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Factors to Consider When Designing Multimedia CBL Tools in Health Professional Programs

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ABSTRACT

Multimedia case studies are effective constructivist instructional tools that can help to design contextually authentic scenarios while also scaffolding instruction to help students move beyond their current skill and knowledge base. Although there are many advantages of using multimedia case-based learning, there are also many challenges associated with designing technology-enhanced case studies for constructivist learning. The research described herein presents the advantages and challenges that emerged from three unique learning environments in health professional education programs. In each of these environments, a multimedia educational tool (named the multimedia case-based learning sports injury assessment educational tool) was designed to engage students in authentic sport injury case scenarios. Feedback was gathered from multiple stakeholders in each learning context and used to explore the effectiveness of this technology-enhanced pedagogical approach.

KEYWORDS

Case-Based Learning, Constructivist Learning, Constructivist Teaching, Multimedia Case Studies

INTRODUCTION

The purpose of this article is to present the findings that emerged from three research projects, each one exploring the impact that a technology-assisted educational tool had on the nature of teaching and learning within unique health professional learning environments. For each project, a technological intervention (named the Multimedia Case-Based Learning Sports Injury Assessment Educational Tool (M-CBL SIAET)), was employed to engage students in authentic sport injury assessment scenarios. The purpose of this tool was to guide students through a number of theoretical and skill-based competencies required to perform comprehensive orthopedic injury assessments. The primary interest of each project was to explore the factors that influenced the use of technology-assisted teaching tools, rather than attempt to statistically demonstrate that the intervention better promoted specific learning outcomes. For each research project, this article: 1) describes the health professional learning environment; 2) provides an account of how data was collected; and 3) offers a summary of the results, including the advantages and challenges of designing multimedia-enhanced educational tools that emerged from each study.

Identifying the Research Problem

Health professional programs are extremely complex learning environments because of the expectations for students to acquire a mixture of theoretical knowledge and practical skills in classroom settings, while also demonstrating competence in real-life clinical environments (Wald et al., 2015). Further

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adding to the complexities of these learning environments is the emergence of digital technologies and high-fidelity simulation in training health professionals (Doolen et al., 2016). Multimedia technologies are commonly used within health professional programs to simulate various scenarios, injuries, or illnesses. By creating realistic simulations through innovative technologies, students are able to practice their skills in a safe environment at any time, and in any place, eliminating the risks associated with practicing on actual patients (Issa et al., 2013). Within the literature, implementing multimedia case studies have resulted in many positive outcomes in health professional education, including: enhancing the authenticity of the learning environment by telling a narrative from a patient's perspective (Schell & Kaufman, 2015); developing cognitive skills through active learning (Harris & Bacon, 2019); and bridging the gap between theoretical knowledge and clinical practice (Flood & Commendador, 2016).

Effective teaching in the 21st century requires health professional educators to have more than just extensive content knowledge (Savery, 2015). These educators must understand the complex interplay between teaching and learning (pedagogical knowledge), subject matter (content knowledge), and knowledge of instructional technologies (technological knowledge) (Wright & Davis, 2017). More importantly, to leverage the potential of technology effectively, educators need to develop a specialized body of knowledge that uses technologies in pedagogically meaningful ways (Mishra & Koehler, 2006). This type of evolutionary pedagogical knowledge is less common within the health professions, as it is not necessarily part of their academic preparation (Dent, Harden, & Hunt, 2017). Many health professional educators use technologies in superficial ways (e.g. using technology to deliver course content) without considering how the technology can be integrated to enhance learning or empower competence development (Burbules, 2018). Technology should not be implemented to simply educate differently, rather it should enhance the delivery of the content by providing unique possibilities for learning that could not be accomplished without that technology (Barry, Tierney, & O'Keeffe, 2015).

Exploring this problem, the research projects described herein involved a specific multimedia educational tool for use in health professional programs. This tool used technologies in pedagogically meaningful ways to facilitate learning in several theoretical and skill-based competencies required to perform effective orthopedic injury assessments. Each research project explored the impact that the educational tool had on the nature of teaching and learning within unique health professional learning environments.

