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ORIGINAL RESEARCH

Effectiveness of Mobile Learning on Athletic Training Psychomotor Skill Acquisition

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Context: Instruction of psychomotor skills is an important component of athletic training education. Accommodating the varied learning abilities and preferences of athletic training students can be challenging for an instructor initiating skill acquisition in a traditional face-to-face (F2F) environment. Video instruction available on mobile devices may offer an alternative teaching tool, allowing for student-initiated learning.

Objective: To compare outcomes of Quick Clips (QC) instruction with F2F instruction as measured by skill-examination scores.

Design: Quasi-experimental.

Setting: Five higher learning institutions with Commission on Accreditation of Athletic Training Education (CAATE) accredited athletic training education programs.

Patients or Other Participants: Seventy-four pre-athletic training students, average age 18.86 $\pm$ 1.0 years (49 women, 25 men), volunteered for this study. Participants were randomly assigned to 1 of 2 instructional groups (F2F or QC).

Intervention(s): The principal investigator provided F2F instruction to 38 participants in 3 skills (knee valgus stress test, middle trapezius manual muscle test, and goniometric measurement of active ankle dorsiflexion). The remaining 36 participants watched 3 QC videos demonstrating the same skills.

Main Outcome Measure(s): Three individual skill exam scores and the total score.

Results: A 1-way multivariate analysis of variance indicated a significant effect ($P < .0001$) of instructional method on exam scores. Follow-up univariate analysis of variance indicated knee valgus stress test exam scores were significantly higher after F2F instruction ($P < .0001$). Neither manual muscle test nor goniometric measurement exam scores were affected by instructional method.

Conclusions: The findings support the use of QC as an alternative to F2F instruction for 2 of the 3 skills. This finding is similar to studies reported in the nursing literature on computer-assisted learning, which found inconclusive evidence to support the superiority of one method over another. Mobile video instruction is an effective teaching strategy. It may be best utilized to supplement traditional F2F instruction.

Key Words: Video-based instruction, Quick Clips, ubiquitous

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INTRODUCTION

Societal trends have created a demand for increased use of technology in education.[1,2] Today's generation of students, the Millennials, are native to the digital era, not experiencing a time without computers and the World Wide Web.[3] They like to multitask, prefer receiving information quickly and having unlimited access to educational content, and function best when networked.[2] Today's learners use mobile technology daily for entertainment and socialization; therefore, it is logical to incorporate these devices into the educational environment. Mobile learning (m-learning) involves the use of mobile devices such as mobile phones, personal digital assistants (PDAs), and portable media players such as iPods (Apple, Cupertino, CA) for the purposes of acquiring and disseminating knowledge.[3] Teaching and learning methods that incorporate the mobile technology skills of today's students may be a successful strategy for engaging this generation in the educational environment.[4,5] Along with engaging the Millennial generation, m-learning may provide an effective solution for institutions facing crowded classrooms, high student to faculty ratios, and an increase in "nontraditional" students.

The US Department of Education (USDE) reports that total enrollment in higher education is expected to increase 17% through 2019.[6] As more students attend college, classroom space will become limited, and student to faculty ratios will increase. Data from USDE also suggest a demand for increased flexibility in learning opportunities. The percentage of undergraduates who took distance education courses rose from 16% in 2003–2004 to 20% in 2007–2008.[6] From 2008 to 2019, the projected increase in total postsecondary enrollment is 11% for individuals under the age of 25 and 20% for those aged 25 and older.[7] These projections indicate a likely increase in the number of students with a job, a family, or both, a population that will require flexible learning opportunities such as distance education. Athletic training education programs can provide flexible education opportunities by incorporating m-learning. M-learning will not only provide flexibility but also will support a variety of learning styles characteristic of today's students.

