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Comparison of Live Demonstration versus Multimedia Instruction for Psychomotor Skill Development in Physical Therapy Students

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Abstract: *Hybrid learning is expanding in physical therapy education; however, a limited empirical understanding of the psychomotor domain exists in this context. Moreover, the current literature presents conflicting results. Psychomotor skill instruction traditionally uses live demonstration followed by student practice. This study compared student learning outcomes between the traditional approach and learning management system multimedia instruction in Doctor of Physical Therapy students. Using a cross-over design, half of the psychomotor techniques were instructed using each instructional strategy for cohort one and switched for cohort two. A practical examination compared student performance. Live demonstration scores were slightly higher than the LMS-embedded multimedia scores for the upper extremity techniques. While the differences were statistically significant, the partial eta squared value is small. This pattern was reversed for the lower extremity with slightly lower live demonstration scores compared to the LMS-embedded multimedia instruction. However, the difference between means was not statistically significant, revealing similar outcomes for both instructional strategies.*

Key Words: Physical Therapy, educational technology, multimedia, psychomotor learning

INTRODUCTION

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 and blended-learning models (Brooks, 2011; Tucker, 2013). Physical therapy education has also observed a shift in education delivery. Traditional curriculums with face-to-face learning are declining, and a rise in online integration has yielded increased non-traditional learning methods such as hybrid courses and curriculums (Chung & Lee, 2018). Evidence from the Commission on Accreditation in Physical Therapy Education (CAPTE) 2019-2020 Aggregate Program Data highlights 74.6% of physical therapy programs utilize hybridity within their curricular models (CAPTE, 2020a). With the rise in adaptation to non-traditional teaching styles, there has not been the same magnitude of research identifying best practices for

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utilizing online technology in the physical therapy classroom. Some evidence suggests positive learning outcomes with blended learning formats and hybrid models within physical education (Hughes et al., 2018). However, more information is needed to identify optimal ways of utilizing this technology to support all domains of learning.

The advancement of digital education is not a new topic among higher education for health care professionals (Rose, 2020). Physical therapy curriculums continually evolve to ensure that graduates can provide high-quality patient care in a complex health care system (Adams, 2013; Boucher et al., 2013). Technology can provide added value to support students and faculty while maintaining high levels of education and student satisfaction (Gagnon et al., 2020). Student preference for digital tools and online learning methods has also contributed to embedding online learning resources to help with learner engagement and relevance (Mącznik et al., 2015). Additionally, students readily access the internet and various app-based informational systems as a primary source of information (Mącznik et al., 2015). The utilization of digital technology may help increase student engagement using relevant tools consistent with generational learning preferences (Mącznik et al., 2015).

The COVID-19 pandemic has catapulted the use of online education for foundational and didactic knowledge, along with instructing and assessing hands-on psychomotor skills (Gagnon et al., 2020). Classes previously reserved as face-to-face have now been pushed into a predominately virtual setting (Gagnon et al., 2020). While the effects of COVID-19 on education for health care professions are not fully known, some higher education institutions have pivoted to providing more skills demonstration through a virtual medium (Gagnon et al., 2020). More information on learning outcomes related to psychomotor skills will help instructors develop and implement effective online learning environments to teach and assess these skills.

The development of psychomotor skills is essential for the practice of physical therapy. Regular individual testing and evaluation of student performance of psychomotor skills is required by the programmatic accrediting body (CAPTE, 2020b). The traditional instructional strategy for these skills is live demonstration followed by student practice. This study examines the use of digital technology through a learning management system (LMS). This system embedded instructional multimedia videos as the primary strategy for teaching select musculoskeletal psychomotor skills. This study aims to determine the effectiveness of LMS-embedded multimedia as the primary instructional strategy for psychomotor musculoskeletal manual skills development. This research question guided the study:

> 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?

The available literature evaluating multimedia instruction within physical therapy education is limited, especially pertaining to psychomotor learning. To date, most outcomes related to the investigation of online delivery in physical therapy education have assessed the cognitive impact associated with the use of these online tools. A large component of physical therapy education and clinical practice involves psychomotor skills in assessment and treatment. In a systematic review and meta-analysis using internet-based learning for health care professional education, a wide variety of strategies exist regarding the type of web-based education offered in various curriculums (Cook et al., 2010). Moreover, because a large heterogeneity exists regarding the type of educational technology and instructional methods used, additional definitions are needed to help with direct comparisons and evidence synthesis (Cook et al., 2010). For clarity and consistency, the following definitions adapted from the CAPTE position paper will outline the intended meaning of common terms used throughout the article CAPTE, 2019).