RESPONDING TO THE PROBLEM

Designing the Technological Intervention: M-CBL SIAET

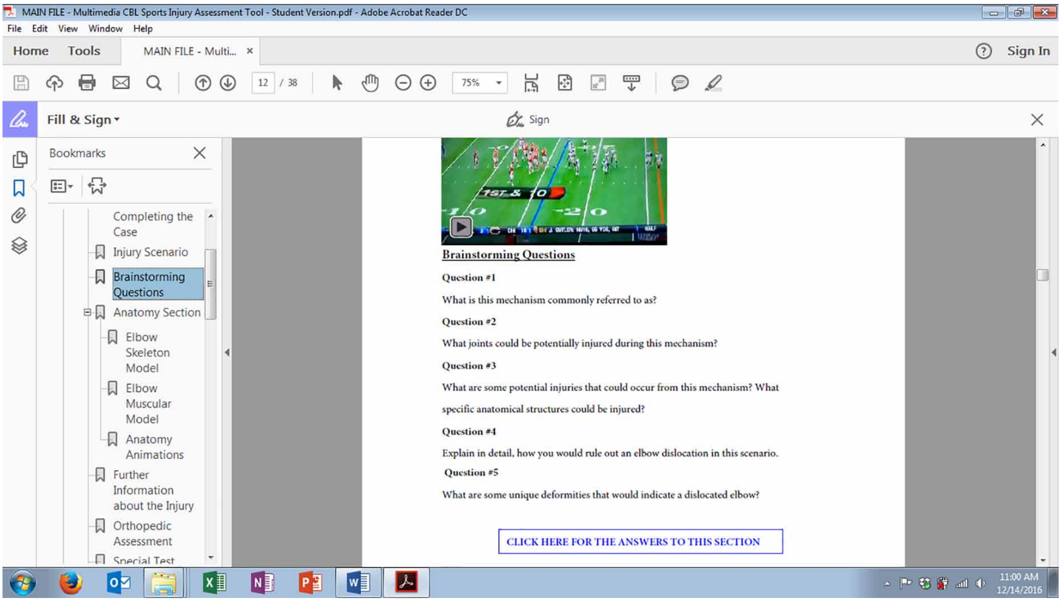
The M-CBL SIAET was designed to include four multimedia enhanced case studies (one shoulder, one elbow, one knee, and one ankle scenario) to engage students in authentic injury scenarios (Figure 1). This tool development followed important tenets of constructivist design (Admiraal et al., 2017), and was rooted in Technological, Pedagogical, Content Knowledge (TPACK) (Mishra & Koehler, 2006) theory to guide the integration of technologies in pedagogically meaningful ways.

Each scenario template was designed with Adobe Acrobat® because of the programs ability to be edited and interact with all types of portable document format (.pdf) content, including various forms of multimedia. Using this interface also made the tool readily accessible for students, as Adobe Acrobat® Reader is a free program that can be downloaded to any computer, tablet, or smartphone that has an internet connection.

Within the M-CBL SIAET, the template for each injury scenario included:

1. An injury scenario with a mechanism of injury video. This section also included initial brainstorming questions and peer activities such as "based on the mechanism of injury demonstrated in the video, what specific anatomical structures could be injured?"

Figure 1. M-CBL SIAET case study template screenshot



2. An anatomy section which included 3-d anatomical models (created using Object2VR®software) (Figure 2), anatomy animations (developed by 3dRx – Kinduct Technologies, used with their permission) (Figure 3), further probing questions and peer activities;
3. Further information about the injury so the student could narrow down their answers to the initial brainstorming questions;
4. An orthopedic assessment section which included various questions and peer activities to guide the student through a comprehensive orthopedic assessment;
5. Special test videos embedded accompanied by a series of questions and peer activities designed to stimulate critical thought about each test (e.g. “describe what is happening in the video, anatomically and biomechanically”);
6. Interpretation of assessment findings which provided results from the assessment and tasked the student with creating indices of suspicion and differential diagnoses based on this information;
7. Choosing an initial rehabilitation plan based on the suspected injury;
8. Further stimulating questions such as “how would you approach this scenario if the injured athlete did not speak English and no one else was around?”
9. Scenario reflection section which guided students through a series of questions to identify perceived strengths and weaknesses of completing a comprehensive assessment.

Project #1 Learning Environment: Undergraduate Kinesiology Program

This pilot study involved 14 third-year students (10 females, 4 males) from a Sports Injury Specialization within a Bachelor of Kinesiology program in a primarily undergraduate Canadian liberal arts university of approximately 3000 students (MacKinnon & King, 2012). This institution extensively promotes the use of various technologies to empower education and all classrooms are fully equipped with multimedia presentation hardware and internet access. Over a four-week period, participants were asked to visit and complete one of the online case studies from the M-CBL SIAET. The students were also asked to submit a hard copy solution to the case study problems presented.

