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Using Training Videos for Learning Clinical Skills Can Influence Perceptions on Expertise: Observations Through a Metacognitive Lens

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Cover Page Footnote

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Introduction

With the termination of the United States Medical Licensing Examination Step 2 Clinical Skills (CS) the responsibility of assessing clinical skills is solely placed on educators, where medical schools assume the role of ensuring their medical students have adequate clinical skill performance prior to graduation.[1] This change requires medical schools to reconsider how to assess medical student clinical competency where an increased emphasis may be placed on Objective Structured Clinical Examination (OSCE) assessments. The OSCE is a validated method for assessing clinical examination skills of medical students. Medical schools must ensure that they are providing valuable and accessible resources for students to learn and maintain these skills over the course of their medical education.

As technology continues to reshape learning approaches and teaching methods at all levels of education, there is a growing need for multimedia-based auxiliary tools in medical education. The use of training videos to teach clinical skills may provide the supplemental instruction necessary to ensure that medical students are graduating with the required knowledge and skillset to successfully perform physical examinations in the clinical setting. Specifically, the authors considered the use of musculoskeletal physical exam training videos created by third-year medical students at the University of South Dakota Sanford School of Medicine (USD SSOM) to help prepare first-year-medical students for their Clinical Foundations OSCE III, which includes musculoskeletal evaluation.

The primary aim of this study was to evaluate whether training videos are effective in aiding student learning in respect to musculoskeletal clinical exam skills. A secondary aim is to evaluate student's perceptions on their level of *anxiety*, *confidence*, and *understanding of expectations* for each clinical skill and whether these were improved with the use of video-based instruction. A third aim was to examine whether perceptions on level of *anxiety* (termed *feeling of anxiety)*, confidence (termed *feeling of confidence*), and *understanding of expectations* for each clinical skill, are correlated with improved knowledge using a series of questions based on procedural knowledge for each clinical skill.

Musculoskeletal disorders are a primary reason patients seek medical care, accounting for nearly 20% of all primary care clinic visits and emergency department complaints.[2] Due to the commonality of musculoskeletal disorders, medical students must be prepared to confidently evaluate and treat pathology of musculoskeletal origin.[2] Current literature demonstrates a deficiency in education within musculoskeletal evaluation in medical schools.[3]

The use of video-based instruction in medical education has risen substantially in recent years and can effectively meet the needs of today's learners in teaching clinical skills. Previous studies investigating the usefulness of accessible training videos for medical learners suggest their effectiveness in developing students' perceived preparedness.[4,5] Instructional videos have been recognized as an effective tool for demonstrating complex procedures, offering step-by-step guidance, and providing opportunities for self-paced learning.[6] There is a lack of current literature specifically investigating the use of instructional videos in OSCE preparation.

It is important to consider the format in which these videos are developed to optimize their teaching potential, and this concept was addressed by Richard Mayer in his Multimedia Learning Theory. He proposed twelve principles to serve as a checklist for multimedia developers to optimize learning potential. Specifically, he emphasizes the importance of aligning visual and auditory instruction in an organized, slow-paced manner to allow the learner the best possible opportunity to engage with the new information.[7] By utilizing this framework, supplemental videos have the potential to be a useful tool in augmenting the physical examination curriculum.

Following video exposure, assessing student knowledge and feelings, such as confidence and anxiety, also poses a challenge. Current literature encourages the use of evaluating confidence in the context of competence to more accurately evaluate students and create an opportunity for more specific feedback.[8,9] Confidence is a multidimensional construct in how it relates to performance and literature highlights that safe clinical practice requires an appropriate level of confidence based on training and experiences. It has been observed that self-assessment of clinical skills is relatively inaccurate, which reflects a mismatch between confidence and competence.[8] Educators must be aware that competence and confidence may not develop at the same rate, and educators should regularly assess learner confidence alongside their competence.[9]