- Learning Management System (LMS): a software or online platform that offers a wide range of tools for both students and educators to support web-based learning. Examples include Blackboard, Canvas, Desire to Learn, and Sakii.
- Traditional Instruction: All course hours reflect face-to-face instruction that occurs in the lab, community, or classroom. This form of education delivery can utilize an LMS for online resources such as multimedia and file sharing as a supplement to synchronous learning.
- Blended Instruction: Learning is distributed between a blend of distance education with asynchronous learning and face-to-face synchronous learning. The total student in seat time is unchanged compared to traditional instruction but more distributed between distance education and face-to-face instruction.
- Online Instruction: All learning (100%) is occurring through an online environment. This can occur through synchronous and asynchronous methods, but the faculty and students are separated by time and distance.

While the use of blended and online courses is increasing, reported student learning outcomes are conflicting. Moreover, some negative faculty perceptions of online teaching represent additional barriers to utilizing digital instruction. In a qualitative study investigating the lived experiences of physical therapy faculty, various themes emerged regarding limitations hindering faculty's integration of technology (Donlan & Alpert, 2018). Time with learning the technological tools and troubleshooting issues as they arose were major barriers inhibiting use and leading to reduced feelings of independence and self-efficacy. Additionally, some evidence suggests negative perceptions of delivering online education from faculty, highlighting a reduced sense of prestige in using online teaching tools (Wingo et al., 2017). These counterintuitive perceptions emphasize the need for continued study exploring effective domain learning to facilitate student competencies.

Educational technology's effectiveness depends on the purpose and implementation (Burbules & Callister, 2000). 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 (Papastergiou et al., 2014). Specific to physical therapy education, technology research for all learning domains is growing, however, more information is needed to match the increased interest and use (Veneri & Gannotti, 2014). A 2015 systematic review demonstrated the availability of only 22 studies related to educational technology in this field of study (Mącznik et al., 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 the cognitive learning domain in both the short and long-term assessments (Adams, 2013; Barker, 1988; Bayliss & Warden, 2011; Campbell & Kohli, 1970; Ford et al., 2005; Jones et al., 2010; Maring et al., 2008; Plack, 2000; Smith et al., 2006; Thompson, 1987; Willett et al., 2008). More information is needed regarding assessments with multimedia instruction pertaining to learning and evaluating psychomotor skills in physical therapy education.

Some evidence evaluating the effectiveness of multimedia instruction within the psychomotor domain exists outside of physical therapy. Seals et al. (2016) examined student satisfaction and examination scores of second-year osteopathic students learning manual therapy techniques using instructional videos compared to live faculty demonstration. The study identified no statistically significant change in student's examination scores despite positive student reports on using the technology. This is consistent with a majority of the available articles that report no statistical difference in student performance using multimedia instruction compared to the traditional teaching strategy (Barker, 1988; Moore & Smith, 2012; Smith et al., 2006). That said, a paucity of literature exists regarding the use of educational technology as a primary instructional strategy for psychomotor skill development within the context of physical therapy education.

Materials and Methods

Utilizing a cross-over study approach, a live demonstration and LMS-embedded instructional multimedia were employed to instruct participants in applying psychomotor manual therapy skills for six body regions. The shoulder, elbow, wrist and hand, hip, knee, and ankle and foot regions were assessed. These six body regions were grouped into upper (shoulder, elbow, wrist/hand) and lower (hip, knee, ankle/foot) extremities for the practical examination testing. In total, the study examined 58 manual therapy techniques as outlined in Table 1.

Table 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=54	A	B	A	B	A	B		A	B	A	B	A	B	
Cohort 2 n=59	B	A	B	A	B	A		B	A	B	A	B	A	

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

The study used the Blackboard LMS platform to deliver all multimedia recordings. This LMS platform was the current instructional tool utilized by the university. Students were instructed to watch the peripheral techniques prior to face-to-face lab time. During the weekly three hours of dedicated face-to-face lab time, students were shown live demonstrations of different peripheral techniques not covered on the LMS platform. Additionally, students were permitted to practice multimedia techniques, ask questions, and receive feedback from course faculty regarding all techniques. No additional formal demonstrations of the LMS platform psychomotor skills were performed beyond feedback and answering of student-led questions. Each participant performed a live demonstration and LMS-embedded instructional multimedia skill for the practical examinations. This data was compared using a one-way repeated measures ANOVA. The Mauchly's test ensured that no assumptions were violated. Descriptive statistics are also provided.