Figure 2. Example of an Object2VR® interactive model for the ankle case scenario

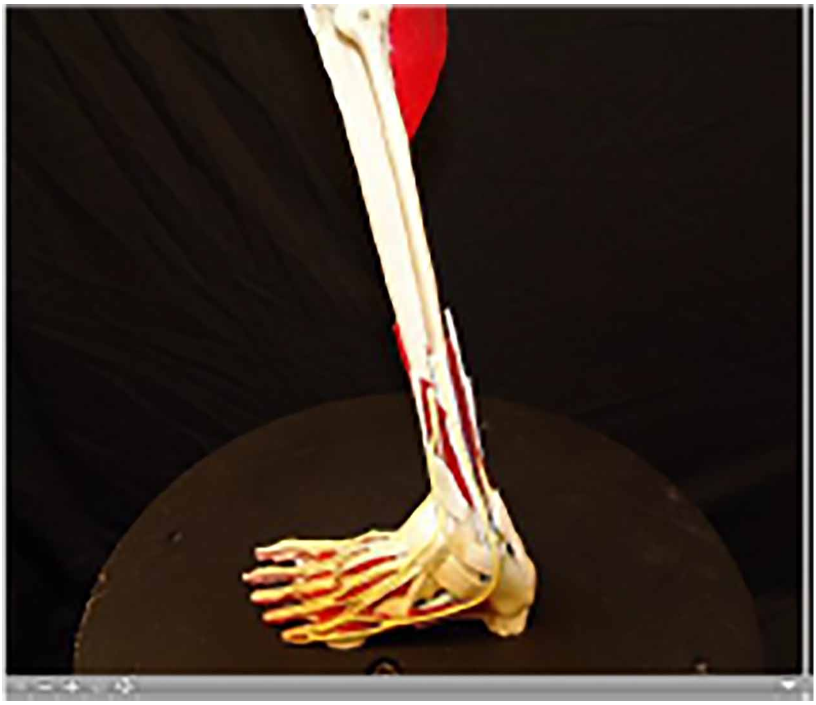
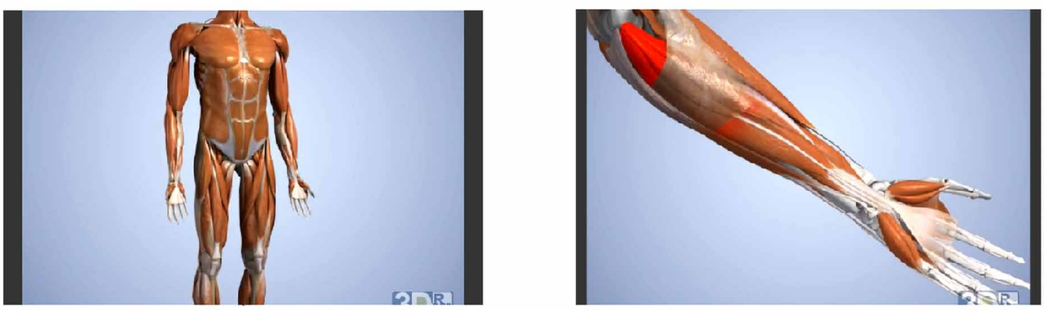


Figure 3. Example of 3dRx® anatomy animations for the elbow case scenario



Project #1 Data Sources

An online questionnaire was designed (Patton, 2015) to obtain quantitative information about students': 1) comfort level with standard computer technology; 2) relative ease of accessing the case studies in the M-CBL SIAET; 3) opinions about the structure and content of the case studies; and 4) reaction to the multimedia technologies embedded in the tool. The questionnaire was 30 questions in length and asked students to respond on a Likert scale that ranged from strongly agree to strongly disagree. All 14 students participated in the questionnaire. These results were analyzed for emergent trends and used to develop a standardized open-ended interview schedule. This schedule was field-tested with three randomly-invited students from the sample to test for question clarity and ambiguity. From the sample, six students (4 females, 2 males) participated in 30-minute audio-recorded individual interviews. These interviews were manually transcribed and coded in an iterative process, incorporating the results from the earlier questionnaire. A preliminary thematic analysis was completed, and peer debriefing was employed to triangulate the interpretation of results. Finally, a single focus group (consisting of three students: 2 female, 1 male) was organized in an effort to corroborate the results (Hesse-Biber, 2017).

Project #1 Results

Overall, the students from this sample preferred these multimedia scenarios compared to traditional textbook case studies. More specifically, the students identified the following advantages of the M-CBL SIAET:

- It provided a clear depiction of how each injury actually transpired;
- The scenarios decreased the need to make assumptions of what happened or how an injury appeared, like in text-based scenarios;
- The tool created consistent contextually authentic cases, so all students were visualizing the same problem when working through it;
- It provided a more enjoyable and engaging activity compared to text-based cases.

The sample of students saw the potential for such a tool, especially when learning about more serious critical injuries. According to one student:

In some injuries, with the neck of spine for instance, it is quite critical that we take the correct step-by-step approach. If we forget to test something than that could harm the individual. As a student, it is important that we see and practice those case; we can do the most damage making mistakes with those types of injuries.

Another student added:

When we are learning about this stuff, every experience will be a new one for us. There will always be a first time for experiencing/seeing an injury. So this tool helps us to think about what we would do. Hopefully when we see that situation, we will be able to respond in the correct way.

