E-Learning Electricity

A Web-Based Training System:

Applied to Teaching the Fundamentals and Function of Electrical Theory as it relates to Direct Current Automotive Circuits.

A Master's Thesis Presented to

Information Design & Technology Program

State University of New York

Polytechnic Institute

Utica, New York

In partial fulfillment of the Requirements for the

Master of Science Degree

By

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August, 2019

DEPARTMENT OF ARTS AND SCIENCE

CERTIFICATE OF APPROVAL

Approved and recommended for acceptance as a thesis in partial fulfillment of the requirements for the degree of Master of Science in Information Design and Technology

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Abstract

The purpose of this thesis project is to create a proposal for a new e-learning program that would span the gap between the theoretical and real-world application of electrical theory as it relates to automotive direct current circuits. This proposed e-learning program will currently be focused on the subject of automotive direct current circuits, but is considered scalable for other subjects in the future. The application of this proposed e-learning program is to be used by learners as a resource to help deepen their knowledge through active learning and subject mastery. Active learning and subject mastery are be achieved by utilizing simulation and gamification as a means of engaging and motivating the learner. This will be accomplished within this proposed e-learning program by implementing the principles of Piaget's Theory of Constructivism, Jerome Bruner's Theory of Discovery Learning and Bloom & Carroll's Theory of Mastery of Learning (Bates, 2016). This proposal also includes design mockups for the homepage, interactive activities, learning games and an assessment quiz. It is my intention to someday see this proposed e-learning program become a reality and be implemented for the future enhancement of education and the edification of learners.

Acknowledgements

I have truly enjoyed my time in the Information Design and Technology program at SUNY Poly. The class offerings within the program are both well-versed and academically challenging. As a teacher, I have found that classes such as instructional design and information design enriched and enhanced my teaching ability and classes such as web design and research methods have stretched me as a student and a lifelong learner. Without doubt, my knowledge of Information Design and Technology has grown exponentially throughout my time studying within the IDT program.

I would like to extend a sincere and heartfelt thank you to each of my professors. It is clear that you are passionate about your work and the success of your students. I hope that each of you continues to teach for many years to come with the same excitement for IDT that you have shared with me.

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Introduction

Development in technology has opened the door for educational systems to advance beyond the traditional use of the lecture format and paper textbook. Today's educators have the unique opportunity to engage their students like no other time before. Not only this, but today's students enter the classroom environment in many ways lacking the skills to effectively engage in the traditional lecture format and study from a paper textbook. Educators have found a partial solution by the way in which the class content is organized, such as a flipped classroom model and/or offering some of the class content online through a hybrid model. By utilizing these models of class content organization, the educator has shifted his or her role from that of expounding in the front of the classroom to that of facilitating the class content. One of the countless advantages of this shift in class content organization is it allows for new technology to be employed by the educator. The goal of implementing such technology is to engage and motivate the learner.

In this thesis project I am proposing one such new technology: an e-learning simulation that incorporates elements of gamification to teach the fundamental principles of electricity as it relates to direct current circuits. By utilizing online or e-learning through a mobile-friendly platform, the learner will have the flexibility to access the content at any time. Additionally, by incorporating elements of simulation and gamification the learner will be involved at a deeper level, resulting in active learning and sharpening the learners' problem solving skills. Active learning is defined as "one time or ongoing student exercises that are introduced in the classroom to encourage student thinking and participation in an effort to engage students in the learning process" (Alanah, Stacie, & Albert, 2017, pg. 23).

A key element of active learning is the learners' engagement in the content they are learning. Engagement will only take place if the learners are motivated to engage themselves in the learning process. Simulation and gamification through an e-learning platform aid in learners' motivation, resulting in his or her engagement in the learning process and leading to active learning. Active learning is one of the first steps toward the learners' ability to master the subject or topic they are striving to learn.

