Ferris State University
Doctor of Optometry Senior Paper
Library Approval and Release

A New Way to Learn Cover Test

I, Michael Seebruck, hereby release this Paper as described above to Ferris State University with the understanding that it will be accessible to the general public. This release is required under the provisions of the Federal Privacy Act.

[redacted]
Signatures : Doctoral Candidate(s)

5-2-2016
Date

SIMULATION-BASED LEARNING, A LITERATURE REVIEW

by

Michael Marvin Seebruck

This page is submitted in partial fulfillment of the
requirements for the degree of

Doctor of Optometry

Ferris State University
Michigan College of Optometry

May 1, 2017

SIMULATION-BASED LEARNING, A LITERATURE REVIEW

by

Michael Marvin Seebruck

Has been approved

May 1, 2017

APPROVED: [redacted]

Faculty Advisor: Dr. Brian McDowell, OD

ACCEPTED: [redacted]

Faculty Course Supervisor

Ferris State University

Doctor of Optometry Paper

Library Approval and Release

SIMULATION-BASED LEARNING, A LITERATURE REVIEW

"I, Michael Seebruck, hereby release this paper as described above to Ferris State University with the understanding that it will be accessible to the general public. This release is required under the provisions of the Federal Privacy Act."

[redacted]

Doctor of Optometry Candidate

__3/13/2017____________________

Date

ABSTRACT

Simulations are becoming more and more commonplace in education at every level, from elementary to post-secondary studies. This is largely due to their ability to tap into multiple aspects of how we learn, and solidify our skills thorough repetition. This literature review explores the current knowledge and utilization of simulation-based learning, and applies it to a simulation that can potentially be used in training optometry students a routine procedure called the cover test. A study of the literature pertaining to simulation-based learning was conducted. A cover test simulator was also constructed using various hardware components and open-source software manipulated specifically for use in the cover test simulator. The cover test simulator was designed to utilize aspects of deliberate practice. The student can use multiple repetitions to solidify the major concepts of the cover test. While the cover test simulator is useful when learning the procedures, there are many improvements that need to be made. It does not utilize all four areas of deliberate practice. It is not able to show all the possible deviations. Further development and study into the simulators effectiveness is required.

TABLE OF CONTENTS

CHAPTER 1

INTRODUCTION

Simulation-based learning is popular in all levels of education, as well as in the workplace. The idea of learning and instruction utilizing simulations has been around for many years. One of the first major applications began in the 1960s with the use of full body mannequins for training anesthesiologists.[1] Since then, simulations have become integral in the training of various professionals, including pilots and military personnel. Simulations encompass a large array of applications. They have been applied to areas where risk associated with the task is high, but repetitive practice is a must. Again, the obvious examples of this are medical, military, and aviation applications. The cover test simulator was developed in tandem with this literature review, and as such, the review will focus on simulation-based learning as it applies to medical professionals. Before looking at the commonly used simulations in medicine, a discussion of the merits of simulations as a tool for learning is required, which involves deliberate practice.

CHAPTER 2

DISCUSSION

Deliberate practice is described by Ericsson of Florida State University as an expert level of practice that over time allows an expert level of performance in a domain.[2-3] This idea has been discussed by Ericsson as an alternative to innate talent being the cause of an individual achieving an expert level of performance. Applying specific outlines to the way we practice skills over a long period of time allows individuals to elevate themselves above the normal level of performance, and thus achieve an expert level of performance. Ericsson writes, “our empirical investigations and extensive reviews show that the development of expert performance will be primarily constrained by individuals’ engagement in deliberate practice and the quality of the available training resources”.[2] Designed correctly, simulations can provide a high level of effectivity when training professionals. What design characteristics should a simulation have to provide the best training opportunities for medical professionals?

Deliberate practice has four important design characteristics. The design of the task, or simulation in this context, must account for your existing level of knowledge. It must also provide the learner immediate and informative feedback on their performance. The simulation or task needs to provide the learner multiple, if not unlimited, repetitions of the skill. Lastly, the learner must have a motivated and intentional attitude towards bettering their skill.[3] These are the four core design characteristics that are considered when designing a simulation used for the training of a skill. The most effective simulations used in the training of medical professionals have many forms, but will have the characteristics explained above in their design.