Although most of the feedback was positive, several challenges also emerged from this study. Students also provided suggestions about how to better streamline the technology-enhanced case studies, including:

- The need for more interaction and skill development opportunities;
- Difficulties accessing media due to inadequate internet connection;
- A lack of instructor involvement.

As one student indicated:

We need to see our prof work through the problem. See how he thinks out loud; how he follows a systematic approach to diagnosing an injury. How to properly establish a rehabilitation protocol. So we need interaction with other more qualified individuals so we know what we are supposed to do and if we are doing something wrong.

Responding to this feedback, the original design of the M-CBL SIAET was modified. It was converted to a DVD format so that all multimedia technologies could be embedded within a single disc. This decreased the dependence on having access to high quality internet connection in order to access the tool. Another significant change that was made to the educational tool was increasing the amount of instructor involvement. The students from this sample were adamant that interactions with the instructor were an essential component of their learning. As one student indicated, "I know that I was wrong but why was I wrong, what did I miss in my diagnosis; I need to know that information otherwise I will keep making the same process mistakes." These students found the technology-enhanced case studies to be useful for its anywhere-anytime access, but by itself the tool was only a supplemental and complimentary way to learn. Responding to this feedback, a pedagogical approach was designed for future applications of the M-CBL SIAET (Figure 4).

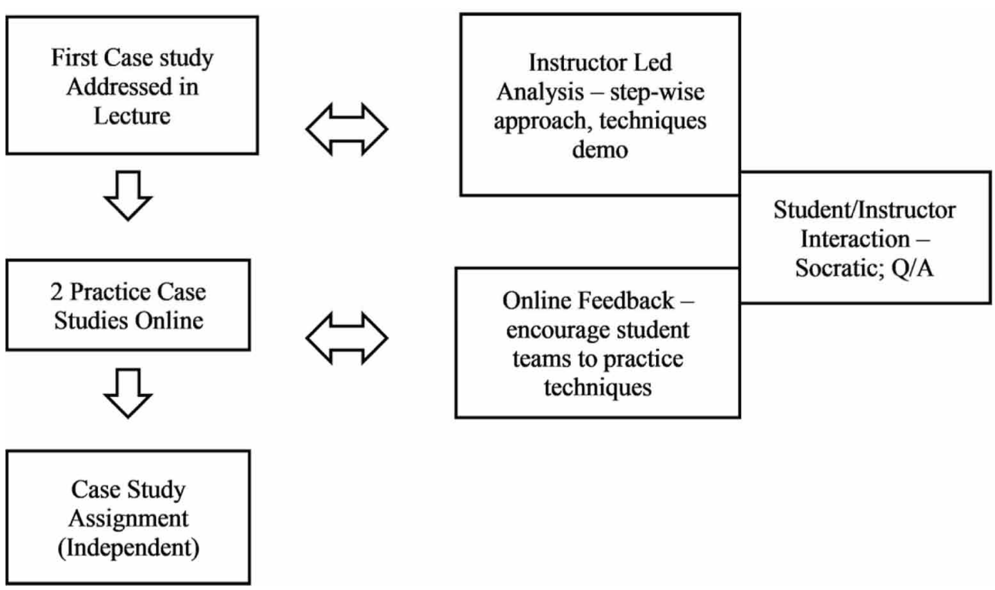
These challenges highlighted the importance of beginning with foundational instructional strategies to enhance learning before simply implementing using educational technologies.

In fact, according to Koehler & Mishra (2015), when designing multimedia case studies, an educator should use effective and established pedagogies to rationalize the use of technology and not vice, versa.

Project #2 Learning Environment: Undergraduate Athletic Training Program

Responding to the feedback from the first study, the M-CBL SIAET was modified to increase accessibility to the various forms of multimedia (by converting to DVD format) and to invoke more student and instructor interactions. A second study was carried out with 15 students (7 females; 8 males) from a Bachelor of Science in Sports Sciences (Athletic Training) program in a primarily undergraduate university in Jamaica (King, MacKinnon, & Lawrence, 2014). The purpose of this study was to: 1) elicit feedback on the effectiveness of the new proposed teaching model; 2) explore the best way to integrate technologies into the specific case studies; and 3) explore potential cultural differences in learning with technology. The students from this sample were each supplied with a copy of the M-CBL SIAET. The course instructor used the tool in the classroom following the recommended pedagogical approach as aforementioned in Figure 4.