Identifying the learning styles of students is an important strategy for creating an effective educational environment. Stradley et al[8] found that no predominant learning-style type characterizes the typical athletic training student; therefore, it is important for educators to address the needs of all students in both the classroom and the clinical setting.[8] Coker[9] used the Kolb Learning Style Inventory to examine the preferred learning modes and subsequent learning styles of undergraduate athletic training students to determine their consistency across traditional classroom versus clinical settings. The preferred learning mode in the classroom was reflective observation, whereas active experimentation was more prevalent in the clinical setting.[9] The learning styles of 58% of respondents changed according to the setting focus.[9] Gould and Caswell[10] administered the Gregorc Style Delineator and the Preferred Teaching and Testing Method Inventory to 200 undergraduate athletic training students and 100 athletic training education program directors. Athletic training students and program directors had significantly different preferences for teaching and testing methods.[10] Program directors' preferred mind style was "concrete sequential (CS)."[10] Concrete sequential individuals are task oriented, favoring factual and concrete information that is presented in a highly structured environment and incorporates hands-on activities.[10] Undergraduate students' preferred mind style was "abstract random (AR)."[10] Abstract random individuals prefer busy environments, social interaction, and unstructured learning such as group discussions.[10] The different preferences create a potentially mismatched educational environment. M-learning may be a viable option for accommodating both instructors and students. Instructors can use mobile devices to disseminate course material in a factual, concrete, and structured fashion. Several authors[4,11,12] described utilizing mobile devices to disseminate course material. Students can use mobile devices to access background information and complete lectures; thereby, providing instructors more time for in-class, hands-on activities.[3,11–13] The learning management systems utilized by many educators can be accessed effectively via mobile devices.[14] All of these mobile applications may be attractive to CS instructors. Mobile devices provide connectivity for spontaneous communication and collaboration.[3] Utilizing this technology in the educational environment may be a successful strategy for engaging AR students. M-learning can support a variety of learning styles (visual, auditory, mixed); and therefore, educators may find mobile technologies beneficial for engaging a diverse group of students. Coker[9] suggests the use of classroom instructional strategies that provide opportunities for discussions, brainstorming, reflective thinking, and critical thinking, while the clinical setting incorporates simulations, case studies, and hands-on experience to maximize learning potential. According to Davie,[3] m-learning can encourage and enhance these types of activities. Several studies have indicated that students have a positive perception of m-learning[11,15,16]; however, minimal research[16–21] has investigated the effectiveness of m-learning in health care education. The information gained from e-learning studies will provide insight into how m-learning may impact academic performance.

E-Learning in Health Care Education

For over a decade, e-learning has been combined with traditional classroom lectures and lab activities to enhance the independent and collaborative learning environment.[3] E-learning includes computer-based instruction (CBI) and computer-assisted instruction (CAI). Fincher and Wright[22] defined CBI as "any form of instruction that uses the computer to present instructional information, with computer-assisted instruction and interactive video being 2 distinct forms of computer-based instruction." Computer-assisted instruction generally consists of text only, whereas interactive video programs incorporate multimedia technology (text, audio-video, and graphic images) to convey information.[22] E-learning has been incorporated into a variety of disciplines including health care education. The literature has reported both positive and negative outcomes of these instructional strategies in health care education including athletic training.[22–35]

Several authors[23,26,28,30,31] have studied the effectiveness of various types of e-learning compared with more traditional teaching methods. Jowett et al[23] found computer-based video training (CBVT) to be an effective self-directed learning environment for 30 novice surgical trainees learning the 1-handed square knot. Positive results from CBVT also were reported by Nousiainen et al[26] who investigated the benefits of learner-directed, interactive CBVT and the addition of expert instruction on learning and retention of the basic surgical skills, suturing and knot tying. Results indicated that video training alone was as effective as the combination of video and expert instruction. The authors concluded that the use of videos to teach basic surgical skills is effective and solves problems involved with practicing on patients and organizing adequate staff for teaching sessions.[22] Video instruction can also provide flexibility to acquire and practice basic surgical skills on the student's own time.[26]

Salyers[28] studied the effects of 2 instructional approaches, Web-enhanced and traditional, on cognitive knowledge acquisition, psychomotor skill performance, and satisfaction with a nursing psychomotor skills course. During the semester, the Web-enhanced group completed 13 modules on a computer, including interactive videos, to learn the course material outside of class at their own pace. The control group proceeded through the same material during a 3-hour lecture/skill demonstration session each week. The skills chosen for evaluation during final exams were nasopharyngeal suctioning, catheter insertion, and wet-to-dry dressing changes. Although not significantly better, the Web-enhanced group performed better on the final psychomotor skills examination than the control group.[28] Kelly et al[30] evaluated the effectiveness of instructional videos available online in terms of student outcomes and to explore students' attitudes toward this method of skills teaching. Students who learned 3 nursing skills through online videos performed as well on the skill examination as those who learned through traditional methods.[30] Smith et al[31] compared the effects of face-to-face (F2F) demonstration with an instructional CD on the acquisition of clinical skills of physical therapy students. Skill exam performances of those who viewed the instructional CDs showed no significant difference in one skill area but had significantly higher scores than the control group in another area. The authors concluded that instructional CDs were at least as effective as F2F demonstration for teaching psychomotor skills.[31]

