously learned						
Answer Choices	Cohort 1		Cohort 2		Total	
Strongly disagree (1)	0.00%	0	2.22%	1	1.14%	1
Disagree (2)	2.38%	1	6.66%	3	4.59%	4
Indifferent (3)	9.52%	4	2.22%	1	5.74%	5
Agree (4)	28.57%	12	48.88%	22	41.37%	36
Strongly agree (5)	59.52%	25	40.00%	18	49.42%	43
Answered	100%	42	97.82%	45	98.86%	87
Skipped	0.00%	0	2.17%	1	1.13%	1

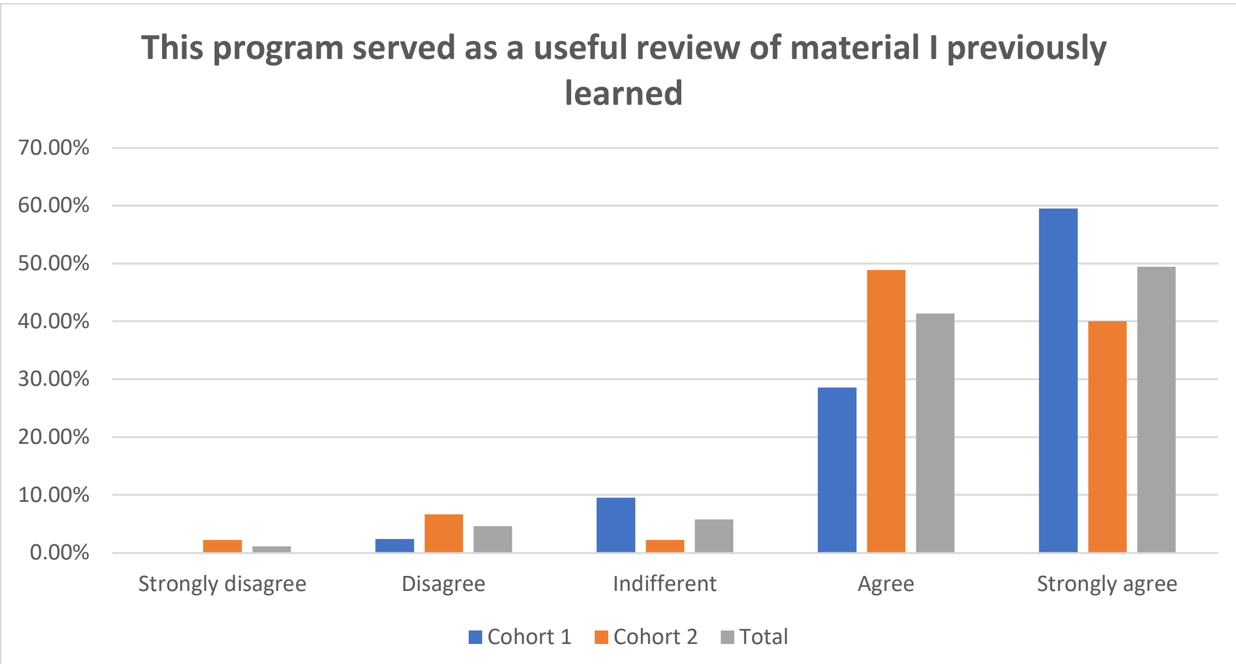

Figure 4.6 Question two results

LMS-embedded instructional multimedia was interesting.

Question three asked if the LMS-embedded instructional multimedia (online video) method of learning was interesting. Table 4.21 illustrates the aggregate data, and Figure 4.7 displays this data graphically. Agree or strongly agree were the most frequent answers representing 80.96 percent of cohort one and 82.03 percent of cohort two. Six participants, 14.29 percent of the sample, in cohort one and 14 participants, 30.43 percent of the sample, in cohort two, answered indifferently to this statement. Two participants in each cohort, 4.76 percent for cohort one and 4.34 percent for cohort two, disagreed with the statement, and one participant, 2.17 percent of the sample, in cohort two strongly disagreed with the statement. The majority of the participants reported that the LMS-embedded instructional multimedia method of learning was interesting. A small number of participants did not find this method of learning interesting.

Table 4.21

Question 3: The LMS-embedded instructional multimedia (online video) method of learning was interesting.						
Answer Choices	Cohort 1		Cohort 2		Total	
Strongly disagree (1)	0.00%	0	2.17%	1	1.13%	1
Disagree (2)	4.76%	2	4.34%	2	4.54%	4
Indifferent (3)	14.29%	6	30.43%	14	22.72%	20
Agree (4)	42.86%	18	41.30%	19	42.04%	37
Strongly agree (5)	38.10%	16	21.73%	10	29.54%	26
Answered	100%	42	100%	46	100%	88
Skipped	0.00%	0	0.00%	0	0.00%	0

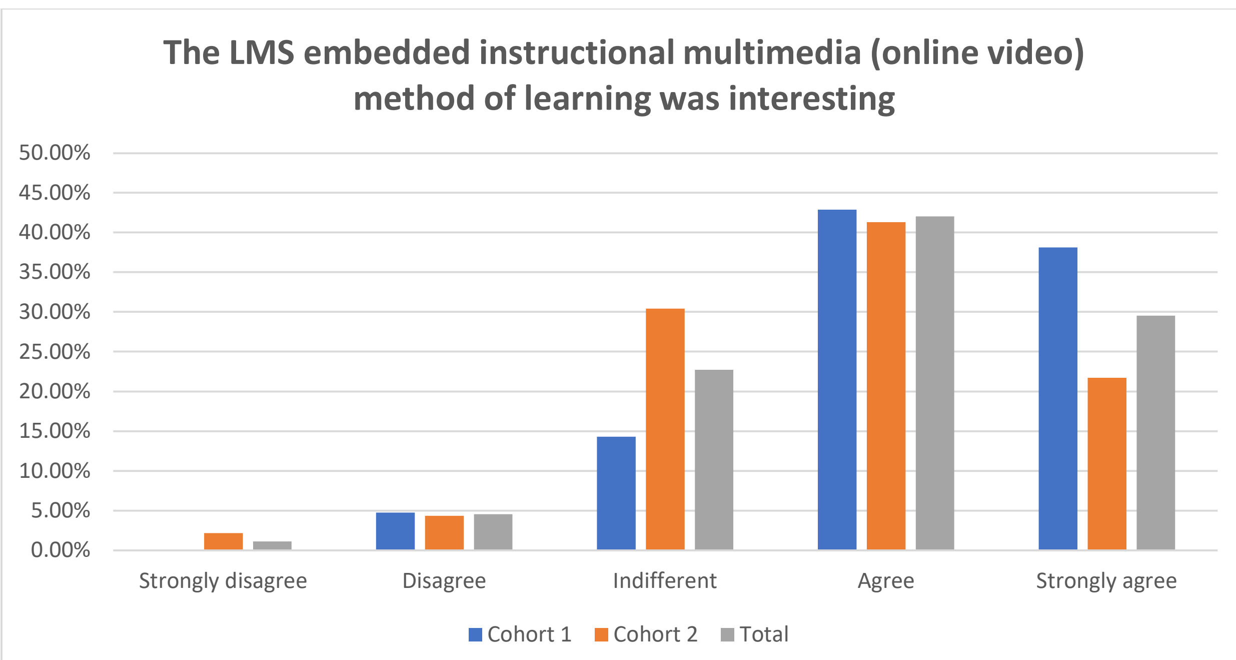

Figure 4.7 Question three results

LMS-embedded instructional multimedia was a waste of time.

Question four asked if the LMS-embedded instructional multimedia (online video) method of learning was a waste of time. Table 4.22 illustrates the aggregate data, and Figure 4.8 displays this data graphically. Eight five percent of cohort one and 78.25 percent of cohort two disagreed or strongly disagreed. Three participants for each cohort responded agree or strongly agree with this statement representing 7.14 percent of cohort one and 6.82 percent of cohort two. The remaining three cohort one participants, 7.14 percent, and seven cohort two participants, 15.21 percent, answered indifferent. The video use was not considered to be a waste of time for a large percentage of each cohort. However, a small proportion of both cohorts responded that it was a waste of time.

Table 4.22

Question 4: The LMS-embedded instructional multimedia (online video) method of learning was a waste of time.						
Answer Choices	Cohort 1		Cohort 2		Total	
Strongly disagree (1)	40.48%	17	36.95%	17	3.86%	34
Disagree (2)	45.24%	19	41.30%	19	43.18%	38
Indifferent (3)	7.14%	3	15.21%	7	11.36%	10
Agree (4)	4.76%	2	2.17%	1	3.40%	3
Strongly agree (5)	2.38%	1	4.65%	2	3.40%	3
Answered	100%	42	100%	46	100%	88
Skipped	0.00%	0	0.00%	0	0.00%	0

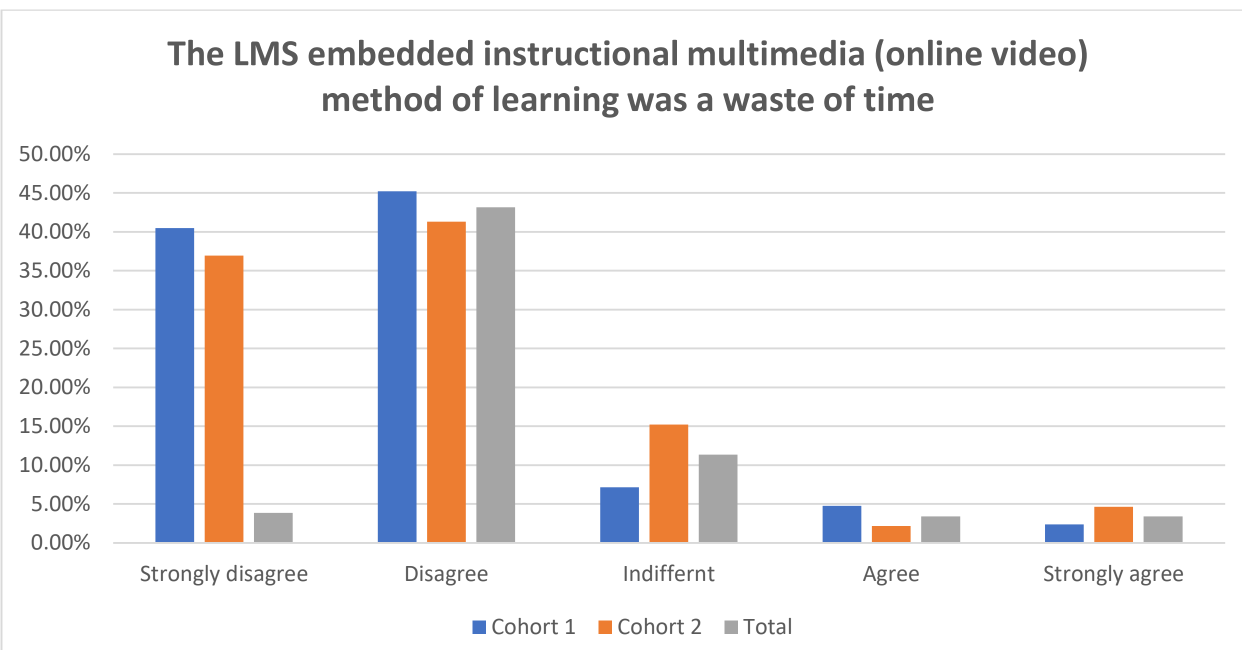

Figure 4.8 Question four results

Student learning and LMS-embedded instructional multimedia.

Question five asked if the participant "learned a lot" from the LMS-embedded instructional multimedia (online video) method of learning. Table 4.23 illustrates the aggregate data, and Figure 4.9 displays this data graphically. The majority of each cohort reported agree to strongly agree with this statement. In total, 78.57 percent of cohort one and 67.39 percent of cohort two answered in this manner. Seven participants in cohort one, 16.67 percent, and ten participants in cohort two, 21.73 percent, answered indifferent to this question. In the disagree to strongly disagree sections, 4.76 percent of cohort one and 10.86 percent of cohort two, representing two and five participants in their respective cohorts, indicated these responses. Most of the participants stated that they learned a lot from the LMS-embedded instructional multimedia, although a small percentage reported that they did not.