Figure 4. The instructional model that was designed for use with M-CBL SIAET



Project #2 Data Sources

The original online questionnaire from Project #1 was modified to include more questions about student comfort level with using the M-CBL SIAET and the effectiveness of the proposed teaching model. The questionnaire was again field-tested for question ambiguity with an instructor from the Jamaican university as well as one of the students from the target cohort. A total of 15 students completed the questionnaire. The questionnaire results were analyzed for emergent trends and the findings informed a standardized open-ended interview schedule (Patton, 2015). This schedule was also field-tested with the same instructor and a different randomly-selected study to ensure that questions were clear and easily understood. From the sample, all 15 students (7 females; 8 males) were invited and concomitantly participated in 30-minute audio-recorded individual interviews. These interviews were manually transcribed and coded in an iterative process, and the findings were combined with the questionnaire results to establish emergent themes. A preliminary thematic analysis was completed, and peer debriefing (Hesse-Biber, 2017) was employed to triangulate the interpretation of results. Finally, two small focus groups (consisting of two students in each group) was invited to respond to the intermediate results in an effort to corroborate the results (Hesse-Biber, 2017).

Project #2 Results

During interviews and focus groups, the sample of students frequently commented how the M-CBL SIAET was an effective tool that helped facilitate critical thinking about assessing and reacting to realistic injury situations. As one student described, “the cases on the DVD ‘peacocked’ your brain and made you open up your mind, think about the possibilities, think critically about the best way to approach the situation.” Students also felt the M-CBL SIAET:

- Increased student interactions compared to traditional text-based cases;
- Provided more accurate simulations of injury scenarios;
- Provided step-wise approach of how to approach solving an assessment problem;
- Helped to integrate different forms of knowledge and psychomotor skills;
- Provided direction by seeing how a professional thought about assessment and interpreted different types of information.

One student summarized these benefits by saying:

We do not get a lot of chance to interact with certified professionals in our program. We focus a lot of the theoretical components and not so much the practical. So this tool helped to outline systematic ways of how to perform a comprehensive assessment and how to approach piecing together the puzzle. I can use this as a part of my studying to really start putting things together and think about how I would do these tests with a real individual.

The sample from this study also identified several challenges to using the M-CBL SIAET, including:

- Trouble accessing the videos on their computers;
- Lack of technological support for the user;
- Lack of structured peer activities to guide psychomotor activities.

Although the tool was moved to a DVD format for this study to increase accessibility, many students still had trouble accessing the videos on their computers. It was found that the students were trying to open the file link in a media program other than the required QuickTime. By doing this, the anatomical models lost many features and the student would not be able to manipulate the image, rotate it in different directions, or zoom in/out on different structures. Responding to this feedback, several improvements were made to the M-CBL SIAET, including: 1) the creation of an instructional guide providing background information about the development and design of the tool itself, and how to access the different media embedded in the tool; 2) tutorial videos were filmed using Screencast-o-matic® software to demonstrate how to navigate through each scenario and how to access the various digital technologies. These tutorial videos were embedded at the beginning of the disc, where a student could select the specific case scenario; and 3) the creation of student and teacher versions of the M-CBL SIAET. The key differences between the two versions were that the teacher's version also included more detailed instructions about how to lead the first case scenario and specific teaching recommendations of how to facilitate learning during each section of the scenario template.

Another concern that emerged from this student sample was the lack of structured peer interactions within the educational tool. During interviews, most students discussed the potential benefits of structured peer interactions including: 1) seeing how someone else approaches or interprets the same injury analysis; 2) sharing differing sport experiences; and 3) sharing differing experiences with the proposed injuries. These students felt that more structured peer interaction sections would help to make the cases more interactive while also benefiting by learning from one another. Responding to this feedback, each section of the M-CBL SIAET was modified to include peer activities. For example, in the special orthopedic test section, the following peer activities were added to each scenario: 1) share your answers to the questions above with a partner. Make sure to share additional experiences that you may have had with that particular test (e.g., I used this test on one of my soccer athletes and really felt excessive movement of the tibia on the femur. It felt like…); 2) practice each special test with a partner. Critique each other's hand positioning, direction of force, etc.; and 3) Videotape or record yourselves doing each orthopedic test. Analyze/critique your own performance in the video. Make comments on hand positioning, description to partner, direction of force, etc.

Project #3 Learning Environment: Undergraduate Athletic Therapy Program

After updating the M-CBL SIAET with feedback from the second project, a third study was carried out with 15 athletic therapy students (11 females; 4 males) and four educators (3 females; 1 male) from a Canadian undergraduate institution. The purpose of this study was to further explore the effectiveness of the M-CBL SIAET, while investigating its impact on the nature of teaching and learning in a specific health professional program.