E-Learning in Athletic Training Education

Two additional studies[24,25] investigated the effectiveness of e-learning in athletic training education. Wiksten et al[24] examined the effectiveness of a CD-ROM program, *Sport Injuries 3-D*, as a supplemental resource in an introductory athletic training laboratory course. The authors found no significant difference in exam scores between the 2 groups (lecture and lecture/CD-ROM).[24] Accessing the CD-ROM was optional, and the majority of students used the resource for 30 minutes or less per week. The results may have differed significantly if students were motivated to utilize the supplemental material. More time-efficient access, as provided by mobile devices, and course content-specific material could increase student use. In another study, Wiksten et al[25] compared Q-angle multiple-choice exam scores, Q-angle practical exam scores, and attitudes toward instruction methods between 3 different instructional groups: traditional lecture, interactive athletic training computer program (IATEC), and a control. No significant differences were found between the traditional lecture and IATEC groups on skill performance.

E-learning, including both CAI and CBI, has demonstrated positive outcomes.[23–25] Computer-based video instruction is as effective on skill acquisition as F2F instruction. M-learning provides the same benefits as CBI with the additional benefit of no location limitation on learning. M-learning has demonstrated positive outcomes in several disciplines including foreign language,[4,36] public speaking,[37] sciences,[11,12] and sociology.[5] To our knowledge, only 1 pilot study[21] has been published examining the use of mobile video instruction.

Lynch[21] produced 6 instructional videos of paramedic psychomotor skills required for providing acute care. The videos were intended for viewing on a mobile device. Analysis of survey responses indicated that the videos positively impacted student ($n = 87$) learning by engaging the learner, improving skill understanding and acquisition, and providing a valuable tool for revision and retention.[21] M-learning research is limited in the health sciences and almost nonexistent in athletic training.[38] The effectiveness of m-learning on athletic training skill acquisition is unknown. An m-learning tool specific to athletic training called "Davis's Quick Clips"[39] has recently been published. The purpose of this study was to compare postinstruction skill examination scores among undergraduate athletic training students learning 3 psychomotor skills under 2 different instructional strategies: F2F and Quick Clips (QC). The authors hypothesized that the QC group would perform as well as the F2F group on the psychomotor skill examination.

METHODS

Participants

Seventy-four participants from 5 of the Commission on Accreditation of Athletic Training Education (CAATE)-accredited athletic training education programs volunteered for this study. The schools were selected because at least 1 of the program's faculty members was a colleague of the principle investigator (E.D.) and, therefore, was willing to provide the physical space necessary to carry out the study and to assist with participant recruitment. One school is located in National Athletic Trainers' Association district 1 with a student population of 11 815. Two schools are in district 2 with populations of 8648 and 1657. Two schools are in district 5 with populations of 1206 and 722. An athletic training educator at each participating school assisted with participant recruitment through e-mail and verbal solicitations. Participants were included if they had declared athletic training as their major but had not begun the professional phase of their program. This population was chosen because they would most likely not have received prior instruction in the skills utilized in the study, and they would be motivated to learn skills that would be required of them in the future. Participants ranged in age between 18 and 25 years with a mean of 18.86 years ($\pm$1.064). Most participants were women (66.2%, n = 74). Institutional review board approval was received from Rocky Mountain University of Health professions as well as from the 5 institutions serving as data-collection sites. A written informational letter apprised all participants of the study's purpose and protocol.

Design

This study followed a quasi-experimental, posttest-only design. A pretest was not used because the outcome measurement tool was an "open-ended" skill examination, and the participants had no prior knowledge of the skills being taught.[32] The independent variable was instructional method. Study participants were randomly assigned to 1 of 2 instructional groups: F2F or QC. Each participant was assigned a human model for skill practice during the instructional session. The models were students at the data-collection sites who volunteered to assist in the research study. Following skill instruction, each participant completed a skill examination. Four dependent variables were measured from the postinstruction skill examination: (1) total examination score (percentage correct out of 25); (2) knee valgus stress test score (percentage correct out of 9); (3) manual muscle test of the middle trapezius (percentage correct out of 7); and (4) goniometric measurement of active ankle dorsiflexion (percentage correct out of 9). The instructional sessions and skill examinations were completed in classroom/laboratory spaces typically utilized for athletic training education.