Throughout this thesis project, I will discuss active learning and subject mastery. An example of active learning and subject mastery is how learning can be enhanced through the use of simulation and gamification through the application of an e-learning platform. This thesis specifically is a functional proposal for my project: E-Learning Electricity; a web-based training system as it applies to teaching the fundamentals and function of electrical theory as it relates to direct current automotive circuits.

Background

The theory and application of electricity is a challenging topic for most to comprehend as it is both theoretical and in some ways tangible. A learner can study the theory of electricity, but yet struggle to understand the practical application of the theory. This is because the learner cannot see electricity, only the effects of electricity on an electrical circuit. For example, a learner can see the effects of electricity as it lights a bulb or they can feel the effects of electricity through an electrical shock. However, this often still leaves most learners with an incomplete understanding of how to connect the theory of electricity to the tangible understanding of how electricity functions in a basic electrical circuit.

As a teacher of automotive technology at SUNY Morrisville, and after many years of casually observing my students, I have perceived that countless students struggle understanding the fundamentals of electricity as it relates to automotive electrical circuits. Many are able to memorize the theoretical concept. They are then able to recite the theories back as a concept; however, they are at a loss when it comes to applying these theories to the practical, real-world application. This is the driving force behind the creation of this thesis project. It is my intention that this proposed e-learning program will engage the learner in active learning that will bridge the gap between the theoretical concepts and the tangible hands-on.

Research Questions

As it relates to the learners' understanding of the fundamentals and function of electrical theory as it applies to automotive circuits:

- How can an interactive web-based simulation bring a learner to a deeper level of understanding of the content being presented?
- What features and interactive functions are required in a simulation to be an effective instructional tool to result in an active learning experience?
- What factors or elements of an interactive web-based simulation affect the motivation and engagement of the learners?
- How can elements of gamification in learning be integrated to promote the development of the learner's problem-solving skills?

Literature Review

Users and Applications:

As we see the culture around us changing, accelerating, and becoming more technologically entrenched, it's no surprise that our students are demanding more from their teachers, classrooms, and laboratories. Gone are the days of "the traditional teaching method described as an expository method of teaching, where the instructor plays the central role while students play more of a passive role which reduces their classroom involvement to capturing information given in the lecture without much interaction with it" (Hamzeh, Theokaris, Rouhana, Abbas, 2017, pg. 2). However, the up rise in technology has resulted in countless platforms and programs that make learning materials more engaging, accessible and can result in a deeper level of learning by the students. "Just as labs and tutorials involve students in the learning process, simulation games/exercises can thus be considered one of these integral methods to achieve an effective learning process" (Hamzeh, Theokaris, Rouhana, Abbas, 2017, pg. 3). As a result of the use of e-learning and simulations the instructor at times in the classroom or laboratory will facilitate instruction *and as a result,* improve the learning experience, and increase understanding" (Hamzeh, Theokaris, Rouhana, Abbas, 2017, pg. 18).

The teacher, as the facilitator of the information within the classroom and/or laboratory, has many options as to how he will distribute the information to his students. "Gamification of learning is a way to use game dynamics and game mechanics in education. Encouraging unmotivated students to become more involved in the process of learning and interacting with other students can be done by adding simple game features in learning" (Hamzah, Ali, Saman, Yusoff, Yacob, 2015, pg. 30).

A comprehensive example of the use of gamification in e-learning is the use of a virtual campus for international students who are studying abroad. “In response to the growing trend of internationalism in education, it is important to consider approaches to help international students integrate in their new settings. One approach involves the use of e-learning tools, such as virtual worlds and gamification” (Zhang1, Robb, Eyerman, Goodman, 2017, pg. 1). Through the use of an avatar, perspective students can learn about the campus, culture, language and meet other students before stepping foot on the actual campus. This article goes on to explain that the students who took part in the pilot of this virtual campus were given a follow-up survey. The overwhelming qualitative feedback of the survey stated that some elements of the virtual campus where too challenging and that they at times preferred to explore and mingle with other students (Zhang1, Robb, Eyerman, Goodman, 2017).