Anxiety has been widely studied for its influence on academic performance. High levels of anxiety can impair cognitive processing, leading to poorer performance on tasks requiring complex cognitive skills.[10] Several studies show improvement in student anxiety and confidence before and after usage of different supplemental learning tools such as simulations or elective supplemental courses to practice clinical skills.[11,12,13]

Methods

The Clinical Foundations OSCE III in the first-year medical curriculum at USD SSOM assesses student knowledge on physical exam skills including musculoskeletal evaluation. Third-year medical students on their own initiative, designed and created teaching videos for first-year medical students regarding the musculoskeletal physical exams for this assessment. Students were given a pre and post video survey and quiz, with the post-survey including additional questions regarding the accessibility, quality, and perceived benefits of the video.

Six videos were created including examinations of the 1) elbow, 2) wrist and hand, 3) hip, 4) foot and ankle, 5) upper spine and neck, and 6) lower spine. Each video demonstrated components of the exam including inspection, range of motion, strength, and any associated specialized testing. A still image from one of the videos can be seen in Figure 1.

Figure 1: Elbow exam teaching video provided to students.

Principles from Mayer's Multimedia Learning Theory were utilized by the video creators in the development of these videos.[7] In the training videos, the students acted out a patient-physician encounter with a narrator simultaneously explaining the actions in a stepwise manner.

Perceived utility of training videos

A survey was developed to determine student utilization and perception of the videos. The survey asked about student satisfaction with accessibility, ability of the videos to provide clarification of exam skill procedures, and whether the videos aided in efficiency of study.

Perceived preparedness survey

The surveys also assessed feeling of anxiety (FOA), feeling of confidence (FOC), and understanding of expectations (UOE) in performing the examinations, using a five-point Likert scale ranging from 1, "strongly disagree" to 5, "strongly agree." A combined form of these areas of exploration (anxiety, confidence, and understanding expectations) are termed perceived preparedness.

Procedural knowledge

A quiz was included with the survey that consisted of procedural knowledge questions in Multiple Choice Questions (MCQ) Single Best Answer (SBA) format, that tested student recall of specific information related to each musculoskeletal physical examination. Students reported their confidence in responses (item-specific confidence judgments) for each question in the quiz. Specifically, following each procedural knowledge question, students were asked "What is your level of certainty in your response to the above question" and student responses were ranked using a four-point ranking scale ranging from "none" (1), "low" (2), "moderate" (3) and "high" (4). A calibration score was calculated. Calibration, or metacognitive accuracy, refers to the relationship between an individual's actual performance and their judgment of their performance. If students responded to the question correctly, a +1 score was provided, which was multiplied by their certainty rating, to produce a positive integer. If they responded incorrectly, the question score was allocated -1, and the calibration score was a negative integer. This method was developed by Greengrass (2024).[14]

Video exposure

First-year medical students completed the standard curriculum for the musculoskeletal system provided by USD SSOM, which included an in-person hands-on training session, where students learned musculoskeletal examination skills in the classroom. This curriculum involved students watching a demonstration video in a small group. Students were then given 30-minutes to practice each musculoskeletal exam with a partner. On the same day, following this practice session, students were provided with the initial survey and quiz. The supplemental student-created videos were subsequently released to the students. These were made accessible to the entire class and all survey respondents reported utilizing the supplemental videos. Students repeated the survey and quiz after being provided access to the videos for three months which was one-week prior to completing their graded OSCE examination. No formal opportunity to practice the set of clinical skills was provided to students during this intervening period.

Data were analysed using SPSS Statistics v29 (IBM 2022). A paired t-test was performed to compare survey results in pre-video and post-video phases. Correlations were analysed using Spearman's rank correlation test to determine any formal relationship between components of perceived performance, referring to their ability to perform each clinical skill (students' feeling of anxiety, feeling of confidence, and understanding of expectations), question performance, item-specific confidence judgements, and calibration scores. The authors were unable to obtain OSCE performance data in respect to graded OSCE III sessions due to regulations surrounding privacy.