Four different forms of simulations for training medical professionals have been outlined by Lateef in his paper: *Simulation-based learning: Just like the real thing.*[1] The first of the four are human patient simulators. The mannequins used by anesthesiologists since the 1960s are an example of human patient simulators. These simulators have become more advanced, and many are now integrated with computer programs that utilize sensors to gather input and react accordingly. Some are able to respond to medications injected into them and provide valuable learning potential without the risk associated of using a live patient.

The second type of simulation outlined by Lateef is the simulated clinical environment.[1] This style of simulation is commonly used throughout a medical professionals training. Some examples are simulated operating rooms for surgeons, or simulated exam lanes for optometry students. These offer the student an opportunity to familiarize themselves with the instruments of their profession and the most efficient layout of their workspace.

Virtual procedure stations are the third form of simulation. These are computer based programs which are used to model specific procedures or skills that the student is to learn and become proficient in. The program will often be capable of presenting multiple different scenarios and conditions that the student may encounter in practice. While some simulations may be completely computer based, more involved designs include the physical instruments required for the procedure, which work in tandem with the software, instead of instruments that are digitally represented and controlled with the mouse and keyboard. The Cover Test Simulator that was developed in conjunction with this literature review is an example of a virtual procedure station.

Lastly, electronic medical records (EMR) are commonly simulated and utilized by the student prior to having encounters with live patients. EMRs are replicated in a separate program that is often called the "sandbox" version of that EMR. The student is then allowed to work with and manipulate data in the program without consequence, as it is not linked to the live version of the program. Sandbox forms of EMRs are also commonly used in the work place for training new employees to work with the live EMR software. The EMR simulations, in combination with webinars and on-site directors, are also commonly used when transitioning a medical center from one EMR software or version to another.

Combining one of the above forms of simulations found in the medical field with the principles of deliberate practice will yield a successful simulation design. One example of this is the simulation used to train nursing students the skill of peripheral vein cannulation (PVC). A study was performed to compare the differences in learning between practicing PVC on live student arms, and practicing on a mannequin arm. The study found that when students practiced on mannequin arms, they performed many more repetitions than students that practiced using their classmate's arms.[4] Another point the study made was when students practice with mannequin arms, they spent more time consulting one another and giving each other feedback when compared to practicing on a live arm. This type of learning is called a student-centered approach. Relying on one another for feedback and guidance caused the students to utilize their textbook guidelines more often than when they practiced on a live arm. When talking about deliberate practice, this is an example of student motivation to learn the skill. The study considered multiple repetitions and student-centered learning to be advantages of learning PVC on a mannequin. However, the role of teaches or experts in the training of the nursing students was emphasized heavily in the discussion. The point being, when students practiced on live arms, they were much more likely to seek guidance from their instructor or expert. Instruction provided by an expert on the topic cannot be replaced by simulations alone.[4] A balanced approach of both a live environment and simulated environment is most affective when learning the skill of PVC.

Simulations, while playing a large role in the way students learn, can also be used effectively in the assessment of a student's skill. Simulations have a large advantage over written exams when assessing a student's knowledge because they model situations the student will encounter in real-world practice.[5] Simulations can also be used in the assessment of entire medical teams and provide valuable insight into how well the team works together to achieve the goal of the simulation. An example of this are simulations used to evaluate emergency room or operating room teams. It is important to understand the correct way to design a simulation that serves as an assessment tool.

Evidence-centered design (ECD) has been one of the most widely used design structures for simulation-based assessments.[5] There are five categories taken into account with ECD. The first is domain analysis. Domain analysis is the process by which the design team studies the skill or "domain" that they are to model in the simulation. This involves gathering information about the terminology, instruments, and current knowledge of the skill or field. Second is domain modeling. Domain modeling is the process of sectioning off the skill to be tested into specific sub skills that the candidate will perform in order to demonstrate their competency of the overall skill. Let's take the example of an optometry student performing a proficiency on biomicroscopy. The overall skill being tested is biomicroscopy, and the student's ability to manipulate the instrument and focus a parallelepiped on a layer of the cornea would be a sub-skill. The third category of ECD is conceptual assessment framework. Conceptual assessment framework encompasses things like the physical rubric and specifications that will be used in grading of the student's ability. Fourth is the assessment implementation. This is the instructions or methods of how data about the performance will be gathered so that it may be scored. Lastly, is the assessment delivery. Assessment delivery is the initiation of the simulation and the utilization of the tools set by the first four categories of ECD to complete the assessment.