Protocol Prior to Instructional Intervention. The principal investigator (E.D.) trained 2 examiners at each site to properly score the skill examinations. The examiners were instructors in the athletic training education program with previous experience in administering skill examinations. Examiner training consisted of a detailed review of the 3 skills and their components. E.D. explained what distinguishes a correctly versus incorrectly performed component of each skill.

When students volunteered to participate in the study, they chose a group instructional session that would not interfere with their regular class schedule. No more than 9 students were in any 1 instructional session. When participant recruitment was complete, E.D. randomly determined which type of instruction each group would receive. The participants did not find out what type of instruction they would receive until reporting for the session.

When the participants reported for their instructional session, E.D. debriefed them on the study procedures and scheduled everyone for a postinstruction examination. The participants completed a brief questionnaire that included demographic information (sex, age, grade point average) as well as specific questions regarding knowledge of the 3 skills being tested (eg, "If you were asked right now to perform a valgus stress test of the knee, would you be able to do so correctly?"). At the beginning of the QC instructional sessions, participants were given a mobile device and a set of earbuds. The mobile devices used were a combination of smart phones, iPods, and Slate Tablets (Hewlett Packard, Palo Alto, CA). Using a practice QC, not being used in the study, E.D. trained the participants in how to access and view the video on their mobile device. E.D. gave explicit instructions to the human models not to talk to the participants or provide assistance in any way.

Instructional Intervention. Instruction of skills for the F2F groups followed the direct instruction model, often referred to as "I do, we do, you do." Direct instruction is modeling with reinforced, guided performance.[40] "It is a viable, time-tested instructional model that plays an important role in a comprehensive educational program."[40] Direct instruction has been extensively studied and has been found to be effective and superior to other teaching models in areas such as learning engagement and student achievement.[40] During the "I do" portion of the instruction in the current study, E.D. explained and demonstrated the first skill (valgus stress test of the knee) on a model. During the "We do" portion, E.D. explained and demonstrated the skill, while the participants simultaneously performed the skill on their model. During the "You do" portion, participants continued to practice on their model with no further interaction with E.D. The direct instruction sequence was repeated for the second (middle trapezius manual muscle test) and third (goniometric measurement of active ankle dorsiflexion) skills. To ensure consistency, the principal investigator's instructions given to the F2F groups were based on the verbal instructions provided in the QC videos. Ten minutes was allotted for instruction of each skill, for a total instructional period of 30 minutes.

Participants in the QC group independently viewed the short, narrated videos of each skill and practiced the skills on a model. E.D. reminded the participants that they could watch the video clips an unlimited number of times while practicing on their model. Ten minutes was allotted for each skill. E.D. was present only to ensure the correct protocol was followed and to assist with any technologic difficulties. The participants were told to view the valgus stress test video and practice the skill. After 10 minutes, E.D. instructed the participants to begin viewing the middle trapezius manual muscle test video and practice the skill on their model. Finally, E.D. instructed the participants to begin viewing and practicing the third skill, goniometric measurement of active ankle dorsiflexion. The total time for instruction of all 3 skills was 30 minutes.

Postinstruction Protocol. After the instructional sessions, participants were reminded the importance of avoiding additional instruction in the 3 skills including discussing their intervention experience with other study participants. They also were reminded to return the following day during their scheduled time for the postinstruction skill examination.

Data Collection

Postinstruction skill examinations were completed the day following skill instruction. The 2 trained examiners, blind to instructional group, administered and scored each examination. Participants completed the examination in random order. Examiners used a 25-point checklist on which they placed a check in the box next to each correctly performed component (Table 1). The required components of each skill were determined from the verbal instructions and physical demonstrations provided by the QC. One examiner read the first set of instructions to the subject and started a timer. The