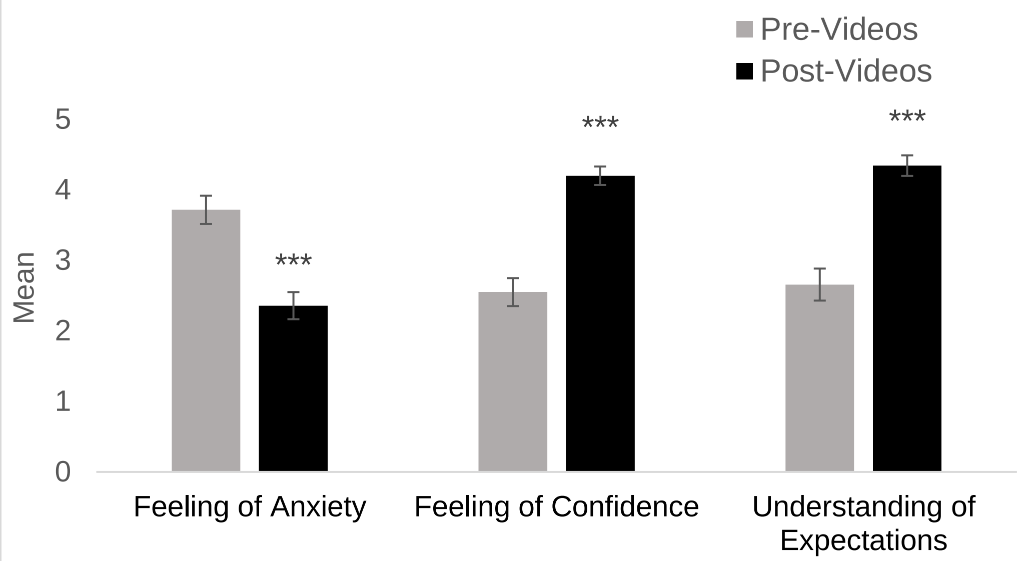
Results

Perceived utility of training videos

A total of 37 students completed the survey related to satisfaction and accessibility of the videos. The majority of students expressed satisfaction. All students reported feeling that the videos had provided adequate clarification on how to perform the musculoskeletal physical exams and improved efficiency of their OSCE preparations. Students agreed or strongly agreed with the statement, "I am satisfied with the accessibility of the videos" (97%); All students (100%) also agreed with the statements, "The videos provide adequate clarification of how to perform the physical exams", "The video demonstrations improved the efficiency of preparation for the musculoskeletal portion of the Clinical Foundations OSCE III", "The supplemental student-created videos decreased my anxiety about the OSCE III," and "I would recommend these videos to future students."

Perceived preparedness survey

Twenty students completed the perceived preparedness survey in respect to *feeling of anxiety*, *feeling of confidence*, and their *understanding of expectations* for each skill. Looking at the mean for each skill, survey results showed that students had greater perceived preparedness with less anxiety, more confidence, and a greater understanding of expectations after watching the videos, as shown in Figure 2. After accessing the videos, students expressed significantly less anxiety (M=2.36, SD=0.86) compared to before (M=3.72, SD=0.90), $t(19)=5.18$, $p<.001$. Students expressed significantly more confidence (M=4.34, SD=0.59) after accessing the videos compared to before (M=2.66, SD=0.89), $t(19)=9.33$, $p<.001$. Students also reported a significantly greater understanding of expectations after accessing the videos (M=4.20, SD=0.60) compared to before (M=2.55, SD=0.94) $t(19)=7.22$, $p<.001$.



Statistical significance representing t-test differences pre and post within each category.
*** P<0.001

Figure 2: Measures of perceived preparedness using Likert scale pre-video and post-video exposure showing mean values across the clinical skill set for each participant.

Procedural knowledge

At the end of the survey, a six-question quiz assessed procedural knowledge of various components of the physical exams. 20 students completed both the pre- and post-video quizzes. A paired samples t-test was performed to compare procedural knowledge quiz scores before and after accessing the videos. There was a statistically significant improvement in scores when comparing the pre-video (M=3.15, SD=1.27) and post-video (M=5.25, SD=0.85) $t(19) = 8.77$, $p<.001$ quizzes, as shown in Figure 3.