Participants

This study used a census sample of two consecutive second-year DPT cohorts enrolled in the curriculum's third musculoskeletal course. All students met the inclusion criteria of course enrollment. However, 54 of the 62 students from cohort one and 59 of the 77 from cohort two agreed to participate in the study. The associated institutional review board approved this study, and each participant signed and returned the informed consent form before the study began. Of note, students already passed two musculoskeletal courses, which included basic psychomotor techniques and precautions. This course was specific to instructing entry-level DPT students on mobilizing techniques of the peripheral joints.

All students met the inclusion criteria, which was course enrollment. The exclusion criterion was course remediation to establish control for prior instruction on the tested psychomotor skills. No students met the exclusion criterion.

Results

Each participant completed a practical examination at the midway point and at the end of the 15-week course. The grading criteria totaled 20 points, and a copy is included in Appendix A. The practical examinations included a live demonstration and an LMS-embedded multimedia instruction technique. The selected techniques for each student's practical examination were assigned using a random number generator. One grader performed all of the practical examinations. This grader was not part of the course instruction and was blinded to the instructional strategy employed for all techniques.

The lower extremity descriptive statistics and one-way repeated measures ANOVA for both groups are represented below in Tables 2 and 3, respectively. The one-way repeated measures ANOVA was used to compare participant scores for the course's lower extremity components. Further examination of each lower extremity body region 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.

Table 2
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 3
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			

One-way repeated measures ANOVA was used to compare participant scores for the upper extremity components of the course. The descriptive statistics are found in Table 4 below. Table 5 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 small (.058).

Table 4
Descriptive Statistics for Upper Extremity Total Score for Both Cohorts

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

Table 5
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 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.

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.

Discussion

This study focused on determining the effectiveness of the LMS-embedded multimedia as the primary instructional strategy for psychomotor skill development. The objective of the study was to explore the differences in learning outcomes between LMS embedded multimedia versus traditional live demonstration in the instruction of psychomotor skills in physical therapy students. The psychomotor testing analysis illustrates the comparison of LMS embedded multimedia and live instruction and clarifies the study's guiding question.

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. Further exploration of the data by each body region (shoulder, elbow, wrist/hand, hip, knee, and ankle/foot) 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; Ford et al., 2005; Howerton et al., 2004; Kelly et al., 2009; Kneebone & ApSimon, 2001; Moore & Smith, 2012; Sanddal et al., 2004; Smith et al., 2006; Xeroulis et al., 2007). Two previous studies reported improved psychomotor performance for live demonstrations over multimedia in a small percentage of skills. While prior studies have also confirmed similar performance within the psychomotor skills through virtual instruction or live, there is some evidence to suggest the complexity of the skill may also have an influence (Davie et al., 2015; van Duijn et al., 2014). In a study that examined psychomotor techniques in the neck, which are traditionally more complex, a slight preference was achieved in the live instructional strategy (van Duijn et al., 2014). Results highlight the technique's complexity may factor into student performance and preference for live versus online instruction. Additionally, student performance and perference may lean towards live demonstration in psychomotor tasks that involve obtaining objective information by way of performing special tests to assess tissue pathology. When comparing student performance of a special test to assess knee ligament integrity, students scored higher in the live demonstration group. However, no difference in learning performance was noted for skills of a lower complexity, such as taking objective measurements for measuring joint motion or muscle strength (Davie et al., 2015).

These findings suggest that the performance of some psychomotor skills is improved with live demonstration instruction Some techniques, such as spine mobilizations, require coordinated movements by the physical therapist and patient while performing the skill. These skills need more sequence steps and may require higher levels of psychomotor coordination and instruction. 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.

Several studies noted improved student performance on psychomotor skill-testing using multimedia to supplement traditional instructional strategies (Arroyo-Morales et al., 2012; Bauer et al., 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.

Potential limitations in this study included some students in both cohorts elected not to participate. Additional limitations that may influence a student's performance are the quality of the video and the techniques' viewing angle. The viewing angle of the smaller body region, such as the foot, can be hard to see and could play into a student's ability to see hand placements and boney landmarks. Future studies should consider video characteristics related to psychomotor skill acquisition using multimedia. Additional research is necessary to ascertain if this finding is reproducible and further investigate potential reasons for this variation.

This study's results demonstrate similar learning outcomes for physical therapy students' psychomotor performance of manual therapy skills 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 (ankle/foot, knee, and hip) did not show a difference between examination testing means. 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. 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. This study validates that an LMS-embedded instructional multimedia is a viable option for primary psychomotor instruction.

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.

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. With increased face-to-face time provided by removing a live demonstration, questions can be discussed at a higher level and improve the clinical reasoning related to these examinations and treatment techniques. 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 address the societal need within healthcare for more medical graduates.

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APPENDIX

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)