Table 4.23

Question 5: I learned a lot from the LMS-embedded instructional multimedia (online video) method of learning.						
Answer Choices	Cohort 1		Cohort 2		Total	
Strongly disagree (1)	0.00%	0	2.17%	1	1.13%	1
Disagree (2)	4.76%	2	8.69%	4	6.81%	6
Indifferent (3)	16.67%	7	21.73%	10	19.31%	17
Agree (4)	52.38%	22	39.13%	18	45.45%	40
Strongly agree (5)	26.19%	11	28.26%	13	27.27%	24
Answered	Answered	42	100%	46	100%	88
Skipped	Skipped	0	0.00%	0	0.00%	0

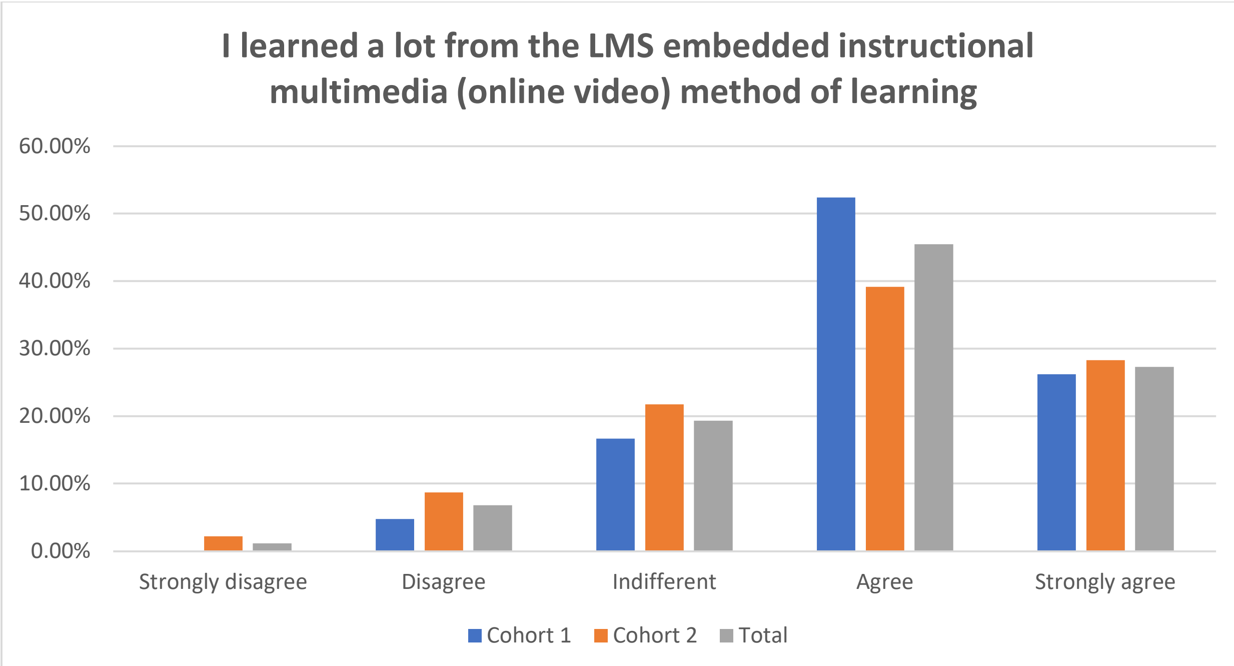

Figure 4.9 Question five results

LMS-embedded instructional multimedia and visual learners.

Question six asked if the LMS-embedded instructional multimedia (online video) method of learning was helpful to the participant because they are a visual learner. Table 4.24 illustrates the aggregate data, and Figure 4.10 displays this data graphically. In cohort one, 76.19 percent responded agree to strongly agree, and 84.76 percent of cohort two answered the same. No participant from cohort one disagreed or strongly disagreed, but one participant, 2.17 percent, of cohort two strongly disagreed with this statement. Ten respondents from cohort one, 23.81 percent, and six from cohort two, 13.04 percent answered indifferent to this question. Participants that viewed themselves as visual learners reported that the LMS-embedded instructional multimedia was helpful. This student perception was predominant in this question, with most participants reporting agree to strongly agree.

Table 4.24

Question 6: The LMS-embedded instructional multimedia (online video) method of learning was helpful to me because I am a visual learner.						
Answer Choices	Cohort 1		Cohort 2		Total	
Strongly disagree (1)	0.00%	0	2.17%	1	1.13%	1
Disagree (2)	0.00%	0	0.00%	0	0.00%	0
Indifferent (3)	23.81%	10	13.04%	6	18.18%	16
Agree (4)	45.24%	19	60.86%	28	53.40%	47
Strongly agree (5)	30.95%	13	23.9%	11	27.27%	24
Answered	100%	42	100%	46	100%	88
Skipped	0.00%	0	0.00%	0	0.00%	0

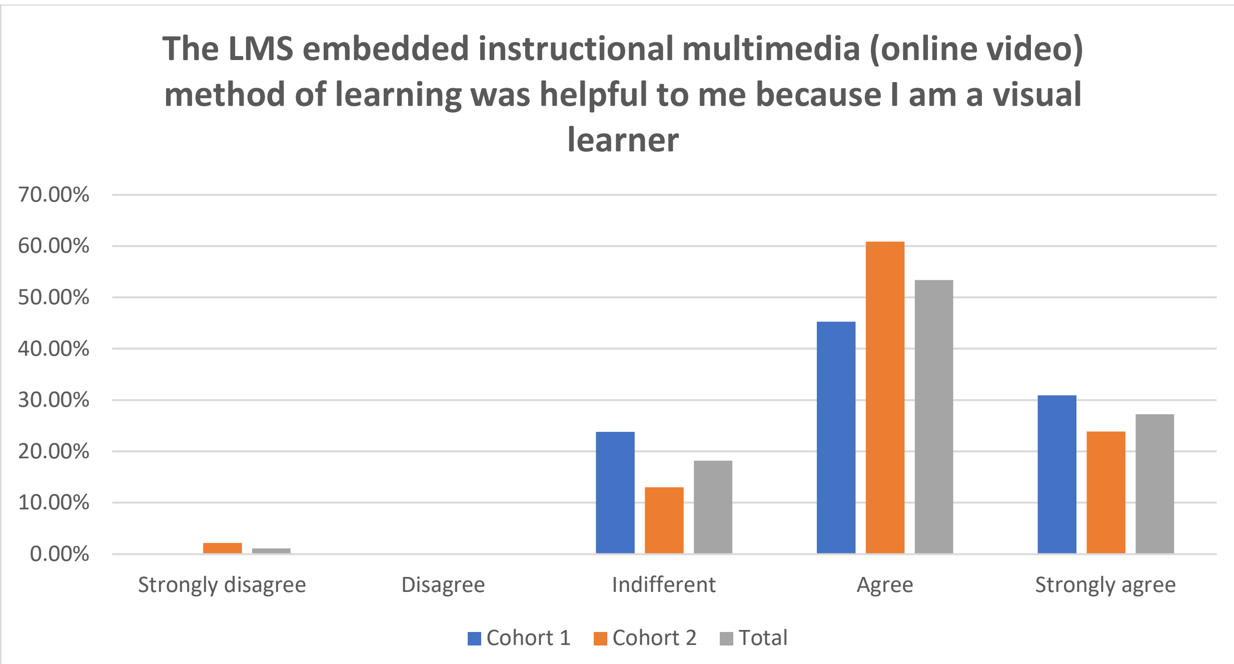

Figure 4.9 Question six results

Future enrollment in LMS-embedded instructional multimedia courses.

Question seven concluded the questionnaire by asking if the participant would enroll in classes that use LMS-embedded instructional multimedia (online video) method of learning again, if available. Table 4.24 illustrates the aggregate data, and Figure 4.10 once again depicts this data graphically. The cohorts differed in their responses to this question. Agree or strongly agree was the response for 59.53 percent of cohort one while 45.65 percent of cohort two responded the same. Thirteen respondents for both cohorts indicated an indifferent response representing 30.95 percent and 28.26 percent for cohort one and two, respectively. This survey question had the largest number of indifferent responses. Four cohort one respondents, 9.52 percent of the sample answered disagree to strongly disagree, and 12 participants in cohort two, 26.08 percent of the sample, indicated disagree to strongly disagree with this question. While the majority of each cohort answered indifferent to strongly agree regarding taking courses that offer LMS-embedded multimedia instructional strategies for psychomotor skills, cohort two had over a quarter report that they wouldn't enroll in these classes.

Table 4.24

Question 7: I would enroll in classes that use LMS-embedded instructional multimedia (online video) method of learning again, if available.						
Answer Choices	Cohort 1		Cohort 2		Total	
Strongly disagree (1)	2.38%	1	6.52%	3	4.545%	4
Disagree (2)	7.14%	3	19.56%	9	13.63%	12
Indifferent (3)	30.95%	13	28.26%	13	29.54%	26
Agree (4)	42.86%	18	28.26%	13	35.22%	31
Strongly agree (5)	16.67%	7	17.39%	8	17.04%	15
Answered	100%	42	100%	46	100%	88
Skipped	0.00%	0	0.00%	0	0.00%	0

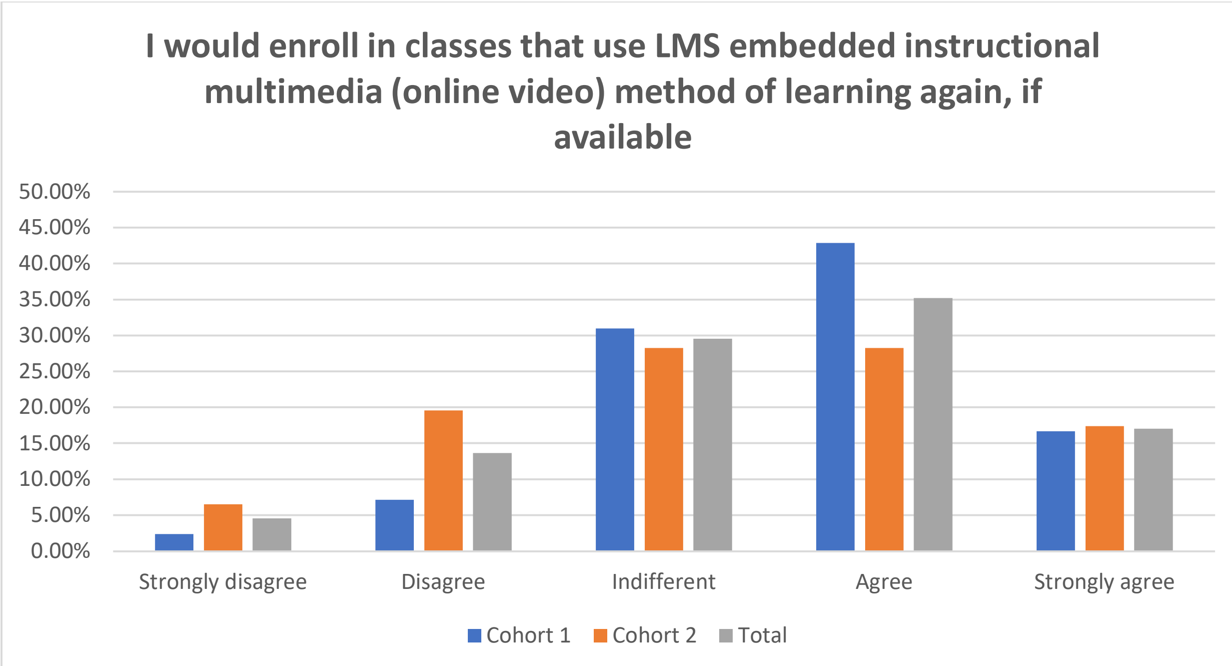

Figure 4.10 Question seven results

Section 4.2 described the results of the seven closed-ended Likert scale questions from the survey. Common responses from this data included the use of LMS-embedded instructional multimedia was interesting, had clear instructions, served as a useful review, and facilitated learning. Additionally, this learning strategy was not perceived to be a waste of time. A more positive experience using multimedia instruction was reported by participants that see themselves as visual learners. The next section will examine the open-ended survey questions and explore emerging themes.

4.3 Open-ended questionnaire data

The questionnaire included five open-ended questions. The responses to these questions were analyzed for themes through an iterative process. Some of the generated themes reinforce prior research findings. That notwithstanding, analysis for each question is presented below with selected quotations from respondents. Tables 4.25-4.36 categorize these themes and quotes. Chapter Five further relates these results to the literature.

Best features.

Question eight was the first open-ended question on the questionnaire and asked what the participant liked best about the LMS-embedded instructional multimedia (online video) method of learning. The thematic analysis and select responses are listed in Tables 4.25-4.30. Seventy-four percent of each cohort responded to this question, and a review of the responses revealed similar themes for both groups.

The primary theme illustrated by the responses was the convenience of access. Twenty-five of the 40 cohort one respondents and 25 of the 44 respondents from cohort two stated that they liked the feature best about the LMS-embedded instructional multimedia. This convenience of access rate of response represents 62.5 percent and 56.81 percent of cohort one and two participants. Table 4.25 demonstrates the convenience of access theme with selected student quotations.