Table 1. One-Day Postinstruction Skill Examination Checklist

Knee Valgus Stress Test
☐ Instructs model to lie supine.
☐ Involved leg is close to the edge of the table.
☐ Stands lateral to the model's involved limb.
☐ One hand supports medial side of distal tibia.
☐ Other hand grasps knee along the lateral joint line.
☐ Knee is placed in full extension.
☐ A medial (valgus) force is applied to the knee while the distal tibia is moved laterally.
☐ Knee is flexed 25 degrees.
☐ A medial (valgus) force is applied to the knee while the distal tibia is moved laterally.
Manual Muscle Testing of Middle Trapezius
☐ Instructs model to lie prone.
☐ Shoulder is placed in 90 degrees abduction.
☐ Shoulder is laterally rotated so that thumb is pointing up.
☐ Scapula is retracted.
☐ Places a stabilization hand on opposite scapular area.
☐ Applies pressure against the arm.
☐ Pressure is applied in a downward direction.
Goniometric Measurement of Active Ankle Dorsiflexion
☐ Instructs model to sit or lie supine.
☐ Lower leg is supported on table.
☐ Foot is positioned in a talar neutral position.
☐ Fulcrum is placed over the lateral malleolus.
☐ Stationary arm is placed along the lateral fibula.
☐ Movement arm is aligned parallel to the lateral aspect of the fifth metatarsal.
☐ Instructs model to dorsiflex the ankle.
☐ Maintains proper alignment of the stationary arm.
☐ Maintains proper alignment of the movement arm.

participant had 2 minutes to perform the skill. The first attempt was scored. After the attempt was made or after 2 minutes had expired, the next set of instructions was read. The protocol continued for all 3 skills. To avoid introduction of an additional variable, the order of skill instruction and assessment was not randomized.

Data Analysis

Both examiners gave each participant 4 scores: (1) a total score of all 3 skills out of 25; (2) a first skill score out of 9; (3) a second skill score out of 7; (4) and a third skill score out of 9. Each score was averaged between the 2 examiners. The average scores were converted to percentages representing the percentage of correctly performed skill components. These percentages were used for data analysis. A 1-way multivariate analysis of variance was calculated examining the effect of instructional group on individual skill and total exam scores. Follow-up univariate analysis of variance (ANOVA) was used to determine which score(s) were significantly related to instructional group. A Pearson correlation coefficient was used to calculate inter-rater reliability. A P value of .05 was used to determine statistical significance. SPSS statistical software PASW 17 (SPSS Inc, Chicago, IL) was used for data analysis.

RESULTS

Seventy-four participants completed an instructional session (38 in the F2F group and 36 in the QC group) and postinstruction skill examination. A t test indicated the instructional groups were similar in grade point average ($t_{69} = -.708$, $P = .733$). A χ^2 test of independence revealed a significant difference between groups and their exposure to athletic training in high school (Pearson χ^2 test (1) = 4.462, $P = .035$). The QC group had significantly more participants who were exposed compared with the F2F group. The instructional groups did not differ significantly in the responses to the other 3 educational background questions. Table 2 reports the participant demographics.

Prior to instruction, 15 participants indicated on the questionnaire that they could already perform the ankle dorsiflexion goniometric measurement correctly. An independent-sample t test was calculated comparing the goniometric measurement mean score of participants who identified themselves as being capable of correctly performing the skill to the mean score of those participants who did not. No significant difference was found ($t_{72} = .307$, $P = .760$). Given the result of the t test, all of the participants' scores were used in the subsequent data analysis.

Postinstruction skill examination scores varied significantly with instructional method ($F_{3,70} = .760$, $P < .001$). Follow-up univariate ANOVAs indicated that total scores ($F_{1,72} = 6.952$, $P = .010$) and knee valgus stress test scores ($F_{1,72} = 19.356$, $P < .001$) were significantly higher after F2F instruction. Neither middle trapezius manual muscle test or ankle dorsiflexion goniometric measurement exam scores were affected by instructional method. Table 3 reports the comparison of postinstruction examination scores between instructional groups. Inter-rater reliability of each component of the postinstruction exam is reported in Table 4. The reliabilities ranged from poor to good.

DISCUSSION

The goal of this study was to compare the effects of QC instruction versus conventional F2F teaching methods on the acquisition of 3 psychomotor skills. Both instructional groups averaged higher than an 80% on each individual skill exam, indicating that both instructional methods were effective in teaching the valgus stress test of the knee, manual muscle test of the middle trapezius, and goniometric measurement of active ankle dorsiflexion. Our hypothesis was supported in 2 of the 3 skills. The findings support the use of mobile videos as an alternative to a F2F teaching session for 2 of the 3 skills. This finding is similar to those from earlier studies reported in the nursing literature that found inconclusive evidence to support the superiority of one method over another.[24,26]

The 3 skills were chosen for the current study because they represented varying levels of difficulty. The valgus stress test was, theoretically, the easiest because the model was completely passive. The manual muscle test was more challenging because the examiner had to provide instructions to the model for him or her to actively participate during the skill. The goniometric measurement was the most difficult because the skill involved providing instructions to the model to perform an action as well as utilizing an instrument.