An additional example of the use of gamification and e-learning is taking existing learning or training materials and adding game-elements to enhance them. “Unlike game-based learning that involves the deployment of standalone interactive learning experiences, gamification involves the application of game design elements to an existing training method to bring about a desirable change in that method. In the training and development context, gamification is often intended to improve a training outcome of interest when existing training is below effectiveness expectations” (Armstrong, Landers, 2018, pg. 162). This article continues by discussing the effects of adding gamification to existing training for employees of a manufacturing company. The company found that their existing video-based safety training was ineffective and was resulting in many on-the-job injuries. As a result, the existing training was revamped to include simulation and gamification elements. The article did go on to say that the company found that the new training method resulted in achieving more of the learning

outcomes. However, the article also stated that there are other human factors that could determine the effectiveness of the training. Examples of this potential negative effect would be: the attitude of the trainee, the attitude of their supervisor and the overall climate of the workplace toward safety and training (Armstrong, Landers, 2018).

Lastly, how is the learner rewarded when completing a learning task assigned by a teacher or a training assigned by a supervisor? Many gamification and e-learning programs reward their players with points, badges, or ranking among their peers. Depending on the learners' internal motivation, the external motivators may or may not be effective. However, "the generally positive findings surrounding point, badge and leaderboard gamification suggest that it can be effectively integrated into training designs in order to improve motivation to learn and learning performance, but that the goals implied by these game elements must be chosen carefully to be successful" (Armstrong, Landers, 2018, pg. 165).

Definitions:

"Learning" or what is more appropriately called "active learning" is defined as "when learners are able to create and store knowledge, skills and *as a result* comprehension will increase as they are highly engaged" (Alessi & Trollip, 2001, pg. 24). According to the National Research Council there are three major identifying factors involved in how people learn. "First, meaningful patterns of information increase processing and retrieval. Second, the organization of information affects the ability to understand and characterize problems. Third, the context for using information is necessary for long-term retention" (Lasley, 2017, pg. 40). This article by Lasley goes on to expand this definition of learning to include what they called "new media literacy" and the students ability to problem solve and "new media literacy integrates students' learning process with game design mechanisms" (Lasley, 2017, pg. 53).

Others define gamification and e-learning by stating, “scholarly research on this concept has defined it more narrowly, as the implementation of game design elements in non-game contexts” (Armstrong, Landers, 2018, pg. 162). As well as, “Gamification is defined as the use of game mechanics in the non-game context to change the behavior of people” (Hamzah, Ali, Saman, Yusoff, Yacob, 2015, pg. 30). And lastly, “Gamification is the craft of deriving all the fun and engaging elements found in games and applying them to real-world or productive activities” (Sturges, Sanchez, Salinas, 2015, pg. 28).

Active Learning:

Active learning is different from passive learning in that the learner is engaged in the learning process. One of the reasons that gamification and e-learning has been found effective by empirical research is that “video games require active learning. Active learning engages students in the act of doing and thinking about what they are doing. Actions include semiotic interrelationships between multiple sign systems (words, images, actions, and artifacts), critical thinking, effective communication, collaboration, problem-solving abilities, open-mindedness, self-discipline, and commitment to cultivating the learning process” (Lasley, 2017, pg. 44). An additional advantage of gamification and e-learning is that the learner feels less constrained and can learn in a freeform environment. Unlike a textbook that has significant constraints by the nature of its format, gamification and e-learning allows for freeform learning. As a result of freeform learning the learner is more likely to experience a feeling of “play” (Lasley, 2017). This “play” through gamification and e-learning will often result in “a new cultural contextual form that stimulates patterning, organizing information and developing relationships, therefore, promoting problem-solving and critical thinking abilities within a socially constructed environment” (Lasley, 2017, pg. 40).

Active learning is also known as sustainable learning and "genuine learning *which* requires active engagement and involves not only memorization, but also more use of the mind" (Hamzeh, Theokaris, Rouhana, Abbas, 2017, pg. 3) and occurs when learners are intrinsically motivated to engage actively in the learning process.