The discussion has included details of Deliberate practice, the four different forms of simulations used in the training of medical professionals, an example of how mannequins are used in training nurses to perform PVC, and how simulations can be applied to the assessment of competence. The Cover Test simulator has been designed to include many, of the principles above.

CHAPTER 3

COVER TEST SIMULATOR v1.0

The cover test is a procedure commonly performed in routine eye exams by eye care professionals to assess the alignment or posture of a patient's eyes. Evaluation of the posture of the eyes is essential in determining the health of a patient's binocular vision system. To discuss the development and application of the Cover Test simulator, a brief discussion of the cover test procedure and the data gathered from it is warranted. The common ocular deviations or misalignments will be discussed in brief as well.

There are many different deviations that can be found using cover test. The first distinction made while performing a cover test is the presence of a phoria or tropia. A phoria is the natural resting position of the eyes. The patient's eyes are aligned when they are fixating a target. When one of the eyes is covered, it will move to its natural resting position and the patient's eyes have then become dissociated. Alternatively, when the binocular vision system breaks down, the patient is only able to fixate a target with one of his or her eyes at a time. This is misalignment of the eyes is termed a tropia. After it is determined if the patient has either a phoria or a tropia, the direction of the phoria or tropia is determined. To designate direction, the prefix exo is used for when an eye is deviated outward, eso is used for an inward deviation, hyper is used for an upward deviation, and hypo is used for a downward deviation. As an example, a patient who's left eye is deviated outward while fixating a target with the right eye, has a left exotropia. Lastly, the magnitude of the phoria is determined using prism to neutralize the deviation.

There are two types of cover tests, the unilateral cover test and the alternating cover test. These are used in tandem when describing a patient's ocular posture. First in the sequence is the unilateral cover test. To perform this procedure, the clinician instructs the patient to fixate a target typically at 40 cm away from them, and then covers one eye to dissociate it while watching the fellow eye for movement either in, out, up, or down. On the uncover stroke of the paddle, the clinician is looking for the presence or absence of a refixation movement. This is repeated three times on each side as the clinician evaluates for the presence of a tropia. Next is the alternating cover test. The clinician alternates covering each eye, allowing enough time between covers for the patient to refixate the target after being dissociated briefly by the cover paddle. This is repeated multiple times to determine the presence, direction, and magnitude of a phoria.

Evaluating phoria vs tropia, magnitude and direction are important for the practitioner to determine the presence of binocular vision disorders. It is also essential when prescribing prism for patients that suffer from double vision due to an unsuppressed tropia. Rarely, cover test can be used to help in the diagnosis of more serious neurological problems that involve the extraocular muscles. Cover test is an important procedure for all eye care professionals to learn.

Instructing students in the cover test procedure involves hours of lecture dedicated to the anatomy of the extraocular muscles, the neurological connections, and the methodology of the procedure itself. The cover test procedure is commonly practiced on classmates for multiple repetitions before the student has the opportunity to perform it on a live patient. This method of instruction poses a problem because the student will only be exposed to whichever deviations his or her classmates exhibit. Encountering one of the rarer deviations in practice before seeing live patients is impossible without help from a simulation to manifest the deviation. This is one of the advantages of using simulations for instruction of the cover test.

The Cover Test simulator is a virtual procedure station designed to give students a method of learning that involves principles of deliberate practice. The simulator uses a Raspberry Pi model 2B to run the python scripted simulation. Along with the Raspberry Pi, a Snake Eyes breakout board provides connectivity to two 1.5” OLED screens and two Hall effect sensors beneath the screens. A customized 3D printed mounting platform is used to connect all the hardware. Open-source software developed by Phillip Burgess of adafruit.com was used in the graphic representation of the eyes and the functionality of the breakout board.[6] The software was then modified to include functionality for the Hall effect sensors.