Table 4.25

Question 8 Convenience of Access Thematic Analysis and Select Quotations

Theme	Select Quotations
Convenience of access Cohort one 25 responses Cohort two 25 responses	"that we had something that we could go back to anytime we wanted" C1R2 "The accessibility of those resources enhances my learning." C1R8 "The ability to go back on my own time and view the manipulations in real time. Instead of attempting to remember what I thought a technique looked like or what I thought I heard the instructor say. We are only taught these manipulations once and the videos helped to refine the techniques." C1R22 "I liked that the videos for the techniques were available at any time if I forgot how to do the technique." C1R28 "I like that I was able to refer back to it whenever I needed to. There were many times when we all had questions and debates about how to perform a specific technique. It was nice that we could look back at the video to confirm." C2R37

Note. C1=Cohort One; C2=Cohort Two; R=respondent

Two conveniences of access subthemes emerged. The first subtheme was using the videos for skill review prior to the practical examination. This type of access was specifically "liked" by 20 percent of the respondents for each cohort. Selected participant quotations for this subtheme are provided in Table 4.26.

The second subtheme was viewing the videos before the laboratory class. Five percent of cohort one respondents reported that this feature was the best. Cohort two had similar feedback, with 6.8 percent of respondents stating the same. Selected participant quotations for this subtheme are provided in Table 4.27.

Table 4.26

Question 8 Review for Test Subtheme for Convenience of Access and Select Quotations

The convenience of Access Subtheme	Select Quotations
Review for test Cohort one 8 responses Cohort two 9 responses	"I liked that I was able to go back and review the material when studying for the test" C1R5 "I have the ability to repetitively watch the video. Clear and precise instructions is known prior to the practical examination." C1R29 "I could revisit the video and watch it again while I'm studying" C1R34 "The online videos are another way of learning the same material. I appreciate having different methods of learning the same content. Seeing it in person, reading about it in the course notes, and also having this online video version really helps solidify my learning. It's also helpful to have a standardized video reference every student sees for practical testing purposes. Sometimes in learning these psychomotor skills there can be variation person to person and understanding the tested technique can get lost." C2R3 "I thought the videos were very helpful in reviewing while preparing for the final. They were a great resource for studying because they were quick and demonstrated the correct way to perform each technique." C2R8 "It was easy to review on multiple occasions when studying for exams." C2R31

Note. C1=Cohort One; C2=Cohort Two; R=respondent

Table 4.27

Question 8 Review Before Class Subtheme for Convenience of Access and Select Quotations

Convenience of Access Subtheme	Select Quotations
Viewing before class Cohort one 2 responses Cohort two 3 responses	"Having the ability to review before class and before exams in a timely manner."C1R4 "I appreciated being able to practice the techniques before class, and to also use it as a quick reference when studying for practicals." C2R19

Note. C1=Cohort One; C2=Cohort Two; R=respondent

Another theme that emerged as a best feature for the LMS-instructional strategy was the student's ability to self-pace the instruction. Specifically, video features, including pause, play, and rewind, were mentioned as positives. Two participants from cohort one and three from cohort two stated that this was the best feature. Selected participant quotations for this theme are provided in the table below.

Table 4.28

Question 8 Self-Paced Instruction Thematic Analysis and Select Quotations

Theme	Select Quotations
Pause/Play/Rewind Cohort one 2 responses Cohort two 3 responses	"Clear and short video instructions on the task at hand. The ability to refer to the video, pausing and replaying during practice was helpful" C1R10 "The capability to pause, rewind, or speed of video to review, learn, or re-examine the techniques discussed." C2R18

Note. C1=Cohort One; C2=Cohort Two; R=respondent

The final theme that emerged from question eight relates to the length of the video. One participant from cohort one and six participants from cohort two reported that the short, concise nature of the videos was the best feature. Selected participant quotations for this theme are provided in the table below.

Table 4.29

Question 8 Best Features Thematic Analysis and Select Quotations

Theme	Select Quotations
Short/Concise Cohort one 1 response Cohort two 6 responses	"I like that the videos are short and to the point." C1R4 "It was quick and easy to watch" C2R1 "It was short, clear, and efficient" C2R2 "They were a great resource for studying because they were quick and demonstrated the correct way to perform each technique." C2R8

Note. C1=Cohort One; C2=Cohort Two; R=respondent

Least positive features.

Question nine asked what the participants liked least about the LMS-embedded instructional multimedia (online video) method of learning. Forty of the 52 participants in cohort one answered this question for a response rate of 76.92 percent. The response rate for cohort two was 69.49 percent, with 41 of 59 participants answering the question. An analysis of the responses revealed similar themes for both cohorts.

This question's primary theme was the limitation of the video's view or angle. Eighteen of the 40 cohort one respondents and 12 of the 41 respondents from cohort two stated that they did not like the limited view angle of LMS-embedded instructional multimedia. Many respondents specifically cited this issue related to smaller joints such as hand and finger techniques. Table 4.30 demonstrates the limitation of the video's view or angle theme with selected quotations.

Table 4.30

Question 9 Least Liked Features Thematic Analysis and Select Quotations

Theme	Select Quotations
Limitation of the video's view or angle Cohort one 18 responses Cohort two 12 responses	"…I would have liked a closer view of the mobilizations of the hand." C1R17 "It was sometimes difficult to see the precise hand placement in the videos, specifically the smaller more detailed mobilizations." C1R20 "Some views on the video were not at an advantageous point of view, such as some of the carpal manipulations" C1R28 "Only one view/ therapist sometimes had to do the technique in a different way than expected of us just so that we could see the hand placements" C1R32 "Some videos we were not able to see clearly the hand placements." C2R24 "Some techniques were hard to see if they were small movements or smaller joints" C2R29

Note. C1=Cohort One; C2=Cohort Two; R=respondent

Another question nine theme regarding the least liked feature of this instructional strategy was an inability to ask questions in real-time. Eight of the 40 respondents from cohort one reported this feature as their least liked. Ten of the 41 respondents from cohort two also highlighted the inability to ask questions as a least-liked feature. Table 4.31 illustrates this theme with selected quotations.

Table 4.31

Question 9 Least Liked Features Thematic Analysis and Select Quotations

Theme	Select Quotations
Inability to ask questions in real-time Cohort one 8 responses Cohort two 10 responses	"if we had any questions regarding the content, we would have to wait till the next class meeting to ask them." C1R2 "Conversely, the inability to ask questions in real time." C1R14 "No chance to see technique on a person in real time, no chance to ask questions about technique as instructor is demonstrating." C1R25 "the inability to ask immediate questions if further clarification was needed." C2R6 "Not able to ask questions." C2R32 "No interaction with instructor in real time" C2R39

Note. C1=Cohort One; C2=Cohort Two; R=respondent

Useful features.

Question ten asked if LMS-embedded instructional multimedia was useful compared to other ways of learning. This question also asked the respondent to state "why" or "why not" to further explain their answer. Forty-one of the 54 participants from cohort one and 43 of the 59 cohort participants answered this question. The response rate for question ten was 75.9 percent and 72.8 percent for cohort one and two, respectively. Similar themes were noted for both cohorts. Most of the participants found this method of learning useful. One reply from each cohort stated that it wasn't useful, which represents 2.4 percent of all respondents. Subthemes were identified regarding the specific useful features of this instructional strategy. Table 4.32 describes one subtheme and included selected quotations. Ten cohort one and 12 cohort two participants reported that the method of learning was useful for reviewing the skills.

Table 4.32

Question 10 Compared to other ways of learning, was this method of learning useful?

Theme	Select Quotations
Useful for review Cohort one 10 responses Cohort two 12 responses	"Yes, because I was able to review in my free time. It was also useful if there was a discrepancy in the book on performance of a technique. I was able to go back and see exactly how the professor would like to see if performed for practicals." C1R4 "Yes; again, it allows for repetition and a very clearly explained set of instructions and demonstration. It allows for more review of the material that may not be clear and as little review as needed of the material that is clear." C1R14 "It was beneficial in terms of reviewing material prior to exams, also clear on direction of force." C1R29 "I like to review at home, watching EXACTLY how the teacher wants us to perform it... rather than just by memory. I have a learning disability and reading sometimes is challenging for me, so visually I can do what is needed. C2R34" "yes, it allowed me to review the technique multiple times." C2R42

Note. C1=Cohort One; C2=Cohort Two; R=respondent

In addition to the review theme, the accessibility of instructional multimedia was also commonly reported. Six cohort one and seven cohort two participants found the accessibility useful. Table 4.33 reveals this theme included selected quotations.

Table 4.33

Question 10 Compared to other ways of learning, was this method of learning useful?

Theme	Select Quotations
Useful for accessibility Cohort one 6 responses Cohort two 7 responses	"It was useful. As stated before, online videos that are accessible at any time are extremely valuable." C1R6 "It is useful because it was easily accessible and I could go back and use it to study from." C1R7 "It was useful to have outside of class and to be able to access it whenever I wanted." C1R40 "Yes, it gave me another chance to view it at my convenience." C2R9 "Yes bc I could access it at my discretion." C2R10 "Yes, it was available the entire term to view the videos instead of looking at pictures and description while relying on memory." C2R24

Note. C1=Cohort One; C2=Cohort Two; R=respondent

The third question ten theme didn't specify a particular trait of this instructional strategy that was useful. Rather, seven cohort one and eight cohort two respondents stated that this method of learning was useful, but they prefer face-to-face instruction. Of the 84 total responses, 17.86 percent indicated a preference for classroom instruction despite the reported usefulness of LMS-embedded instructional multimedia instruction. Table 4.34 highlights this theme and includes select quotations.

Table 4.34

Question 10 Compared to other ways of learning, was this method of learning useful?

Theme	Select Quotations
Useful, but prefer face to face instruction Cohort one 7 responses Cohort two 8 responses	"yes, but prefer in-class instruction." C1R15 "I think it enhances learning, but I would not like it as my only method of instructions. I like real time feed back and the opportunity to ask questions or receive feedback during lab time." C1R17 "Overall, I would say that yes the online videos were helpful, but I still would prefer live demonstrations in class for the newer techniques that we have never seen before." C1R30 "I would prefer in class instruction with the online videos available to use as a supplement for reviewing material." C2R1 "Not as useful as in person techniques but definitely helpful." C2R32 "Yes it was useful but I feel online videos are best as a supplement to face to face learning." C2R41

Note. C1=Cohort One; C2=Cohort Two; R=respondent

Other utilized educational technology resources.

Question 11 asked if the participants used other educational technology resources to assist in learning the manual therapy psychomotor skills and, if so, to identify these resources. Thirty-eight of 54 cohort one and 45 of 59 cohort two participants answered this question for a response rate of 70.4 percent and 76.3 percent. Table 4.35 lists the additional resources used by each cohort.

The majority of respondents indicated that they did not use additional educational technology resources to assist their learning. Fifty-one of 83 participants answered "no" to this question, which represents 61.4 percent of all responses. That said, differences between cohorts were present for those participants that did report using supplemental resources. Fewer participants from cohort one, 31.5 percent, indicated that they used additional educational technology compared to 40 percent from cohort two. Differences in the utilized resources between groups were also noted, and this information is illustrated in Table 4.35.

Table 4.35

Additional educational technology used by each cohort

	Cohort one	Cohort two
YouTube	8	4
PhysioU	1	6
Facebook	0	7
Physiopedia	1	1
Prehab Guys	1	0
Essential Anatomy	1	0
Total	12 of 38 respondents (31.5%)	18 of 45 respondents (40%)

Additional comments.

Question 12 was the final open-ended question, and it provided an opportunity for the participants to list any other comments. This inquiry had the questionnaire's lowest response rate of 61 percent for cohort one and 55.9 percent for cohort two. The response analysis revealed a reiteration of some prior themes, including that the videos serve as a good source of review and that some participants prefer face-to-face instruction.

Moreover, an additional theme was noted within this question's responses. A request for increasing the number of videos to include additional psychomotor skills and expanding this instructional strategy to other courses was noted. This theme was reported in 10.6 percent of the total responses. Table 4.36 shows this theme and includes selected quotations.

Table 4.36

Question 12 Any other comments?

Theme	Select Quotations
Cohort one 4 responses Cohort two 3 responses	"Thank you for providing the LMS videos for this class! I would have loved to use the LMS videos for each technique in this class as well as every technique for MSI and Therapeutic Exercise I (manual therapy skills, special tests, MMTs, MLTs, stretching and strengthening techniques, etc) because your systematic approach was superior to all other videos I watched online when in those classes and FAR more superior to the instructions given in class, due to my difficulty with learning material when I only see it performed once in class. Thank you again!!" C1R22 "I think that videos demonstrating techniques would have been helpful in other courses as well (ThereEx I especially)." C2R8

Note. C1=Cohort One; C2=Cohort Two; R=respondent

Section 4.3 reported the results of the five open-ended questions from the survey, and a thematic analysis was performed. The majority of participants found LMS-embedded instructional multimedia useful, especially for review and accessibility. Moreover, the ability to self-pace instruction was deemed positive. Limitations were also noted. An inability to ask questions in real-time was reported as the least liked feature, and body regions with small joints, such as the wrist and hand, were reported to have challenging viewing angles. Interestingly, many participants that found this instructional strategy useful also reported a preference for face-to-face instruction. The next section will examine the focus group sessions and further explore these themes.