Procedural knowledge and calibration

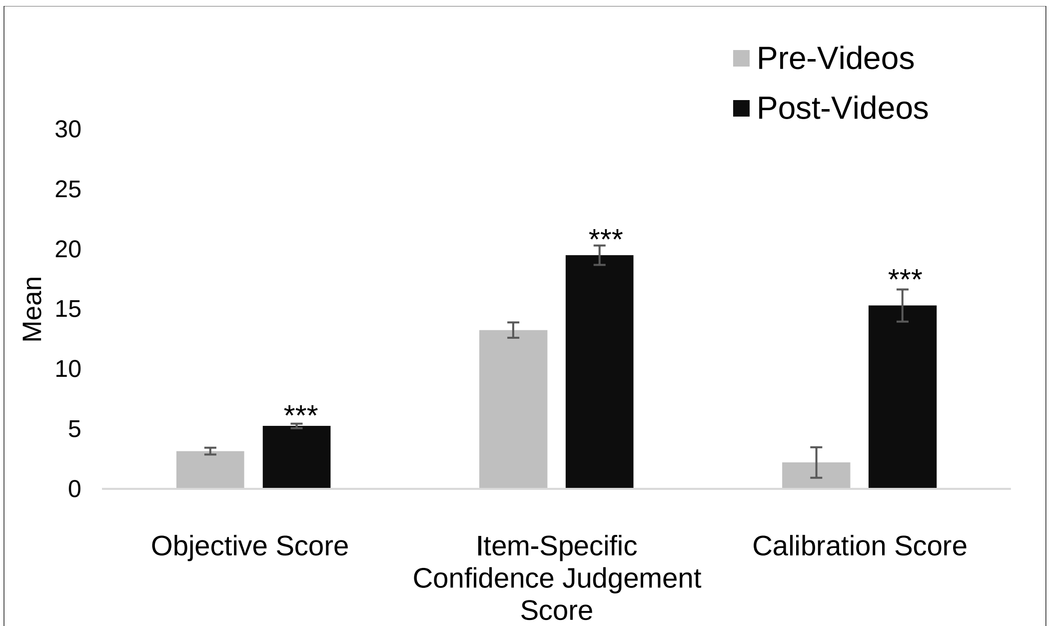
Paired samples t-tests were performed to compare item-specific confidence judgement scores and calibration scores before and after accessing the videos. Total item-specific confidence judgement scores were increased from before video release (M=13.3, SD=2.86) to after video set exposure (M=19.5, SD=3.6). This finding was statistically significant, $t(19) = 6.00$, $p<.001$ (Figure 3). Calibration scores were increased from prior to video release (M=2.2, SD=5.69) to after exposure (M=15.3, SD=6.0) which was also statistically significant, $t(19) = 8.75$, $p<.001$ (Figure 3).

Correlation between perceived preparedness and procedural knowledge scores

Spearman's rank correlation was computed to assess the relationship between perceived preparedness components: feeling of confidence (FOC), feeling of anxiety (FOA), and understanding of expectations (UOE), and item-specific confidence judgements before and after accessing the training videos. A positive correlation $r(18)=0.61$ ($p<.011$) was found pre-video exposure between FOC and item-specific confidence judgements. No correlations between pre-video item-specific confidence judgement scores and FOA nor UOE values were detected. Post-video exposure, no correlations between item-specific confidence judgement scores and any of the variables were found.

Correlation with calibration values

Spearman's rank correlation was computed to assess the relationship between calibration scores and FOA, FOC, and UOE values before and after accessing the training videos. Data analysis demonstrated that prior to video exposure, there were no correlations between any of these measures. Post-video exposure, FOA and FOC values were not correlated with calibration score; however, UOE was now positively correlated with calibration scores $r(18)=5.23$ ($p<.050$).