Project #3 Data Sources

The same online questionnaire that was used in Project #2 was employed to gather students' experiences with the updated M-CBL SIAET and accompanying pedagogical model. To ensure its applicability for the current sample, the questionnaire was first screened by two athletic therapy students to field test for question ambiguity. The questionnaire results were analyzed for emergent trends and further informed the standardized open-ended interview schedule. This schedule was also field-tested with two randomly-selected participants to ensure that questions were clear and appropriate for exploring the research question. From the sample, ten students (8 females; 2 males) participated in 30-minute audio-recorded individual interviews. These interviews were manually transcribed and coded in an iterative process, and the findings were combined with the questionnaire results to establish emergent themes. A preliminary thematic analysis was completed, and peer debriefing was employed to triangulate the interpretation of results (Hesse-Biber, 2017). Two small focus groups (consisting of three students in each group) were invited to respond to the intermediate results in an effort to corroborate the results (Hesse-Biber, 2017). Finally, full-time athletic therapy educators (3 females; 1 male) were also recruited to help triangulate the findings. The purpose of these additional interviews was to investigate the impact of using technology-assisted pedagogies within an athletic therapy curriculum.

Project #3 Results

This sample of athletic therapy students viewed scenario practice as being an essential component of developing orthopedic injury assessment competence. However, the student sample described traditional practice sessions as being very generalized and non-specific. For example, the most commonly used traditional scenario practice, as described by the sample of athletic therapy students, involved one person making up an injury and acting out that injury as a standardized patient. The other individual, playing the role of the therapist, then performed an orthopedic assessment and made an index of suspicion based on what they found. The majority of students found this approach to be unconducive to their learning. As one student indicated,

When we are given written cases in class, it is tough to picture what the teacher is describing. They try to explain it but you have to assume so many things; did the athlete land this way? How did they fall afterwards? What was the amount of force? Where was the forced applied?

Responding to this problem, the students felt that the M-CBL SIAET provided supplementary structured learning activities to these injury scenarios that would ultimately enhance critical thinking skills, clinical reasoning, and overall competence as an athletic therapist. More specifically, several themes merged from this study, describing the positive impact that the M-CBL SIAET had on student learning. Participants believed the tool:

- Created realistic, visual, and consistent contexts that defined each injury situation;
- Stimulated higher levels of thought and clinical decision-making required of competent athletic therapists;
- Encouraged students to actually think about what they need to do instead of simply being told what to do;
- Helped develop clinical reasoning skills;
- Helped to extend learning opportunities outside of the classroom.

The sample of students felt that this approach was more effective than using traditional written scenarios. According to one student:

When you actually have a video of the mechanism, you are able to watch it over and over again and look at something different each time. This is really important when we are learning about these types of injuries because we do not have the experience to make a lot of assumptions. Therefore, we can watch the video of the injury, slow it down, look at different areas each time, to think about what could potentially be injured.

Another student appreciated the format of the M-CBL SIAET and though it was a useful tool to prepare them for their practical placements. This student said:

During our practicum placements we are almost thrown into these situations anyways (although there is some form of supervision) but we are expected to work with real people and assess and treat their injuries. And oftentimes, we are trying to assess an area or injury that we have not covered in class yet so it can be difficult to be confident in your skillset. This tool helped because it gave us the flow of what should be included in a comprehensive orthopedic assessment and a framework to help guide our thought processes and decision making.

The participants from this study also identified several challenges to using the M-CBL SIAET, including:

- Accessibility issues due to not having access to a DVD drive;
- Differences in preferred learning styles;
- Level of comfort with using innovative pedagogical approaches.

When discussing the potential for integrating technology-enhanced case studies into the curriculum, the athletic therapy educators talked about their level of comfort with using innovative pedagogical approaches. These participants suggested that most athletic therapy educators taught the same way and did not consider how technology could benefit student learning. These educators were more likely to simply use technology to convey information to the student. This sample felt that most athletic therapy educators relied on these traditional teaching methods because it was within their pedagogical comfort zone. According to one of the athletic therapy educators:

We [AT educators] start by being discipline experts first, so we have the content knowledge. Not a lot of us learned specific pedagogical techniques, unless we have taken some additional pedagogy courses. Teaching in how you were taught is usually your fall back plan [referring to resorting back to using a teaching approach that you experienced as a student]. Then you have this other new piece, technology, and you know that you should be using technology in the classroom because the students are expecting it but that is the challenge. Thinking about how can technology can help me do something differently than what has been done. To see where technology fits in to helping students with deeper learning.

Therefore, athletic therapy educators may need to be educated themselves on the benefits of technology integration and how technology-enhanced case studies can enhance student learning when done properly.

Discussion: Integrating the Findings From Three Projects

The findings from these three studies demonstrated that when designed and implemented carefully, technology-enhanced case studies have the potential to empower learning in health professional education programs. The M-CBL SIAET was thought to stimulate higher levels of clinical decision-making while engaging students in realistic and authentic injury scenarios.