4.4 Focus group data

This section presents the results of the focus group sessions and addresses the third research question: What is the student perception of using LMS-embedded instructional multimedia? Transcript analysis from the two focus groups was performed to discover codes, categories, and themes. Chapter Three includes a description of this process.

The focus group sessions occurred at the end of the 15-week study and followed the completion of the two psychomotor examinations and the questionnaire. A single meeting was held for each cohort focus group. Focus group one had six participants and lasted 41 minutes. Focus group two had four participants and lasted 30 minutes. More women than men volunteered for both focus group sessions. Sixty-six percent of cohort one and 75 percent of cohort two participants were female. This ratio is similar to the physical therapy profession in the USA, which is 70 percent female (APTA, 2013). The focus group participants were seated in a circular pattern around a conference table. Similar codes and categories were present in both focus groups, and Appendix J lists this data for each topic area. The key themes from this analysis are presented together and illustrated with individual focus group participant quotes.

Theme 1: The videos were perceived positively for preparation and review.

The first theme that emerged was that most focus group participants have a positive perception of LMS-embedded instructional multimedia. One participant captured the essence of what was shared about this topic area.

> *I liked being able to look at it before class just to prep for class. Then we got more class time of instruction and feedback, which helps facilitate our learning and make sure that we are doing it correctly.* (Focus Group 2 Participant 4).

Since the research questions investigated LMS-embedded multimedia as a primary learning strategy, the intention was for participants to watch the videos before the laboratory class a means of preparation. While this practice was described positively, many participants reported using the videos mostly for practical examination review.

> *I [watched] it once or twice before class, and I took preliminary notes on it. Then, I didn't really look at them again until a week or two before the practical when I was*

> *running through skills, and I was like where is my hand, was line of force this way, am I standing to the left of you, so then I could rewind and watch the video to see where you are positioned and copy what you did and bring my memory back. I found it more useful as a study tool than an initial instructional strategy. Although, that [videos] was a nice thing to have before class.* (Focus Group 1 Participant 1).

Further discussion on using the videos for examination review revealed that participants considered them a supportive tool. The convenience of access and repetitive viewing were highlighted as essential features for the skill review process. Participant four from the second focus group stated:

> *I feel like that it was mainly for the review. It really supplemented my ability to prepare for the practicals because I knew that I was doing it correctly. Rather than having that one-time classroom experience.*

Moreover, the videos were perceived as helpful to standardize skill performance expectations and increase examination review efficiency.

> *I still had the same review process, whether I was recalling what I saw in person or the video…The only difference was like participant four said about discrepancies. One [video] has a standard, and the other requires recall from class.* (Focus Group 1 Participant 1).

Another added:

> *It allowed for us to be very clear on what the actual technique was supposed to be. Rather than my interpretation was this or that. We would just watch the videos, so we were 100 percent clear, and there's no confusion amongst us or different understanding.* (Focus Group 2 Participant 2).

The positive perceptions regarding the use of videos extended beyond this study's class. Three participants reported that they used videos to supplement their learning of psychomotor skills in other courses. One respondent sums up this category well.

> *I don't know if it changes the way that I look at videos for instruction, but I used videos before. So I will continue to use videos as a supplement. I think that for me, what helps video instruction is hearing the topic from multiple sources. Hearing the same topic from different people helps me. I used videos in a lot of different classes.* (Focus Group 1 Participant 5).

Additionally, nine participants expect to use this learning strategy in the future as a supplement and for review.

Overall, most focus group participants have a positive perception of LMS-embedded instructional multimedia. Class preparation, review, convenience, repeated viewing, skill standardization, and efficiency were listed as useful features. That said, all focus group members did not share these positive perceptions.

Theme 2: If given a choice, live demonstration was preferred.

The second theme revealed that some participants prefer face-to-face instruction for psychomotor skills despite the positive effects of the LMS-embedded instructional multimedia discussed above. One participant shared their strong opinion on this subject.

> *I admittedly prefer, especially at a graduate level, to have live demonstrations. I think that should be the number one. I understand if there are other conflicts like getting all the material taught, but I think that primarily, we are paying a lot of money, and I want to be in the classroom face-to-face with my professor.* (Focus Group 1 Participant 4).

Another added:

> *I do not prefer it [LMS-embedded instructional multimedia] because I like to show up in an environment where I can be with my cohort, and I can ask my teachers questions and interact with them because we are going into a teamwork profession*. (Focus Group 2 Participant 3).

One reported limitation of LMS-embedded instructional multimedia use as a primary strategy was noted in classroom collaboration. This limitation may account for the differences in instructional strategy preference. Two participants reported a more challenging practice session if their laboratory partner was not prepared. One participant experienced this situation from multiple lenses.

> *So in class, if you were paired with a partner that didn't watch the videos, it made it a more difficult process because you had to spend the time to teach them and go over it. Sometimes people would pull it out and watch it in the moment, which I understand. There's no way to track who is watching the video before they come to class, or maybe there are ways. But you can't guarantee that your partner has prepared the same way that you did. I would say that in class, it did affect the way that I collaborated with my classmates because I did that. I've been in both positions where my partner hadn't watch the video or I had forgotten to watch it. So, it changed the in-class dynamic. (*Focus Group 2 Participant 2).

This inclination discouraged some focus group members from using psychomotor skill instructional videos in other current courses and the future. Four participants stated that they did not apply this learning strategy to different classes. One participant expanded on the use of this instructional strategy in the future:

Yes, I feel like it's, unfortunately, the direction that we are heading, and in the future, class seminars will be replaced with things like Skype in format. I would much prefer to have something in class or in-person regardless of the efficiency or travel because I think I'm able to understand things better when its demonstrated in person there's just so many more connections that I make to a situation and to the person that it's being demonstrated on and to the little nuggets of information that come from it. So I probably will use it in the future, but I would prefer not to. (Focus Group 2 Participant 2).

While most participants view LMS-embedded multimedia for psychomotor skill development positively, some prefer live demonstrations. Differences in learning preference are expected, but enhancements to the educational technology may improve the delivery method. To that end, the focus group topic areas included areas for improvement.

Theme 3: Participant recommendations.

The third theme listed additional features that participants conveyed regarding ways to improve LMS-embedded instructional multimedia as a primary psychomotor teaching strategy. The most commonly reported feature for the videos used in this study was a zoom and multiangle viewing, which was reported by eight focus group participants. Additionally, the ability to ask questions was another frequently mentioned desired feature.

Another recommendation is an assurance that the multimedia is generated from a reliable source. Several respondents questioned video reliability when not provided by the instructor. This apprehension limits the use of this learning strategy. One participant stated that "*it's hard to find them [videos] for ones that are accurate and corresponded*" (Focus Group 2 Participant 4). Another reported that "*I wouldn't say that I rely too much on [it]…I'm just a little wary that* *if I see something else that is incorrect, you know because we learn a very specific way to do a technique in a specific theory…"*(Focus Group 2 Participant 2). A third indicated:

> *I do think that it's becoming more of a thing for physical therapists sharing information. I would use it with caution as I would like to talk to another physical therapist or mentor of sorts for a valuable and trustworthy source.* (Focus Group 1 Participant 4).

Three themes resulting from the focus group analysis summarize the student perceptions: positive perceptions for preparation and review, a preference for face-to-face instruction despite positive characteristics of LMS-embedded instructional multimedia, and features to improve the instructional strategy.

4.5 Summary

Chapter Four presented the study's data in four sections. The first section presented the practical examination score comparison for the live demonstration and LMS-embedded instructional multimedia groups. This data includes scoring for both lower and upper extremity examinations. The second section presented the Likert question data from the questionnaire, and the third section highlighted themes from the open-ended questions. The focus group discussion analysis was shown in section four. Chapter Five provides a summary of the critical analysis and discussion of these results.

Chapter 5: Discussion and Conclusion

The focus of this study was to determine the effectiveness of the learning management system (LMS) embedded multimedia as the primary instructional strategy for psychomotor musculoskeletal manual skills development. Additionally, this endeavor explored the perceptions of physical therapy participants toward the use of this instructional strategy. Three research questions formed the template for the study:

1. What is the difference in learning outcomes between LMS-embedded multimedia versus live demonstration as an instructional strategy for manual therapy psychomotor skills in physical therapy education?
2. How does LMS-embedded instructional multimedia affect psychomotor skill performance?
3. What is the student perception for using LMS-embedded instructional multimedia?

This chapter aligns the study's data with these research questions. Additionally, study limitations, future research directions, and conclusions are presented.

5.1 What is the difference in learning outcomes between LMS-embedded multimedia versus live demonstration as an instructional strategy for manual therapy psychomotor skills in physical therapy education?

Learning outcomes are an essential element when comparing educational strategies. This study examined two consecutive cohorts' performance on psychomotor examinations for the lower and upper extremities. In total, 113 participants performed two practical examinations over the study's duration. A lower extremity assessment occurred at the midway point, and an upper extremity assessment was performed at the end of the 15-week course. Each student was evaluated on a live demonstration technique and LMS-embedded multimedia instruction technique for both the lower and upper extremity practical examinations. The grade means for the live demonstration and LMS-embedded multimedia instruction for each participant was calculated, and these means were compared for the lower and upper extremities using a one-way repeated measures ANOVA. The psychomotor testing analysis illustrates the comparison of these instructional strategies and provides clarification to the study's first guiding question. What is the difference in learning outcomes between LMS-embedded multimedia versus live demonstration as an instructional strategy for manual therapy psychomotor skills in physical therapy education?

For the lower extremity, cohort one had a slight performance advantage for the LMS-embedded multimedia over the live demonstration learning condition. However, this effect was swapped in cohort two. The differences between the means are very small and are not statistically significant. While the lower extremity body regions did not show a difference between examination testing means, the upper extremity data revealed a larger score for the live demonstration group. The difference between these means is statistically significant; however, the partial eta squared value is quite small. Further exploration of the data by each body region revealed no statistical difference between examination means test scores for any of the six body regions. In other words, the learning outcomes for physical therapy students' psychomotor performance of manual therapy skills are similar for LMS-embedded instructional multimedia and live demonstration instructional strategies.

These findings are consistent with other studies that reported no difference in student performance when using multimedia as the primary instructional strategy for psychomotor skills (Barker, 1988; Howerton, Enrique, Ludlow, & Tyndall, 2004; Kelly, Lyng, McGrath, & Cannon, 2009; Kneebone & ApSimon, 2001; Sanddal, et al., 2004; Ford, Mazzone, & Taylor, 2005; Moore & Smith, 2012; Smith, Jones, Cavanaugh, Venn, & Wilson, 2006; Xeroulis, et al., 2007).

Two previous studies reported improved psychomotor performance for live demonstrations over multimedia in a small percentage of skills. One of four cervical spine skills favored the live demonstration instructional strategy in the van Duijn, Swanick, and Donald (2014) article. The Cervical Natural Apophysial Glide was performed better by students who received live demonstration instruction, and no difference was reported for the Sharp-Purser Test, Craniovertebral Rotation Intervertebral Motion Test, or Cervical Spine Downglide Manipulation (van Duijn, Swanick, & Donald, 2014). Additionally, Davie, Martin, Cuppett, and Lebsack (2015) reported improved performance in the live demonstration group for one of three skills. Specifically, the Valgus Stress Test for the knee scored higher for students in the live demonstration group, and no difference was noted for goniometric measurement for ankle dorsiflexion or manual muscle testing of the middle trapezius (Davie, Martin, Cuppett, & Lebsack, 2015).

These findings suggest that the performance of some psychomotor skills is improved with live demonstration instruction. Perhaps, the complexity of the skill impacts the learners preferred instructional method. The Cervical Natural Apophysial Glide requires coordinated movement by the physical therapist and patient while performing the joint mobilization technique. This skill has more sequence steps than the other three skills from that study. Moreover, the Knee Valgus Stress Test is an assessment technique for joint mobility and differs from goniometry and manual muscle testing. Joint mobility skills are often classified as a higher-level or more complex skill. Although the selected techniques for the LMS-embedded instructional multimedia and live demonstration group were similar, a specific difficulty status of these techniques was not assigned. Future studies should consider the skill complexity as it pertains to instructional strategy.

Another possibility for some skills favoring the live demonstration instructional strategy is the quality of the video. The multimedia for the van Duijn, Swanick, and Donald (2014) and Davie, Martin, Cuppett, and Lebsack (2015) articles are not available for analysis. Still, certain aspects of the LMS-embedded multimedia could account for the differences in selected skills. For this study, the viewing angle was a reported theme in the questionnaire analysis, especially for smaller joint techniques such as the wrist and hand. Specifically, some participants noted challenges seeing a few of the techniques. While the analysis for wrist and hand techniques did not show a statistical difference between instructional strategy, a difference may be noted between skills with good and poor viewing angles. Unfortunately, these skills were not specifically identified by participants in either the open-ended questionnaire data or focus group discussions. Future studies should consider video characteristics related to psychomotor skill acquisition using multimedia.