Because active learning requires a learner to be intrinsically motivated, an educator must discover what motivates a learner to engage in active learning. "There are many factors that affect motivation in e-learning. Student engagement is the primary mechanism that enables motivational processes to contribute to e-learning and development" (Hamzah, Ali, Saman, Yusoff, Yacob, 2015, pg. 30). One of the primary mistakes made by educators is the classic mindset that for a learner to be engaged, his or her primary learning style must be satisfied. "The popular notion that you learn better when you receive instruction in a form consistent with your preferred learning style, for example an auditory or visual learner, is not supported by the empirical research" (Brown, McDaniel, & Roediger, 2014, pg. 4). Additionally, the traditionally taught method of repetition is also largely ineffective. "People commonly believe that if you expose yourself to something enough times you can burn it into memory. Not so" (Brown, McDaniel, & Roediger, 2014, pg. 9). However, this is contradicted by Alessi and Trollip by saying "the more information is practiced or used, the better and longer it is remembered" (Alessi & Trollip, 2001 p. 23).

When talking about the topic of active learning in the book *Make It Stick*, the authors give an account of a student who is in flight school. The student recalls the rigors and boredom of sitting in class day after day learning the ins-and-outs of all of the systems on the aircraft he will be flying. The student said he felt his time spent in the classroom as meaningless until the instructor started making real-world applications and giving the students scenarios to overcome.

From there the classroom information took on more meaning when he was tested in the flight simulator. This resulted in the student reigniting his need to be engaged in active learning. This can be done by "trying to solve a problem before being taught the solution leading to better learning, even when errors are made in the attempt" (Brown, McDaniel, & Roediger, 2014, pg. 4). An additional element of motivation for learning is that "learning is stronger when it matters, when the abstract is made concrete and personal" (Brown, McDaniel, & Roediger, 2014, pg. 11).

With the example given above, it is clear that the flight school student must master his knowledge of the aircraft for his own safety and the safety of his passengers. But what if students are disengaged in learning a topic that does not hold life and death in the balance? How can a student be motivated to be engaged in active learning and avoid the pitfalls of the "illusion of knowing" (Brown, McDaniel, & Roediger, 2014, pg. 15)? The authors of *Make It Stick* say that the illusion of knowing is the result of learners using ineffective study methods resulting in the learner assuming they have mastery of a subject, when in fact they do not. Instead it has been found that "in virtually all areas of learning, you build better mastery when you use testing as a tool to identify and bring up your areas of weakness" (Brown, McDaniel, & Roediger, 2014, pg. 5). Additionally, "testing helps calibrate our judgments of what we've learned" (Brown, McDaniel, & Roediger, 2014, pg. 5). Going back to the example above, the flight school student can test his knowledge of the aircraft's hydraulic systems during a simulated failure in a training flight simulator. This will give the flight school student feedback on his knowledge of the aircraft's hydraulic systems without the risk of being 30,000 feet up.

Simulation can also be used beyond flight training and is an effective tool to facilitate active learning and student motivation. When talking about a class of engineering students, this article states that "simulation exercises are now common in management for all levels of

education; they are an ideal method for transferring knowledge of the complex management systems without risk" (Hamzeh, Theokaris, Rouhana, Abbas, 2017, pg. 3). The article goes on to say that "in engineering teaching, simulation gives a real world case as it is but without risks, this helps people to learn by experimenting, especially notions in engineering that require experience" (Hamzeh, Theokaris, Rouhana, Abbas, 2017, pg. 3). The advantages of simulation and gamification through the platform of e-learning is that it "can be used to change a behavior, increase engagement/motivation, acquire skills and more." (Sturges, Sanchez, Salinas, 2015, pg. 42).