Similar findings can be found throughout the medical education literature (Bullock & Webb, 2015; Fung, 2015). These three projects also showed that student-centred, scaffolded, constructivist teaching and learning environments can offer great promise for emerging technologies to assist educators in reaching their instructional goals. Likewise, similar pedagogical approaches were previously found to benefit educators in medical education (Schell & Kaufman, 2015), physiotherapy (Coulson & Frawley, 2017), and nursing (Shellenbarger & Robb, 2015).

Although these findings offer great promise, it is important to note that there is no universal step-by-step design process to systematically design effective technology-enhanced educational tools for any academic program (including information technology). However, established educational theory, such as the TPACK theoretical framework, can be implemented to design effective technological tools that are used in pedagogically meaningful ways. The TPACK framework provides researchers and educators alike with the theoretical means to recognize the types of knowledges that should be considered to effectively implement various technologies in the classroom (Mishra & Koehler, 2006).

Responding to the challenges that emerged from the three research projects, the TPACK framework can be applied to identify several important factors for educators to consider when designing pedagogically sound technological educational tools. These factors are outlined in Figure 5 and further discussed in the ensuing sections.

TPACK Principle #1: Identifying a Pedagogical Problem

When designing educational technologies, educators should begin by thinking about a pedagogical problem. Why are students struggling with a particular topic or skill? How do I normally teach this particular topic or skill? What can be done to enhance student learning in the current context? Once a problem has been identified, it can then be used to define specific learning goals and objectives and provide a starting point for the design of an educational tool. This is an example of backward design, which is a method of designing curriculum by setting educational goals and objectives before choosing specific forms of assessment and the supporting pedagogical strategies (Joyce & Swanberg, 2017).

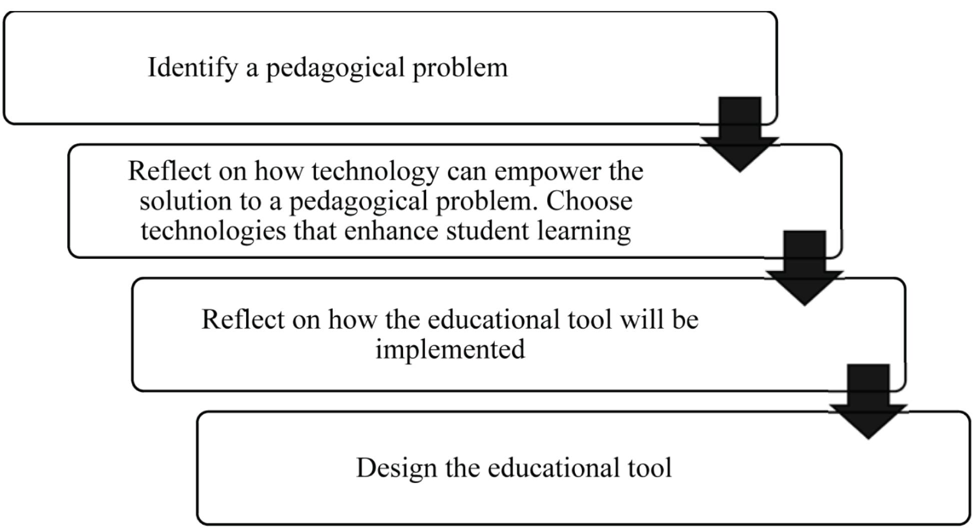
TPACK Principle #2: Reflecting on how Technology Can Empower the Pedagogical Problem

After identifying the pedagogical problem, an educator can then consider how to integrate technology in a pedagogically meaningful way. As an example, in the M-CBL SIAET, digital technologies were implemented to create a more contextually-enriched example for the student. Technologies included: 1) mechanism of injury videos so that students could see exactly how the athlete was injured; 2) anatomy animations to review important anatomical structures; and 3) special test videos to evaluate student knowledge, psychomotor skill, and critical thinking ability. Findings from the three studies showed that when students were given a less authentic scenario (e.g., a brief word description of a particular injury), they were often left to make many assumptions about what happened and how the injury actually presented itself. Oftentimes, students have not reached the level of competence (or accumulated enough experience) to be able to make these comprehensive inferences. Based on these assumptions, technologies were implemented to ensure that all students were provided with the same detailed information and contextually-authentic experience.

TPACK Principle #3: Thinking About how the Tool Will be Implemented in the Classroom

Educators cannot design an educational tool without thinking about its intended use. Educators need to identify the specific learning outcomes of the tool, think about how it will be presented to the students, identify the pedagogical approach to implementation (e.g., using a flipped classroom model),

Figure 5. A graphic outlining how to use TPACK to design pedagogically meaningful technology tools. This graphic is not meant to be a step-by-step design process but rather outlines important factors to consider when designing effective educational tools.



think about how learning will be scaffolded, and think about how student learning will be evaluated or assessed. This approach was not taken in the first project, as the multimedia tool was simply distributed to students for their personal use. The overwhelming response from these participants was that the tool needed more instructor involvement to help facilitate student learning. This first project exposed the importance of considering the pedagogical impact of technology integration, which is essential to using educational technologies effectively (Koehler & Mishra, 2015).