The sequence of body regions started with the lower and ended with the upper extremity, and this progression was the same for each cohort. This progression may have impacted participant examination scores. As previously stated, no statistical difference between participants' mean testing score was noted for the lower extremity. However, the difference in upper extremity participants' mean testing score was statistically significant in favor of the live demonstration group. While the effect size was small, the question of this finding as unique or a mere statistical anomaly remains. Nothing in the literature suggests the decreased efficacy of instructional multimedia over time. The novelty of the multimedia instruction likely returned to a baseline for the end of term examinations. However, this study's longer duration may link with this novel finding. Future studies should consider reversing the body region's sequencing within the course to investigate this variance further.

As noted in Chapter Two, several studies noted improved student performance on psychomotor skill-testing using multimedia as a supplement to the traditional instructional strategies supplements (Arroyo-Morales, et al., 2012; Bauer, Geront, & Huynh 2001; Beeson & Kring 1999; Cantarero-Villanueva, et al., 2012). The participants in this study did not have access to LMS-embedded instructional multimedia for the skills that used live demonstration instruction. To that end, this study cannot further elucidate the question about improved student performance using multimedia as a supplement to live demonstration. Additional research is necessary to ascertain if this finding is reproducible and further investigate potential reasons for this variation.

5.2 How does LMS-embedded instructional multimedia affect psychomotor skill performance?

The second research question asked how LMS-embedded instructional multimedia affects psychomotor skill performance. Since the research questions investigated LMS-embedded instructional multimedia as a primary learning strategy, the intention was for participants to watch the videos before the scheduled laboratory class. A small number of participants highlighted that viewing the video before class made them feel more prepared to practice the skill. The questionnaire responses listed viewing the videos before class as the best feature for five percent of cohort one and 6.8 percent of cohort two. Additionally, the focus group discussions highlighted this feature positively. One participant captured the essence of what participants shared about this topic area.

> *I liked being able to look at it before class just to prep for class. Then we got more class time of instruction and feedback, which helps facilitate our learning and make sure that we are doing it correctly.* (Focus Group 2 Participant 4).

These findings are consistent with those of Sole, Schneiders, Hebert-Losier, and Perry (2013), who reported that some students found the video instruction helpful for laboratory class preparation.

That said, it was also reported that despite instructions, some study participants did not view the video until class time, which decreased the available instructor feedback practice time for those student pairs. This issue was highlighted during the focus group discussions. Sole, Schneiders, Hebert-Losier, and Perry (2013) also noted this concern reporting that many students did not practice before the scheduled laboratory class. Time constraints were the most often cited reason (Sole, Schneiders, Hebert-Losier, & Perry, 2013). The inconsistent use of the videos by some participants for laboratory preparation is an interesting finding from these two studies. Is this finding due to a perception that they can delay learning the skill until closer to the examination since they have the resource? This reasoning would allow the students to focus on the immediate assignments and tests in other courses and link with the aforementioned time constraints. Also, the live demonstrations may be preferred by some to minimize the laboratory class preparation time.

A larger proportion of study participants reported that they used the videos for review and examination preparation. To that end, the 'how' participants used the multimedia extended beyond the initial instruction. This finding was present in both the questionnaire responses and the focus group discussion. Ten cohort one and 12 cohort two participants reported that the method of learning was useful for reviewing the skills in the questionnaire. Moreover, 90 percent of the focus group members mentioned that the videos were mostly used for practical examination review.

Sole, Schneiders, Hebert-Losier, and Perry (2013) also noted that their students used multimedia as a reference tool after class. These researchers also reported other video uses, including catching up after missed classes and preparing for the examination. A critical feature for using the video for study and testing preparation was that it standardized the skill (Sole, Schneiders, Hebert-Losier, & Perry, 2013). The consistency of skill performance expectation was highlighted by this study's participants in both the questionnaire results and focus group discussions as a positive feature. This topic was summarized well by one of the focus group members.

> *Yes, prepare by watching the video, but I think it came more into play in a group study session where we were practicing the manipulations, and I would have one opinion and someone else would have another, so we would refer to the video because it's very clear where the proper placement was. It was helping us perfect our techniques (Focus Group 2 Participant 2).*

The analysis of the questionnaire and focus group discussion revealed a positive perception of using the video as a standard for examination performance. However, some faculty believe that access to this type of multimedia allows the students to "cram" for the examinations, and while the psychomotor skill performance for the test may be adequate, questions regarding clinical application arise (Sole, Schneiders, Hebert-Losier, & Perry, 2013). Appropriate spacing of learning sessions improves long-term learning by providing students time to encode the new information (Kornell & Bjork, 2008). This approach also allows for distributed practice, further reinforcing the memory (Carpenter, Cepeda, Rohrer, Kang, &

Pashler, 2012). The massed practice, often demonstrating with 'cramming', is not the most effective method for student learning (Bloom & Shuell, 1981). To that end, future studies should consider a delayed post-test of the skills to examine the retention of these skills using multimedia as the primary instructional strategy. These studies will assist in answering Sole, Schneiders, Hebert-Losier, and Perry's (2013) ascertain that students use instructional multimedia to "cram" for tests resulting in less long-term retention of the material.

Efficiency was another theme that relates to how LMS-embedded instructional multimedia affects psychomotor skill performance. The participants reported increased efficiency as one of the best features of LMS-embedded instructional multimedia. This theme was categorized from the questionnaire data analysis. Moreover, the focus group discussions highlighted this feature too. This study's videos were under two minutes in duration. The short video length and inclusion of both verbal and demonstration instructions were recommendations from previous research for psychomotor skill acquisition for physical therapy students (Macznik, Schneiders, Athens, & Sullivan, 2018). Two areas were identified from the student lens related to improved efficiency, including classroom and review productivity in this study. Some participants noted that the length of the video made it quicker to teach the skill during class and easier to review the skill. The open-ended questionnaire thematic analysis demonstrated that the short, concise nature of the video was one of the best features of LMS-embedded instructional multimedia instruction. Furthermore, this topic was discussed during the focus group sessions. One focus group participant summarized both of these areas well.

> *Like participant two mentioned about some students watching it in class, I would often have the video pulled up on my computer too because sometimes I would forget the skills [even if I watched them before class], so then I would have to review it quickly. But then*

again, it was only two minutes, so it didn't take a lot of time. For class time, it [the videos] was more efficient than gathering everyone around, getting everyone to quiet down, and then you know. That and again like participant two said it made it more efficient during practice time because we weren't debating what the right skill was. (Focus Group 2 Participant 4).

That said, an issue from participants that did not preview the video instruction before the laboratory class was noted. Decreased efficiency in learning the skill was reported in these instances. It should also be noted that not all participants agreed that the LMS-embedded instructional multimedia was more efficient. This exchange from the second focus group exemplifies this different view.

Participant 2—I totally agree that it's more efficient and a skill can be taught in a minute and thirty seconds versus 15 plus or 20 minutes that it takes in class, but I think that the time that we spend in class in addition to that minute and thirty seconds in order to understand it probably adds up to be the same because for me at least I can watch it and it's less than two minutes but then I'm going to even more time practicing and asking questions and trying to understand it, so the time that I'm allotted to it probably ends up being just about the same.

Facilitator—so maybe more efficient class time, but potentially less efficient to actually learn the skill?

Participant 2—yes, for me personally, yes.

Instructor efficiency is another area of potential benefit. Several studies reported that psychomotor skills instruction was more productive using multimedia instruction (Campbell & Kohli, 1970; Smith, Cavanaugh, & Moore, 2011; Xeroulis, et al., 2007). Adams (2013) further conveyed that multimedia instruction reduces the burden on faculty time and classroom space, and Murray, McCallum, and Petrosino (2014) further state multimedia instruction allows for improved efficiency in physical therapist education. While official data was not collected regarding instructor efficiency in teaching the psychomotor skills using LMS-embedded instructional multimedia, the observations from this researcher agree with these reports. The potential advantage of increased classroom efficiency allows for additional educational activities during the face-to-face laboratory sessions. Kinney, Keskula, and Perry (1997) state that the efficiency of all multimedia instruction warrants further research. Moreover, future studies should examine the impact on student clinical reasoning using multimedia as the primary instructional strategy for psychomotor skills while replacing the traditional live demonstration with higher-level active learning exercises.

The second research question asked how LMS-embedded instructional multimedia affects psychomotor skill performance. Participants mostly reported that they used the videos to prepare for the laboratory sessions, review the skills for examination preparation, standardize the performance expectations, and increase efficiency. It should be noted that a small number of participants stated that decreased efficiency occurred when matched with an unprepared partner. The third research question investigated the student perceptions of using LMS-embedded instructional multimedia. The next section summarizes the analysis and discusses the study results for this question.

5.3 What is the student perception of using LMS-embedded instructional multimedia?

While outcomes are important, a consideration about the process focusing on how the participants feel should also be analyzed (Kelly, Lyng, McGrath, & Cannon, 2009). For this study, the participant perceptions were gathered using the questionnaire data and focus group discussions. This information was analyzed to answer the question: What is the student perception of using LMS-embedded instructional multimedia? Results from the questionnaire and focus group discussions were used to gather data on this topic.

The questionnaire results reported that the majority of participants found LMS-embedded instructional multimedia useful, especially for review and accessibility. Moreover, the ability to self-pace instruction was deemed positive. Limitations were also noted. An inability to ask questions in real-time was reported as the least liked feature, and body regions with small joints, such as the wrist and hand, were reported to have challenging viewing angles. Interestingly, many participants that found this instructional strategy useful also indicated a preference for face-to-face instruction.

The focus group discussions and thematic analysis revealed similar findings. Three themes resulting from the focus group analysis summarize the student perceptions: positive perceptions for review and preparation, a preference for face-to-face instruction despite positive characteristics of LMS-embedded instructional multimedia, and features to improve the instructional strategy.

The questionnaire and focus group sessions thematic analysis revealed that the LMS-embedded instructional multimedia was useful for review and accessibility, especially for examination preparation. This finding is consistent with other physical therapy education studies related to psychomotor learning and multimedia instruction. Hurst (2016), Lazinski (2017), Osborn and Tentinger (2003), and Sole, Schneiders, Herbert-Losier, and Perry (2013) all reported a positive student experience with multimedia instruction. In addition to these positive perceptions, two studies from the physical therapy education literature review demonstrated an equal preference for live demonstration and multimedia instruction (Bayliss & Warden, 2011;

Smith, Cavanaugh, & Moore, 2011). Also, increased student confidence with psychomotor skill performance was noted for multimedia instruction (Sole, Schneiders, Hebert-Losier, & Perry, 2013).

Comparing these themes to include other healthcare professions reveals similar findings. Favorable views of multimedia use for psychomotor learning were reported for dentistry students (Howerton, Enrique, Ludlow, & Tyndall, 2004), medical students (Kneebone & ApSimon, 2001), and occupational therapy students (Toth-Cohen, 1995). Moreover, dentistry students not only reported favorable views of multimedia instruction; they indicated a preference for this teaching strategy over traditional classroom lecture instruction (Howerton, Enrique, Ludlow, & Tyndall, 2004).

While Smith, Cavanaugh, and Moore (2011) stated no student perception differences existed between the live demonstration and multimedia instruction, they further reported that student perception regarding the depth of instruction was higher using multimedia than the live demonstration. This study's analysis revealed differing opinions concerning which instructional strategy was more thorough. One response from the open-ended questionnaire strongly agreed with Smith, Cavanaugh, and Moore's (2011) findings.

> *Thank you for providing the LMS videos for this class! I would have loved to use the LMS videos for each technique in this class as well as every technique for MSI [musculoskeletal one course] and Therapeutic Exercise I (manual therapy skills, special tests, MMTs [manual muscle tests], MLTs [muscle length tests], stretching and strengthening techniques, etc.) because your systematic approach was superior to all other videos I watched online when in those classes and FAR more superior to the*

> *instructions given in class, due to my difficulty with learning material when I only see it performed once in class. Thank you again!!* (Cohort 1 Respondent 22).

However, others in this study stated a different opinion. One focus group participant captures the essence of their opinion.

> *I really feel like I'm paying for the faculty, their insight, and experience, especially clinically. Like when you brought up the Anterior Shear Test in class, and we had the clusters [of special tests]. You talked about how Cyriax had his standard, and I'll remember that when I go to the clinic, but that personal story wouldn't have been on the video.* (Focus Group 2 Participant 3).