The program projects one eye to each of the OLED screens, which are separated by 64mm from center to center. A cover paddle with an embedded magnet is then introduced to the Hall effect sensor. The Hall effect sensor changes its state, signaling to the program that the eye associated with that sensor has been covered. The eyes will move per the deviation the program is presenting to the user.

The Cover Test Simulator has two advantages over practicing the cover test on live students alone. Firstly, it allows for unlimited repetitions of the skill, one of the aspects of deliberate practice. The student can perform the skill as many times as he or she wishes without the need of a fellow student. PVC training utilizing mannequin arms also showed the advantage of multiple repetitions. Secondly, the Cover Test Simulator can present any ocular deviation that would be seen with cover test, provided the desired deviation has been included in the program. The simulation can be used to give the student experience with rare types of ocular deviations. This allows the program to account for the users experience level, which is an aspect of deliberate practice.

Simulations are not perfect however, and the Cover Test Simulator has its disadvantages as well. The program is in its first version and is not fully developed. It does not have the capability to show all the possible ocular deviations. The program also does not have a method of giving useful performance feedback to the user, which is one of the four aspects of deliberate practice. Another disadvantage is the program does not have a graphical representation of the eyelids and facial structure. Only the eyes are represented, in this simulation, which takes away from the physical-fidelity of the simulation.

The Cover Test Simulator is in the first version of development, and there are many improvements that can be made. First, the software needs to be developed to a level where the student can select any ocular deviation to practice on. The simulation is currently limited in this capacity. Secondly, the software needs to include a graphical user interface (GUI) where the student can navigate the program and see feedback. Thirdly, a future version of the simulation should include instant performance feedback. One example of helpful feedback would be the speed at which the student is performing the alternating cover test. Students that are new to the procedure will often perform the alternating cover test too quickly. Allowing the use of loose prism, or prism bars to neutralize the deviation would also be a way to improve the simulation. Lastly, using the GUI, the student or professor should be able to change the magnitude of the deviation. A future version of the Cover Test Simulator with the above improvements may be adapted as an assessment tool.

Following the ECD structure, the Cover Test Simulator could be utilized in the assessment of optometry student's proficiency with the cover test. Students cover test skills are currently evaluated using a fellow student as a simulated live patient. The student being evaluated will likely have experience with his or her partner's specific eye posture, which puts the validity of the assessment in question. The Cover Test Simulator could allow the proctor of the exam to select any deviation, including its magnitude. This would eliminate any familiarity with the patient's deviation and create a more objective assessment of the student's skills.

CHAPTER 4

CONCULSION

Simulation-based learning is becoming more relevant with advancement in technology. It allows instruction of students in various medical fields while removing the risk associated with practicing difficult procedures on live patients. Well-designed simulations utilize all four aspects of deliberate practice, enhancing their effectivity in training students. Using evidence-centered design, simulations can be helpful in the assessment of skill. The Cover Test Simulator is just one example of a technology that can be used to enhance the knowledge of students. Well-designed simulations provide a better learning potential, and hopefully better outcomes for our patients. Simulations have many applications in education today and have vast potential to continue revolutionizing the way medical professionals are instructed.

REFERENCES

1. Lateef F. 2010. Simulation-based learning: Just like the real thing. Journal of Emergencies, Trauma, and Shock 3:348. [accessed 2017 Mar 9]

2. Ericsson K, Nandagopal K, Roring R. 2009. Toward a Science of Exceptional Achievement. Annals of the New York Academy of Sciences 1172:199-217.

3. Anders Ericsson K. 2008. Deliberate Practice and Acquisition of Expert Performance: A General Overview. Academic Emergency Medicine 15:988-994.

4. Ravik M, Havnes A, Bjørk I. 2017. Defining and comparing learning actions in two simulation modalities: Students training on a latex arm and each other's arms. Journal of Clinical Nursing.

5. Spector J. 2015. The SAGE encyclopedia of educational technology. 1st ed. Thousand Oaks: SAGE Publications, Inc.

6. Burgess P. 2017. Overview | Animated Snake Eyes Bonnet for Raspberry Pi | Adafruit Learning System. Learn.adafruit.com. [accessed 2017 Feb 19]. https://learn.adafruit.com/animated-snake-eyes-bonnet-for-raspberry-pi/overview