TPACK Principle #4: Designing Tools in a Non-Linear, Recursive, and Reflexive Manner

As demonstrated in the findings from these three studies, there are always challenges that arise when designing educational tools. There are also a number of different instructional design models that can inform the design and development process. A popular model, the recursive and reflective design and development (R2D2) model (Willis, 2009), encourages the design process to follow an iterative process, allowing the designer to make refinements and revisions at any time, using feedback from multiple stakeholders and not just the designer. Educators should not think about the educational tool design process as being a rigid, linear, step-by-step process. Rather, feedback should be elicited from students and other educators at different points in time to help continuously improve the tool. Because there are so many complexities associated with teaching and learning, this recursive and reflexive approach to the design process will assist in developing effective pedagogically sound technology tools that are constantly evolving and improving.

LIMITATIONS AND FUTURE DIRECTIONS

Several potential limitations emerged from the three studies presented in this article that should be considered in future research applications. One such limitation was related to the quality of students who volunteered for each study. Many of the students in these studies possessed excellent grade point averages. Therefore, the constructions of positive feedback could be representative of a strong cohort of students. Top students often like to be challenged and may prefer to use more learner-centered/self-directed learning approaches. Comparatively, academically weaker students may have differing opinions and may not consider multimedia tools to be as conducive to their learning. Future research should take these potential differences into consideration and explore whether multimedia tools are beneficial to all groups of students, or just those who are engaged, motivated, active learning who prefer this type of learning.

Multimedia case studies also have the potential to enhance the authenticity of the learning environment by informing students about the types of complex social issues that may arise in the health professional's workplace (Schell & Kaufman, 2015). In the current studies described in this article, the specific hypothetical scenarios did not encourage discussion about important social factors such as social class, gender identity, ethnicity, material and cultural factors, psychosocial factors, social support, and life events. Careful writing of future case scenarios can help to expose students to some of these social complexities and stimulate thought about important societal factors that are often overlooked when teaching health professional students (MacLeod, 2011). Therefore, future studies could investigate effective ways to stimulate thoughts about these important complex social issues.

Finally, many health professional programs are undergoing (or have already made the transition) major pedagogical/curriculum shifts towards implementing competency-based educational models. For example, all Canadian medical education programs are currently designed to follow the CanMEDS competency framework. This framework has become the most widely accepted and applied physician competency framework in the world (Frank & Danoff, 2007). Competency-based education differs from traditional curriculum delivery models and allows students to advance based on their ability to master a skill or competency at their own pace, regardless of the learning environment. Therefore, future research should explore how compatible technology-enhanced learner-centered pedagogies (such as the one described in this article) are within this competency-based educational model.

CONCLUSION

The findings from these three projects identified important factors that influenced the use of technology-assisted teaching tools in unique health professional learning environments. However, the theoretical findings from these studies are relevant to all forms of education, including the field of information technology. The M-CBL SIAET was designed with a specific purpose by using multimedia technologies in pedagogically meaningful ways to enhance student learning and competence development in health professional students. The three projects found that the M-CBL SIAET enhanced student learning by: 1) increasing student engagement compared to traditional text-based scenarios; 2) creating realistic, visual, and consistent injury scenarios; 3) stimulating higher levels of thought and clinical decision-making; 4) encouraging students to critically think; 5) developing clinical reasoning skills; and 6) extending learning outside of the traditional classroom setting. However, several challenges also emerged from these projects, including: 1) accessibility issues; 2) lack of technological support in-class; 3) lack of instructor involvement; 4) lack of structured peer activities; and 5) level of comfort with using innovative pedagogical approaches. These findings demonstrate the importance of using educational technologies to enhance teaching and learning while also encouraging educators, regardless of the discipline, to critically reflect on how they typically integrate technology in their respective classrooms.

Although these findings are promising, it is important to note that the essence of this work does not advocate for or against implementing a particular technology. Due to technological advancements, an innovative educational technology that was shown to be effective today can quickly be considered outdated. Therefore, this article is not about recommending one technology over another, rather it demonstrates the critical stances for any educator to consider when deciding to use technologies as a part of their teaching. Conceptual frameworks such as the TPACK framework can help to identify the important factors that should be considered to effectively integrate digital technologies into the classroom. Any educator should consider the resulting impact that a technology has on their pedagogical approach and constantly take the role of reflective practitioner. By doing so, will uncover multiple benefits and challenges that will evolve over time but will increase the likelihood of integrating pedagogically meaningful technologies that enhance instruction and improve student learning.

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