This view is not unique to this study. Jones, Dean, and Hui-Chan (2010) found that while students liked the independent method of web-based learning, a small number of participants reported that they missed the instructor's reinforcement. The use of patient stories for the clinical application of skills as an example of instructor reinforcement is highlighted in the quote above. Updates to videos to mitigate this perceived deficit and the other least liked features highlighted below are discussed later in the chapter.

The questionnaire and focus group analysis also established the least liked features using LMS-embedded instructional multimedia as a primary teaching strategy. These concerns included an inability to ask questions in real-time and challenging viewing angles for body regions with small joints such as the wrist and hand. The videos were produced with the parameters established by Macznik, Riberiro, and Baxter (2015), which recommended short and concise videos that included both demonstration and verbal instructions. Unfortunately, these guidelines did not address the issue of the inability to ask questions in real-time. This least liked feature is inherent to asynchronous instructional design.

Challenging viewing angles for smaller joints is a longstanding issue for live demonstration instruction and in the videos produced for this study. Two focus group participants discuss viewing angles challenges from each instructional method.

> *Often during lab, the entire class gathers around the table, and because the classes are getting bigger, cameras are used to show the skill on the screen too…For these reasons, the videos might be better than doing the demonstration in class.* (Focus Group 1 Participant 3).

Another focus group participant added:

> *[T]he one angle of the video in some of the smaller techniques like the wrist and hand it's kind of hard to see where the therapist's hands are. In the live demonstration, you can get a little closer* (Focus Group 2 Participant 5).

The size of the body region and the number of students in a class can impact viewing angles. While some participants reported that live demonstration allows them to move and adjust for better viewing, this solution is not possible for everyone, especially with bigger class sizes. The participant recommendations for multiple angles and zoom features are good ones.

As mentioned previously, some participants stated a preference for live demonstration despite finding LMS-embedded instructional media beneficial. The questionnaire results reported that 17.86 percent of respondents preferred live demonstration of the psychomotor skills. Additionally, 9.52 percent of cohort one and 26.08 percent of cohort two stated that they would not enroll in another course that used multimedia for teaching psychomotor skills. These numbers may be low when factoring in the 15.6 percent of the population who elected to not participate in the study.

Other physical therapy education studies report similar findings. Lazinski (2017) found that 25 percent of the study sample indicated that the face-to-face interactions were the best part of the course despite the overall positive reviews for multimedia instruction. This preference was also published by Hayward (2004) and Maring, Costello, and Plack (2008). Willett, Sharp, and Smith's (2008) stated that the students in their study did not show favor multimedia or live demonstration. However, these statistics have a noted caveat: thirty-three percent of their first sample and fifteen percent of their second sample opted out of the study. This large number of students who declined participation may demonstrate a preference for traditional classroom instruction.

This individualized preference is further exemplified by Jones, Dean, and Hui-Chan (2010). This article found that some students preferred the self-paced independent instructional strategy, while others preferred live demonstrations. A lower confidence level using the less structured video-linked format was reported for those students who preferred live presentations (Jones, Dean, & Hui-Chan, 2010). Perhaps confidence using technology is a factor in preference and outcomes. Thompson (1987) found one questionnaire item that linked with better student learning using multimedia instruction. Specifically, students who liked working on computers achieved higher scores using multimedia. Another consideration emerges from the focus group discussions, which highlighted the importance of instructor feedback to refine these psychomotor skills. It should be noted that the instructor feedback practice sessions were deemed of paramount importance by the group regardless of instructional strategy.

Expanding the live demonstration preference to other healthcare professions illustrates similar results. Kelly, Lyng, McGrath, and Cannon (2009) reported that nursing students in their study preferred classroom instruction. Although, they noted the benefit of having videos of these skills available for review. Davie, Martin, Cuppett, and Lebsack (2015) agreed with the recommendation of using videos as a supplement in their study with athletic training students.

Research question three regarding student perceptions of using LMS-embedded instructional multimedia was analyzed using the questionnaire and focus group discussions. Similar to previous studies, most of the participants found the instructional strategy useful, interesting, and helpful, especially the convenience of access for skill review and preparation. That said, some participants prefer live demonstrations despite agreeing with the stated advantages of multimedia instruction. Instructor access and opportunities for feedback were listed as reasons for preferring live demonstrations. As with all research, this study has limitations, and the next section reviews and discusses these issues.

5.4 Limitations

This study was for partial fulfillment of a Doctorate in Education degree. To that end, the author is a student, a novice researcher. Much was learned from the process of thesis proposal, IRB review, data collection, and manuscript writing. Additionally, limitations were noted. Some of these limitations were known during the proposal, and others were appreciated during data collection and manuscript writing.

One of the known limitations was the utilized questionnaire. This instrument has not been validated, which limits the generalizability of the study's findings associated with this tool. That said, it has been used in past research with this subject population and psychomotor skill acquisition. To that end, this questionnaire was selected to link the previous studies to this research study. The questionnaire was modified after consultation with Smith (personal correspondence 1/16/2017 e-mail), who used it in earlier research in this domain. These changes made for a more concise and understandable questionnaire by merging two similarly structured questions.

While using the same instrument allows for easier comparison of studies, additional modifications would improve meaningful data collection. For instance, removing the item regarding the use of multimedia for the visual learner is necessary. Studies testing the validity of learning styles contradict the notion that different methods of learning impact student performance (Pashler, McDaniel, Rohrer, & Bjork, 2008). Moreover, inquiries regarding how participants used the multimedia would provide finer detail about the instructional strategy. Specific questions regarding class preparation and examination review would provide this insight, including an understanding about massed and distributed practice. Skill acquisition and practice time queries would also assist in comparing the efficiency of each instructional strategy.

Performing insider research was another limitation. The investigator's background and position influence the study methodology and findings (Malterud, 2001). To that end, the researcher needs to be mindful of bias (Flemming, 2018). One reason this researcher selected this thesis topic was to promote additional higher-level clinical reasoning exercises during face-to-face laboratory time. Instructional multimedia for psychomotor skill acquisition would need to be at least equivalent to live demonstrations to justify its ongoing use and create time for these learning activities. The study utilized a blinded examiner for all of the examinations to mitigate this bias.

Another issue was that the study's author facilitated the focus group sessions and performed the thematic analysis of the questionnaire and focus group transcripts. Due to this foreseen limitation, steps were taken to ensure the trustworthiness of the data. The triangulation of data sets between the questionnaire and focus group sessions aid in the study's credibility and confirmability. Moreover, the raw data, analysis and synthesis products, and the focus group audio recordings are saved. This audit trail further aids confirmability.

Another method to increase the credibility of the focus group thematic analysis is using additional coders (Ranney, et al., 2016). While this process was not formally performed during this study, peer debriefing during the coding, categorization, and thematic analysis occurred. This peer debriefing procedure serves as a method to decrease bias and increase the credibility of the analysis (Nowell, Norris, White, & Moules, 2017).

The prolonged engagement of the researcher at the institution and previous course instruction with study participants did allow for rapport development. This condition supports the credibility of the study findings (Cohen & Crabtree, 2006). However, the inexperience of the researcher as a focus group facilitator restricted the depth of topic area discussion. This issue affects the transferability of the study's findings by limiting the thick description of the phenomenon.

Unfortunately, the research design did not provide adequate time to include participant review of the focus group audio transcripts. The participants had concluded their didactic coursework and started their clinical fieldwork upon completing the course. Approval of the focus group transcripts improves confirmability and provides more confidence in the researcher's interpretations (Birt, Scott, & Cavers, 2016). The lack of transcript review or member checking and subsequent participant validation is a study limitation.

Limitations that arose during the study included the number of enrolled participants, the questionnaire response rate, and focus group participation. This study occurred over two consecutive semesters and involved two class cohorts. Cohort one had 64 enrolled in the course, and cohort two was slightly larger with 71 students. All of the students met the inclusion criteria and were invited to participate in the study. Fifty-five members of cohort one and 69 members of cohort two agreed to participate. In total, the participation rate was 84.4 percent. While this number appears high, the potential impact on student perceptions of this instructional strategy may be artificially inflated if the students' reason for not participating was a negative perception of multimedia instruction.

In addition to the number of students that elected to participate in the study, the research design has other limitations. Specifically, the questionnaire completion request and focus group sessions were at the end of the 15-week term. This timing is busy for students with final examinations scheduled for other courses. Additionally, this semester is the last on-campus term for these students, and the remainder of their degree requirements occur offsite during associated fieldwork. The timing of this data collection may have limited participation in questionnaires and focus groups. While the completion rate for the questionnaire was 77 percent, this rate may have been higher if distributed earlier in the semester.

Moreover, the focus groups did not reach the desired eight participants. As previously discussed, the size of a focus group should range between six and 12 participants, which is an appropriate size to stimulate discussion (Baumgartner, Strong, & Hensley, 2002; Guest, Namey, Taylor, Eley, & McKenna, 2017). The number of volunteers may have been impacted by the timing of the focus group sessions.

Another focus group limitation was the sampling method. Ideally, qualitative research is conducted using purposeful sampling. However, the primary researcher, who also performed these focus group sessions, was an instructor of the participants. Given the potential for perceived power influence, the Institutional Review Board (IRB) at the USAHS recommended against purposeful sampling. The sampling method and number of volunteers that participated in the focus group sessions are limitations. After further discussion with the thesis committee, the perceived power influence could be mitigated by using a different facilitator for the focus groups. This change would permit purposeful sampling and also address the limitation of researcher inexperience in leading focus groups.

Finally, some participants reported technical difficulties accessing this study's multimedia, especially from their mobile devices. These technical problems are not unique to this study. Issues accessing and using the multimedia were reported in the literature review related to psychomotor skill acquisition (Boucher, Robertson, Wainner, & Sanders, 2013; Osborn & Tentinger, 2003). Moreover, others discussed similar concerns when using multimedia for the cognitive learning domain (McGown & Faust, 1971). This finding indicates that technical issues will arise when utilizing multimedia. Care should be taken when selecting the platform to disseminate the information to ensure compatibility. Moreover, user error should be considered when employing educational technology in the classroom. Providing adequate time for learning how to use the technology should be allocated to mediate this potential limitation.

5.5 Classroom and institutional changes as a result of the study

Elaboration Theory provided the instructional design framework for this research study. This approach is recommended for teaching medium to complex content in the cognitive and psychomotor learning domains (Carr-Chellman & Reigeluth, 2009; David, 2014) through a constructivist lens (Perswal, 2011). Accordingly, this framework and learning theory align with the content and intended learning outcomes for this course and represents current teaching trends for psychomotor skill instruction in physical therapy education (Qasem, 2015).

The LMS-embedded instructional multimedia established the beginning of the elaborative sequence, demonstrating the psychomotor skill epitome in specific detail. The student practice with instructor feedback of each skill remained an integral part of the face-to-face class time. By using the instructional multimedia for the initial skill demonstration, more face-to-face time for the summary, synthesis, and expansion of the elaborative sequence was available, allowing for more higher-level clinical reasoning learning activities. Moreover, spiral sequencing builds in synthesis and review processes allowing the learner to view interrelationships between topics, identify real-world versions of the task, and enhance motivation (Kowch, 2002; Reigeluth & Carr-Chellman, 2009). This study demonstrates similar learning outcomes using instructional multimedia for psychomotor skill acquisition, which allows for a more flexible curriculum design. Several classroom and institutional changes occurred as a result of this study.

As previously discussed, participants appreciated access to videos of psychomotor skills for laboratory preparation and ongoing review, including studying for tests. Throughout this study, videos were produced for all the skills instructed in the Musculoskeletal III: Advanced Extremity Examination, Evaluation, and Manipulation class. Access to all the videos was provided to study participants. Additionally, these videos are available to all current and future students who enroll in this course, including the expanded use to the other USAHS's campuses. The similar learning outcomes using multimedia as the primary instructional strategy for psychomotor skill acquisition validates its continued use in this researcher's classroom. The additional time afforded using this instructional design allows for more higher-level learning activities during face-to-face laboratory classes. Furthermore, the student's report of the importance of obtaining multimedia instruction from a reliable source illustrates the importance of creating individual course content.

Improvements to the associated video content are planned and include a section for clinical utility for each technique and common errors. Students frequently ask for this information during live demonstrations, and its inclusion should help address the listed limitation of an inability to ask questions during LMS-embedded instructional multimedia instruction. These actions were determined based upon the study's results.

Moreover, the USAHS has made an investment in educational technology as a direct result of this study's findings. Specifically, a green screen and high-resolution cameras have been purchased for recording psychomotor skills for all courses. This investment should allow for the inclusion of additional techniques throughout the curriculum, and it should be noted that several university faculty having starting filming techniques for their courses.

This advanced technology can also accommodate the participant request of videos from this study to include more than angle and zoom on techniques for the smaller joints such as the wrist and hand. Updated videos for these body regions are planned based on the participant feedback. This investment provides additional resources for psychomotor skill instruction and review. Revisiting student performance and perceptions of LMS-embedded instructional multimedia with the updated videos will provide additional insight into this educational strategy.