Statistical significance representing t-test differences pre and post within each category. ***

Figure 3: Means of total quiz scores pre- and post-videos using ranking scale.

Discussion

Several studies have highlighted that video content allows students to learn at their own pace and review information outside of the classroom.[15,16] This study confirms these observations with students reporting that the online videos were a helpful and effective tool in supplementing the standard curriculum while stating that they would recommend these videos to future students. The current findings align with existing medical education literature regarding student-created videos for teaching clinical skills.[4]

Perceived preparedness

This study investigated how *perceived preparedness* changed before and after exposure to the instructional videos. *Perceived preparedness* represents a multifaceted array of components which all impact preparedness to perform a task.[17] Video exposure significantly decreased the *feeling of anxiety* and increased the *feeling of confidence* and the perceived *understanding of expectations* in respect to performance of clinical skills covered within the videos. This indicates that video exposure exerted a positive effect on affective measures relating to preparedness.

Performance outcomes

Even as learners have mastered a particular skill or topic, their performance may still be inadequate if they lack situational confidence in their abilities.[8] Therefore, it is crucial for medical professionals to not only possess professional competence but also have appropriately calibrated situational confidence to practice medicine safely.

In this respect, exposure to the video set significantly improved procedural question scores, confidence, and calibration or metacognitive accuracy. A significant result in this study was that video exposure improved calibration, which demonstrates the advantage of this educational approach within both cognitive and metacognitive domains and appears to offer a solution to issues reflecting the mismatch between confidence and competence.[8,9]

Reliability of self-reported preparedness

Measures of perceived preparedness are frequently used in medical education literature.[17] The present study attempted to determine whether perceived preparedness components were correlated with item-specific confidence judgments and calibration values in a quiz designed to test student knowledge of procedural steps for each of the clinical skills that were demonstrated in the training videos. Results suggest that for measures of perceived preparedness, some factors may have a subjective rather than functional basis.

Feelings of anxiety and confidence

It is noteworthy that the components of *feeling of anxiety* and *feeling of confidence* were not correlated at any time with quiz scores and resulting calibration values. The authors' findings imply that measures of *feeling of anxiety* (FOA) and *feeling of confidence* (FOC) are unrelated to actual preparedness which was evaluated by the presence of procedural knowledge. Therefore, it can be assumed that FOA and FOC although improved by video exposure, are marked by their subjectivity, being a consequence of video exposure, not linked to improved knowledge attained from video content and are likely not useful in gauging actual ability to perform clinical skills.

Understanding of expectations

It is of note that post-exposure, but not pre-exposure, the third component of the perceived preparedness triad, *understanding of expectations,* was significantly correlated with calibration scores. This implies that the training videos aligned perception in respect to *understanding of expectations* (related to performance of tasks) with metacognitive accuracy in respect to actual procedural knowledge. Where prior to training video exposure, this perception was misplaced, yet is correlated after exposure to training videos, supports the idea that UOE can serve as an accurate self-evaluation measure only once a certain threshold of knowledge has been achieved. However, determining this threshold is likely impossible without objective measures of performance. Therefore, UOE alone cannot be utilized as a standalone measure, but may provide valuable insights into metacognitive processes only if combined with objective performance measures.

Limitations to this study include the lack of a control group, relatively low response rates, and inability to compare survey responses and performance to students' actual graded OSCE performance.

This study demonstrates that medical students can play an active role in improving medical education. Students offer a unique perspective to education because they can recognize first-hand where there is room for improvement in curriculum and in educational resources. Furthermore, this study also demonstrates an interesting relationship between student self-perceptions and objective procedural knowledge, which calls into question the use of several commonly utilized domains of assessment.

The results of this study support the conclusion that supplemental multimedia-based resources, when prepared by students according to instructional design principles, can provide useful tools for students to learn and perform musculoskeletal physical exam skills. In addition, video-based instruction improves calibration, which further supports their utility within the metacognitive domain. In this respect, this study validates that student-created instructional videos can be a helpful supplement to the traditional curriculum for medical students learning clinical physical exams.

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