Table 2. Participant Characteristics

	F2F (n = 36)	QC (n = 38)	Test of Equality	*P* Value
Sex, No. (female/male)	21/15	28/10	$\chi^2 = 1.947$	.163
Age, y (mean ± SD)	18.72 ± .741	19.00 ± 1.29	$t = -1.124$	.265
GPA[a] (mean ± SD)	3.22 ± .46	3.29 ± .47	$t = -.708$	.733
Anatomy course,[b] No. (yes/ no)	34/1	35/2	$\chi^2 = .292$	.589
AT course,[c] No. (yes/no)	31/4	36/1	$\chi^2 = 2.119$	.145
AT workshop,[d] No. (yes/ no)	5/30	6/31	$\chi^2 = .052$	.820
AT experience in HS,[e] No. (yes/no)	21/14	13/24	$\chi^2 = 4.462$	.035*

Abbreviations: AT, athletic training; F2F, face-to-face; GPA, grade point average; HS, high school; QC, Quick Clips.
[a] Two participants did not have a GPA at the time of data collection.
[b] Currently enrolled in or have previously taken a college-level anatomy course; 2 participants did not respond.
[c] Currently enrolled in or have previously taken a college-level AT course; 2 participants did not respond.
[d] Attended an AT workshop; 2 participants did not respond.
[e] Had an AT course in HS, observed/assisted an athletic trainer while in HS, or both; 2 participants did not respond.
* Denotes significance.

Despite being the "easiest" skill, the F2F instructional group performed significantly better on the knee valgus stress test as compared with the QC instruction group. Thinking back to the instructional interventions at each data-collection site, the principal investigator theorized this particular outcome was affected by the lack of participant understanding of the term "valgus." The instruction of this skill did not include an explanation of the word "valgus." As the valgus stress test was demonstrated by the principal investigator for the F2F group and by the video for the QC group, the statement "apply a valgus force to the knee" was verbalized while the force was applied. No further explanation such as "a valgus force means that pressure is applied to the lateral side of the knee, thereby stressing the medial knee structures" was provided. The QC group may have had a more difficult time than the F2F group deciphering how to apply the correct force because they were viewing the skill demonstration on a small screen rather than in person. The instructional groups performed similarly on the other 2 skills; however, the significant difference in performance on the valgus stress test resulted in an overall significant difference in the total skill examination scores.

Mobile video instruction is an effective teaching strategy. It may be best utilized to supplement traditional F2F instruction. This is the first study to our knowledge that utilized mobile devices to disseminate video instruction. The smaller screen size may have had an impact on the effectiveness of the videos. Other studies have found video instruction to be superior to traditional F2F instruction[33]; however, these studies have utilized larger screens typical of a desktop or laptop computer. Lee et al[33] found a 10-minute instructional DVD followed by 10 minutes of skill practice on a mannequin superior to traditional F2F teaching of pediatric intraosseous needle insertion. Cardoso et al[34] also studied the use of video instruction on a full-size screen. A pretest/posttest design was used but was not compared with a traditional instruction group. The use of an educational video with a simulation of puncture and heparinization of totally implantable central venous access ports was an effective strategy that increased both cognitive and technical knowledge.[34]

Durmaz et al[41] compared CBI with traditional instruction on nursing students' knowledge and skill in preoperative and postoperative care management. The study included 82 participants, similar to the current study. No significant difference was found between the practical deep breathing and coughing exercise education skill scores of the students in the 2 groups (screen-based computer simulation laboratory and traditional skill laboratory).[41] An additional study by Jeffries et al[42] reported no significant differences in 12-lead electrocardiogram skill-examination scores between 2 instructional groups: interactive CD-ROM and traditional lecture/demonstration/skill practice.[42] Both of these studies support the results of the current study in that mobile learning can be an alternative or adjunct instructional method to traditional classroom or skill laboratory instruction.