This study's results support these local institutional changes and investments. The similarity in age, degree level, and intent of the skills further reinforce instructional multimedia's use in other healthcare related fields. Also, this instructional strategy can be considered as an option for continuing education for existing healthcare practitioners, which are historically instructed with live demonstration and emphasizes skill performance. A change in instructional strategy would allow for more face-to-face time higher-level learning activities.

5.6 Future research directions

The Chapter Two literature review illustrated a timeline of research related to educational technology. While the technology changed over time, similar learner outcomes, student perceptions regarding the technology, and implementation challenges were noted. Additional study is necessary to continually monitor the learning outcomes and gauge student perceptions of these instructional design changes. A few suggestions for future studies were mentioned earlier in this chapter, and this section expands those earlier references.

The literature review showed that some psychomotor skills were performed at a higher level by students instructed through live demonstrations. Specifically, the Cervical Natural Apophysial Glide (van Duijn, Swanick, & Donald, 2014) and the Valgus Stress Test (Davie, Martin, Cuppett, & Lebsack, 2015) for the knee were the skills linked with better student learning outcomes. Both of these techniques relate to joint assessment or treatment skills and are categorized as a more complex skill when compared to the others in their respective studies. Perhaps, the complexity of the skill impacts the learners preferred instructional method. Future studies should consider the skill complexity as it pertains to instructional strategy.

Video characteristics represent another area that would benefit from additional study. Some participants noted challenges seeing a few of the techniques. While the analysis for wrist and hand techniques did not show a statistical difference between instructional strategies, a dissimilarity in learning outcomes may be noted between skills with zooming features and multiple viewing angles. Future studies may provide insight into the role of these video characteristics related to psychomotor skill acquisition.

The potential advantage of increased classroom efficiency allows for additional educational activities during the face-to-face laboratory sessions. Kinney, Keskula, and Perry (1997) state that the effectiveness of multimedia instruction warrants further research. Moreover, future studies should examine the impact on student clinical reasoning using multimedia instruction as the primary instructional strategy for psychomotor skills while replacing the traditional live demonstration with higher-level active learning exercises, including problem-based learning and simulated patient care. This researcher is currently involved in a multi-institutional study to examine the impact of multimedia instruction on clinical reasoning.

There have been no studies on the effect of teaching orthopaedic manual therapy through the use of video alone (Ferronato & Hruby, 2011). This instructional strategy is an exciting avenue for future studies. These types of studies will elucidate potential differences between students who learn from multimedia compared to live demonstration with instructor guidance. Several opportunities exist for researchers interested in psychomotor skill acquisition using educational technology. These future studies will help to refine the instructional design of medical education courses.

5.7 Conclusion

This mixed-methods explanatory design study investigated LMS-embedded instructional multimedia's effect on psychomotor skills on musculoskeletal psychomotor skills and physical therapy student perceptions. Three research questions guided this study and were discussed at length in sections 5.1-5.3. The data from two psychomotor tests, questionnaire results, and focus group discussions were analyzed. These results were compared to the physical therapy education literature review and expanded to several additional healthcare professions. This study added to the available research on using instructional multimedia for psychomotor skill development. The advantages of this study included the larger sample size and increased number of techniques utilized. Additionally, this is the first study to examine assessment and treatment skills related to upper extremity joints. Several themes were noted throughout this manuscript, including student learning outcomes, efficiency, cost, student perceptions and their recommendations for improvement. This concluding section will summarize each topic and establish the groundwork for future research.

Outcomes.

The learning outcomes for physical therapy students' psychomotor performance of manual therapy skills are similar for LMS-embedded instructional multimedia and live demonstration instructional strategies. No statistical difference between these instructional strategies was found for any of the six body regions. Moreover, the lower extremity body regions did not show a difference between examination testing means. The upper extremity data revealed a larger score for the live demonstration group. The difference between these means is statistically significant; however, the partial eta squared value is quite small. Since this is the first study to include upper extremity techniques, definite conclusions cannot be drawn. Student responses also noted that the viewing angles for smaller joints were challenging, which may account for the upper and lower extremity differences. Additional study is necessary to elucidate this possibility.

Efficiency.

The participants were asked to preview the short two-minute video before the assigned laboratory class. Participants noted that this strategy allowed for more student practice with instructor feedback time during the face-to-face portion of the course. Other participants reported that short videos improved efficiency during the skill review and examination preparation. One student noted while laboratory productivity increased, the time spent practicing the skill and asking questions equated to similar time requirements to learn each technique. This change from passive instructor-led demonstrations to more active engagement in the content is a potential positive. As previously stated, many of the student questions center around clinical application of these techniques. With increased face-to-face time, these questions can discussed at a higher level and improve the clinical reasoning related to these examinations and treatment techniques. A study investigating the clinical reasoning learning outcomes using this instructional strategy is necessary.

Cost.

Student loan debt in the United States of America (USA) exceeds $1 trillion (Board of Governors of the Federal Reserve System, 2017). The amount of student loan debt could have a dramatic and negative impact on the national economy. Colleges and universities are looking at technological solutions to lower costs. Anderson and Conley (2000) reported equivalent learning outcomes between traditional and multimedia instruction for students at both six months and one year for anatomy students. Given the high cost of conventional gross anatomy courses, including human cadaver dissection, these researchers suggested that multimedia instruction could achieve appropriate learning outcomes while decreasing expenses. This opinion is shared by Xeroulis, et al. (2007), who stated that computer-assisted technology might offer a cost-effective alternative to traditional instruction for medical students. While this study did not analyze expenditures, the USAHS did invest capital into updating the audio and video recording technologies with the intent of increasing the use of multimedia instruction for psychomotor skills, which over time, may decrease the cost of course instruction.

Student perceptions.

Positive features of LMS-embedded instructional multimedia for psychomotor skill acquisition were noted, specifically for review, accessibility, and ability to self-pace instruction. This study's findings match previous research regarding multimedia instruction use. Some limitations were also noted through the questionnaire and focus group analysis. An inability to ask questions in real-time and challenging viewing angles for smaller joints were the least liked features.

Improvements to the associated video content are planned using the newly available recording resources that allow for zooming and multiple angle display. Moreover, a section for both clinical utility and common errors will also be added to the written description for each technique. This information is frequently requested by students during live demonstrations, and its inclusion should help address the listed limitation of an inability to ask question during LMS-embedded instructional multimedia instruction.

Lastly, a preference for face-to-face instruction despite the positive characteristics of LMS-embedded instructional multimedia was noted. To that end, institutions and faculty need transparency in communicating how courses will be instructed. This upfront communication allows students to enroll in classes that align with their preferred instructional strategy. Also, faculty can mitigate negative perceptions by explaining the available research related to outcomes and show the additional classroom learning opportunities that are available due to the increased efficiency.

Final thoughts.

This study demonstrates that LMS-embedded instructional multimedia is a viable option for primary psychomotor instruction on a larger scale. The USAHS made an investment to improve the video quality, and this technology is available to all faculty. To that end, several additional instructors have created videos of psychomotor skills for students. The institution is monitoring the impact of this change as part of its programmatic review process. While changes have been made, the rapid expansion of technology in academia needs continuing research. The 'best' practices for its use require continued refinement. There is potential for improved course learning outcomes using LMS-embedded videos for psychomotor learning, especially if higher-level learning activities such as problem-based learning and clinical reasoning exercises can be added to the laboratory time. The inclusion of these activities will make the content more meaningful for the student and potentially improve institutional learning outcomes. Moreover, improved efficiency could allow for the instruction of larger classes, which help to address the societal need for more medical graduates.

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Appendix A—Manipulation technique practical examination criteria

Patient Position (2 points)	
Therapist Position (1 point)	
Appropriate Joint Position (2 points)	
Palpation for Joint Alignment (1 point)	
Hand Placement—Stabilization (4 points)	
Hand Placement—Manipulation (4 points)	
Direction of Force (4 points)	
Amount of Force—Assessment or Graded (2 points)	

80 percent criteria required for passing grade (16/20)

Appendix B—List of psychomotor skills and employed instructional strategy for each cohort

	Cohort 1—Live Demonstration Cohort 2—LMS	Cohort 1—LMS Cohort 2—Live Demonstration
Ankle/ Foot		
	Superior Motion of Fibula	Posterior Movement of Distal Tibia on Fibula
	Distraction of Talus with Leverage Prone	Distraction of Talus with Leverage Supine
	Posterior Glide of Tibia and Fibula	Medial and Lateral Arc Glide Treatment
	Distraction of Calcaneus with Leverage Prone	Distraction of Calcaneus with Leverage Supine
	Medial Glide of Base of Phalanx	Medial and Lateral Sequence
	Long Axis Rotation of Phalanx	Unicondylar Glides of 2nd and 3rd Base of Phalanx
	Dorsal and Plantar Movements of Metatarsal Heads	Dorsal and Plantar Sweep
Knee		
	Medial and Lateral Tilt of Patella	Superior and Inferior Tilt of Patella
	Distraction of Tibia with Leverage Prone	Distraction of Tibia with Leverage Supine
	Posterior Glide of the Femur	Anterior Glide of Tibia
	Anterior Tilt of the Tibia	Distraction of Tibia in Sitting
	Posterior-Medial Glide of the Fibular Head	Anterior-Lateral Glide of the Fibular Head (All Fours)
Hip		
	Lateral Stretch	Lateral Stretch Outside of Loose Packed Position
	Anterior Stretch Prone	Anterior Stretch Supine
	Posterior Stretch	Posterior Stretch Outside of Loose Packed Position
Shoulder		
	Inferior Glide of the Clavicular Head	Posterior Glide of the Clavicular Head
	Clavicular Glides on the Acromion	Distraction of Scapula Prone
	Distraction of Scapula Side lying	Cephalic and Caudal Movement of Scapula
	Upward and Downward Rotation of Scapula	Lateral Distraction of Humeral Head with Short Lever
	Lateral Distraction of Humeral Head with Long Lever	Anterior Glide of the Humeral Head Prone
	Inferior Glide of the Humeral Head without Scapular Stabilization	Posterior Glide of the Humeral Head with Shoulder Elevation

Elbow		
	Caudal Movement of the Radius	Cephalic Movement of the Radius
	Dorsal Glide of Radius on Ulna	Outward Roll of Radius on Ulna
Wrist/ Hand		
	Medial (Ulnar Glide) of First Metacarpal Base	Intercarpal Glides and Carpometacarpal Distractions and Glides
	Medial Glide of the Proximal Carpal Row	Dorsal (Posterior Glide) of the First Metacarpal Base
	Volar Glide of the Capitate and Hamate on Proximal Carpal Row	Volar Glide of Trapezium and Trapezoid on Proximal Carpal Row
	Long Axis Rotation of Base of Phalanx	Unicondylar Glides of Base of 2nd and 3rd Phalanx
	Dorsal and Volar Movements of Metacarpal Heads	Dorsal and Volar Seeps of Metacarpal Heads

Appendix C—Videos and description of the LMS-embedded multimedia instruction

Appendix D—Student Experience Questionnaire

EVALUATION OF EXPERIENCE WITH METHOD OF LEARNING
I. Please check the appropriate box below:
Gender □ Male □ Female Age _______

II. Please circle the correct answer below:
1. The instructions for using this method were clear.
Strongly disagree (1) Disagree (2) Indifferent (3) Agree (4) Strongly agree (5)

2. This program served as a useful review of material I previously learned.
Strongly disagree (1) Disagree (2) Indifferent (3) Agree (4) Strongly agree (5)

3. This method of learning was interesting.
Strongly disagree (1) Disagree (2) Indifferent (3) Agree (4) Strongly agree (5)

4. This method of learning was a waste of time.
Strongly disagree (1) Disagree (2) Indifferent (3) Agree (4) Strongly agree (5)

5. I learned a lot from this method of learning.
Strongly disagree (1) Disagree (2) Indifferent (3) Agree (4) Strongly agree (5)

6. This method of learning was helpful to me because I am a visual learner.
Strongly disagree (1) Disagree (2) Indifferent (3) Agree (4) Strongly agree (5)

7. I would enroll in classes that use this method again, if available.
Strongly disagree (1) Disagree (2) Indifferent (3) Agree (4) Strongly agree (5)

III. Please answer the following questions.

8. What did you like best about the method of learning?

9. What did you like least about this method of learning?

10. Compared to other ways of learning, was this method of learning useful? Why or why not?

11. Did you use other educational technology resources to assist in learning the manual therapy psychomotor skills? If so, which one/s did you use?

12. Any other comments?

13. Please estimate below the total number of hours you studied this content (the musculoskeletal techniques) outside of the classroom: alone_________ minutes with classmates__________ minutes

Appendix E – Topic areas for focus group discussion schedule

- What did you think about the use of LMS-embedded multimedia as a primary instructional strategy?
- How did you use the LMS-embedded instructional multimedia?
- Did the LMS-embedded instructional multimedia help or support your learning?
- Did the LMS-embedded instructional multimedia change how you collaborate with your classmates?
- In what ways have you applied these techniques to other learning situations?
- Do you anticipate using LMS-embedded instructional multimedia in the future?
- Would anything make this resource more useful?
- Should the LMS-embedded instructional multimedia include anything additional?

Appendix F—USAHS IRB Approval

UNIVERSITY OF ST. AUGUSTINE
FOR HEALTH SCIENCES

June 5, 2017

Christopher Ivey
40333 Trenton Court
Temecula, CA 92591
RE: IRB# 0410-017

Dear Dr. Ivey,

The members of the Institutional Review Board (IRB), responsible for the review of research involving human subjects, has reviewed and edited your research proposal. You are to provide the edited informed consent to the IRB. Approval of the project will be for one year, starting June 5th, 2017.

This approval is granted with the understanding that no changes may be made in procedures to be followed until after such modifications have been submitted to the IRB for review and approval.

Any unanticipated problems involving risk to human subject or serious adverse effects must be promptly reported to the IRB. Please include the IRB number assigned above on all documents related to this research.

Prior to the expiration of this approval, you will receive notification of the need for updated information to be used for the project's continuing review.

Should you complete this research project prior to the annual renewal date, please notify the IRB.

Sincerely,

, PT, PhD, GCS

Dr. Marilyn E. Miller
Chair, CA IRB

700 WINDY POINT DR. - SAN MARCOS, CA 92069 PHONE (760)591-3012 - FAX (760) 290-3997 - WEBSITE: www.usa.edu

Appendix G—University of Liverpool VPREC Approval

UNIVERSITY OF LIVERPOOL | ONLINE PROGRAMMES

Dear Christopher Ivey

I am pleased to inform you that the EdD. Virtual Programme Research Ethics Committee (VPREC) has approved your application for ethical approval for your study. Details and conditions of the approval can be found below.

Sub-Committee:	EdD. Virtual Programme Research Ethics Committee (VPREC)
Review type:	Expedited
PI:	
School:	Lifelong Learning
Title:	Learning management system embedded instruction multimedia's effect on musculoskeletal psychomotor skills and physical therapy student perceptions
First Reviewer:	Dr. Baaska Anderson
Second Reviewer:	Dr. Susan Bolt
Other members of the Committee	Dr. Martin Gough, Dr. Rita Kop, Dr. Ruolan Wang, Dr. Greg Hickman, Dr. Marco Ferreira, Dr. Kathleen Kelm, Dr. Josè Resi Jorge
Date of Approval:	26/08/2017

The application was APPROVED subject to the following conditions:

Conditions			
1	Mandatory	M: All serious adverse events must be reported to the VPREC within 24 hours of their occurrence, via the EdD Thesis Primary Supervisor.	

This approval applies for the duration of the research. If it is proposed to extend the duration of the study as specified in the application form, the Sub-Committee should be notified. If it is proposed to make an amendment to the research, you should notify the Sub-Committee by following the Notice of Amendment procedure outlined at http://www.liv.ac.uk/media/livacuk/researchethics/notice%20of%20amendment.doc.

Where your research includes elements that are not conducted in the UK, approval to proceed is further conditional upon a thorough risk assessment of the site and local permission to carry out the research, including, where such a body exists, local research ethics committee approval. No documentation of local permission is required (a) if the researcher will simply be asking organizations to distribute research invitations on the researcher's behalf, or (b) if the researcher is using only public means to identify/contact participants. When medical, educational, or business records are analysed or used to identify potential research participants, the site needs to explicitly approve access to data for research purposes (even if the researcher normally has access to that data to perform his or her job).

Please note that the approval to proceed depends also on research proposal approval.

Kind regards,

Lucilla Crosta

Chair, EdD. VPREC

Appendix H—Permission letter from USAHS leadership for the study

March 27, 2017

Christopher J. Ivey
The University of St. Augustine for Health Sciences
San Marcos, CA

Re: Research Permission

Dear Mr. Ivey:

At your request, you are given permission to complete the research project entitled, "Learning management system embedded instructional multimedia's effect on musculoskeletal psychomotor skills and physical therapy student perceptions" at the University of St. Augustine for Health Sciences, San Marcos, CA campus.

To complete this project, you are requesting access to the following resources:

- Access to fifth term Doctorate of Physical Therapy students on San Marcos, CA campus;
- Blackboard access to embed instructional multimedia;
- Room use for focus group discussion;
- Use of the University's Survey Monkey under the directive of the Director of IR for survey development.

You are granted permission to utilize these resources. I wish you much success in your upcoming research project and hope to learn for your results in the near future.

Sincerely,

Wanda Nitsch

Wanda Nitsch, PT, Ph.D.
President/Chief Academic Officer

Appendix I—Informed consent form

IRB
University of St. Augustine for Health Sciences
Out of town: 1-866-577-3731 x2468; Local: 1-760-591-3012 x2468

IRB Informed Consent Form, IRB # 0410-017

Title:
Learning management system embedded instructional multimedia's effect on musculoskeletal psychomotor skills and physical therapy student perceptions

Principal Investigator:
Principal Investigator: Christopher J. Ivey
Address/phone/e-mail: 700 Windy Point Dr. San Marcos, CA 92069
1-760-591-3012 Ext. 2452
civey@usa.edu

Funding Source:
This study has no external funding.

Description of the Study:
The purpose of this study is to investigate the effectiveness of online instructional multimedia as the primary instructional strategy for musculoskeletal psychomotor skills in physical therapy students and examine the student perceptions of this educational approach. You have been selected to participate in this study because you are enrolled in PHT 5134C (Musculoskeletal III: Advanced Extremity Examination, Evaluation, and Manipulation. The study will analyze the practical examination data for the mobilization/manipulation skills in the course. The study will also require the completion of a survey and potentially participation in a voluntary focus group discussion. The time commitment for this study is the duration of the term (15 weeks). The principle researcher for this project is enrolled in doctoral study in Higher Education at the University of Liverpool, and this study fulfills a partial requirement for the degree program.

Benefits and Risks to the Participant:
Since the proposed study uses instructional strategies that are currently utilized by the university, this study poses no additional benefit or risk.

If you have any concerns about your participation in the study, you should discuss them with the Principal Investigator, Christopher J. Ivey at 1-760-591-3012 Ext. 2452. Additionally, you can contact the Institutional Review Board Chair, Dr. Marilyn Miller at 1-760-591-3012 Ext. 2468.

Costs and Payments to the Participant:
No costs or payments will be incurred by participating in this study.

The University of St. Augustine for Health Sciences is not liable for any cost or compensations incurred as a result of participating in this study.
Confidentiality: All information obtained in this study is strictly confidential unless disclosure is required by law. Information collected from the study will stored electronically in a password protected account.

Participant's Right to Withdraw from the Study:
Your participation is totally voluntary, and even if you begin participation, you are free to withdraw at any time without explanation or penalty. Results up to the period of withdrawal may be used if you are happy for this to be done. Otherwise, you may request that they are destroyed, and no further use is made of them.

Voluntary Consent by Participant: Participation in this research project is totally voluntary, and your consent is required before you can participate. If you choose not to participate, your practical examination scores will not be used or reported in the research study. In addition, you will not need to complete the study's questionnaire or participate in the focus group discussion. See signature statement below.

Investigator's claim:

I have explained to______________ the purpose of the research study, the procedures required, and the possible risks and benefits to the best of my ability.

Investigator's signature: ______________________________ Date: _______________

Investigator's printed name: ___________________________

Participant's claim:

I have read this consent form (or it has been read to me) and I fully understand the contents of this document and voluntarily consent to participate. All of my questions concerning this research have been answered. If I have any questions in the future about this study, the investigator listed above or his staff will answer them. A copy of this form has been given to me.

____ ________________
Participant's signature Date

____
Participant's printed name

Appendix J—USAHS's Office of Assessment and Institutional Research letter confirming confidentiality of the questionnaire responses.

Bryce Pride, PhD
Senior Data Scientist
The University of St. Augustine for Health Sciences
1 University Blvd
St. Augustine, FL 32086
1-904-826-0084 ext. 1319

Christopher Ivey
700 Windy Point Drive
San Marcos, CA 92069
1-760-591-3012 ext. 2452

10 August 2017

Dear Mr. Ivey:

This letter is to provide assurances that the student responses to the administered questionnaire will be kept confidential and stored in a secured manner. Access to this data is limited to the institutional research staff, and it requires a password to enter the system. Once the participants complete the questionnaire, you will be provided with anonymous data. Please let me know if you need additional assistance in this manner.

Sincerely,

Bryce Pride, PhD

Appendix K—Categories and codes for the focus group topic areas

What did you think about the use of LMS-embedded multimedia as a primary instructional strategy?

Category	Codes	Frequency
The videos were perceived positively for preparation and review.	Liked it (FG1P1,3)	2
	Prepared (FG1P1,2,3) (FG2P1,4)	5
	Beneficial (FG1P3)	1
	Nice aide (FG1P5)	1
If given a choice, live demonstration was preferred.	Didn't like it as primary (FG2P1,2)	2
	Prefer live demonstration (FG1P6)(FG2P3)	3

Note. FG1=Focus group one; FG2=Focus group 2; P=Participant

How did you use the LMS-embedded instructional multimedia?

Category	Codes	Frequency
The videos were used for preparation before class.	Before class (FG1P1,2,3,5) (FG2P1,2,3,4)	8
The videos were used mostly for practical examination review.	Before the practical (FG1P1,2,5)	3
	Practical review (FG1P6)	1
	Resource for the practical (FG1P5)	1
	Practical exam (FG1P3)	1
	Study for the exams (FG2P1,4)	2
	Review (FG2P3)	1
	Group Study (FG2P2)	1

Note. FG1=Focus group one; FG2=Focus group 2; P=Participant

Did the LMS-embedded instructional multimedia help or support your learning?

Category	Codes	Frequency
The videos were supportive of student learning as a tool for review with convenience and repetition highlighted as important features.	Support-prepared (FG1P2)	1
	Reference (FG1P2)	1
	Support--go back at any point (FG1P5)	1
	Support--watch it over and over (FG1P6)	1
	Very helpful to go back (FG2P3)	1
	Yes--review (FG2P4)	1

Note. FG1=Focus group one; FG2=Focus group 2; P=Participant

Did the LMS-embedded instructional multimedia change how you collaborate with your classmates?

Category	Codes	Frequency
The videos were perceived as helpful to standardize the skill and increase efficiency.	Standard for the test (FG1P1, 2, 4)	3
	Review [access to standardized skill] (FG1P5,6)(FG2P2)	3
	Level it out to baseline (FG1P4)	1
	Increased efficiency (FG2P3,4)	2
The videos did not change classmate collaboration.	Not really (FG1P1)	1
	Barely (FG1P2)	1
	No (FG1P3)(FG2P1)	2
If the laboratory partner was not prepared, the process was more difficult.	More difficult process [if paired with someone who didn't watch the videos] (FG2P2,4)	2

Note. FG1=Focus group one; FG2=Focus group 2; P=Participant

In what ways have you applied these techniques to other learning situations?

Category	Codes	Frequency
This learning strategy was not applied to other situations.	I haven't (FG2P1,2)	2
	No (FG1P3,4)	2
This learning strategy was applied to other situations using the videos a supplement	As a supplement (FG1P5)	1
	For review [in other courses] (FG1P5)	1
	A lot [posted links from topics in school] (FG1P2)	1
It is difficult to use this learning strategy unless it comes from a reputable source.	It's nice when it comes from the professor (FG1P2)(FG2P3)	2
	It's hard to find accurate ones (FG2P4)	1

Note. FG1=Focus group one; FG2=Focus group 2; P=Participant

Do you anticipate using LMS-embedded instructional multimedia in the future?

Category	Codes	Frequency
This learning strategy is anticipated to be used in the future.	Yes (FG1P1,2,3,4,5,6) (FG2P1,2,4)	9
	As a supplement (FG1P2)	1
	For review (FG1P6)	1
	Yes, but prefer not to (FG2P2)	
The reliability of the source is important.	From a trustworthy source (FG1P4)	1

Note. FG1=Focus group one; FG2=Focus group 2; P=Participant

Would anything make this resource more useful? Should the LMS-embedded instructional multimedia include anything additional?

Category	Codes	Frequency
Video features such as zoom and multiple viewing angles would be useful.	Zooming (FG1P1,2)	2
	Closer view (FG1P5)	1
	Multiple views/angles (FG1P3,6)(FG2P2,3,4)	7
The ability to ask questions about the technique would be useful.	Interactive for questions (FG2P2)	1

Note. FG1=Focus group one; FG2=Focus group 2; P=Participant