Table 3. Comparison of 1-Day Postinstruction Exam Scores Between Instructional Groups

	QC (N = 36)	F2F (n = 38)	
Scores indicate the percentage correct	Mean ± SD	Mean ± SD	*P* Value
Knee valgus stress test	80.86 ± 16.82	94.74 ± 9.49	.000*
Middle trapezius MMT	91.07 ± 11.62	94.74 ± 7.73	.113
Goniometric measurement active ankle dorsiflexion	85.40 ± 13.81	85.53 ± 14.18	.954
Total examination score	85.33 ± 11.46	91.42 ± 8.21	.010*

Abbreviations: F2F, face-to-face; MMT, manual muscle testing; QC, Quick Clips.
* Denotes significance.

Table 4. Inter-Rater Reliability of Postinstruction Skill Examination

	Pearson Correlation
Valgus stress test	.764
Middle trapezius manual muscle test	.689
Goniometric measurement of ankle dorsiflexion	.378
Total examination score	.718

Even though the participants were instructed not to, we do not know for sure whether they practiced or sought additional instruction prior to the skill examination. Participants were assigned a human model, not otherwise involved in the study, to avoid peer-assisted learning; however, instructional sessions took place in groups of 3 to 9, which means participants could have watched each other during the practice portion, not unlike what would happen in a normal classroom setting. In order to control the amount of instruction received and to maintain consistency between groups for comparison purposes, the QC group was not given access to the videos outside of the instructional session. Ubiquitous access to the videos is a major benefit of mobile learning, a component not specifically assessed in the current study. Future research should examine the effectiveness of ubiquitous access to mobile videos in comparison to F2F instruction. Given the positive outcomes that many instructors find with student collaboration, it would be beneficial to investigate small-group utilization of mobile learning to determine if students are more likely to engage in skill practice with classmates while having ubiquitous access to educational content.

Limitations and Future Research

Only 3 skills were included in this study. Further research is needed on additional skills to determine the validity of the results to athletic training skills as a whole. The fact that 1 skill was not acquired as well through QC supports the thought that mobile videos may be more appropriate for teaching some skills than others. Future research examining a combination of traditional and mobile learning is also warranted.

The inter-rater reliabilities, particularly for the goniometric measurement portion of the skill exam, were lower than desired, introducing a source of error. However, examiners within each data-collection site were consistent for each participant regardless of instructional group, lending to the viability of the research results. Skills with higher inter-rater reliabilities should be used in future research on the effectiveness of m-learning.

English language learning, one of the first fields to utilize m-learning, was highly effective when ubiquitous opportunities were provided for vocabulary acquisition. Similar athletic training cognitive knowledge, such as medical terminology, may be effectively disseminated and learned using mobile technology and warrants further research.

Another aspect of m-learning warranting future research is the perception held by athletic training students as well as instructors of the instructional method over traditional strategies. Students of other health care professions have rated m-learning positively for providing a self-paced learning environment and ubiquitous access to videos and other content for review.[21,30] Qualitative studies utilizing surveys and interviews would be beneficial for understanding athletic training educators' perceptions of m-learning. Athletic training program faculty may be successfully incorporating m-learning into their courses, or they may have little to no knowledge of m-learning and how to include the method in their teaching. Currently, there are no studies that have investigated athletic training educators' knowledge of m-learning or their ability and willingness to incorporate m-learning into their courses. Gromely et al[43] investigated dental students' perceptions of and attitudes toward various components of electronic learning presented as part of a blended instruction approach to a clinical skills course. Overall, students felt positively toward the e-learning content. A number of significant associations were observed including those students who reported to have spent more time online studying rather than for leisure purposes performed better in a clinical skills exam. Similar studies should be conducted to investigate student familiarity with m-learning applications and attitudes toward their in use in athletic training courses.

CONCLUSION

While further research is required to investigate the application of mobile learning to a wider variety of clinical skills, the results of this study provide impetus to look beyond conventional teaching practices to more innovative, flexible methods. Students consistently rate mobile learning highly for providing increased autonomy, a sense of responsibility for learning, and a self-paced learning environment.[30] The use of alternative psychomotor skill teaching methods may allow for greater flexibility for both staff and infrastructure resource allocation.[35]

The results of this study and those from other health care fields demonstrate that m-learning, specifically video instruction, is a viable educational tool that produces similar outcomes to traditional teaching methods. The convenience of mobile technologies for both skill acquisition and revision is unmatched by traditional strategies particularly in the sometimes remote athletic training clinical environments.

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