Instructional Design:

When considering simulation and gamification of learning as it relates to instructional design we must take into account "the new generation is growing up playing video games and using microcomputers in different facets of their daily life. Education should be molded to reach students in a way similar to their habits and desirable methods of learning. Moreover, previous studies report that students do not learn much by just sitting in class listening to teachers, memorizing prepackaged assignments, and spitting out answers" (Hamzeh, Theokaris, Rouhana, Abbas, 2017, pg. 2). This is also true when bearing in mind the needs of active learning and "the same attributes for meaningful learning are present in game design and gamification. Gamification learning stimulate students' intrinsic motivation through challenges associated with real-world problems" (Lasley, 2017, pg. 52). This is distinctly different from the traditional classroom where the learner is reduced to a "neutral agents receiving information from the lecturer and recording it in their own notes without a cognitive assessment of the information in their minds" (Hamzeh, Theokaris, Rouhana, Abbas, 2017, pg. 3).

It is vitally "important for instructional designers to treat gamified training as they would any other training redesign method. Training designers should follow the instructional system design model, conduct a needs assessment, use theory to develop an initial training design, implement the training and conduct a training evaluation, redesigning and reevaluating as necessary" (Armstrong, Landers, 2018, pg. 165). This does not mean that every element of the training needs to be developed into a simulation or gamification. Instead training needs should be assessed and evaluated to determine the problem area(s) in a training system. The designer creating the training system should start by considering the typical problem areas in the training process and how the principles of simulation and gamification could be applied to improve the learners' knowledge, skill, attitude, motivation or lack of information transfer. Additionally, "if training designers develop excellent content but are confident that trainees will not find it engaging, gamification may be appropriate." Like any other instructional design, "after conducting the first training sessions, data should be collected and analyzed to evaluate the effectiveness of the training" (Armstrong, Landers, 2018, pg. 166). For example, using the study mentioned above about the virtual campus for international students, the qualitative data found that "most students said that they didn't want to play games to access resources but, instead, be able to access resources directly. This shows that gamification, while it has many potential benefits, must be implemented carefully. Gamification should be used to increase engagement with a system but not be a barrier to information and resources" (Zhang1, Robb, Eyerman, Goodman, 2017, pg. 13).

When speaking about information design that will facilitate active learning, Sturges, Sanchez, and Salinas say, "Among the great challenges in higher education is developing methods and techniques to foster innovation, creativity, motivation, engagement, and learning

into effective design and delivery of courses in all platforms, but in online courses in particular. Online course design and implementation have recognized the perceived and proven results of gaming and simulations as teaching strategies during the past sixty years" (Sturges, Sanchez, Salinas, 2015, pg. 23). An additional real-world example from the book *Make it Stick* was about the nation-wide company Jiffy Lube. This company uses an e-learning employee training program that utilizes elements of simulation and gamification to foster active learning. Each employee is required to achieve a specified level of training before he or she can perform those tasks on a customer's vehicle. "The e-learning and on-the-job training are active learning strategies that incorporate various forms of quizzing, feedback, and spaced and interleaved practice. All progress is displayed by computer on a virtual dashboard that provides an individualized learning plan, enabling an employee to track his or her performance, focus on skills that need to be raised, and monitor his or her progress against the company's completion schedule" (Brown, McDaniel, & Roediger, 2014, pg. 246).

Information Design:

When designing new training materials or new curriculum, Bates, in his book *Learning Theories Simplified,* says "there is not only a need for well-designed materials that the student may complete independently but also for well-designed group activities that can be completed in a collaborative, blended, or face-to-face setting" (Bates, 2016, pg. 4). Regardless of the delivery method, information must always be designed with the intention of learner engagement which results in active learning. It is for this reason that when considering gamification and e-learning of new learning curriculum, we also consider how we would effectively redesign existing curriculum. "With a strong design foundation already in place, gamification can often be used to improve learning outcomes further through a variety of specific redesign choices inspired by

video game and psychological research" (Armstrong, Landers, 2018, pg. 163). Considering the fact that most teachers, instructors and trainers will have existing learning resources, Armstrong and Landers raise the question: when redesigning existing training materials, is it better to redesign the content or the method? In this article, Armstrong and Landers go on to state the following findings; "there is an inherent tradeoff to gamifying content versus gamifying method. When gamifying content, gains are potentially more transformative. By reinventing content, an entirely 'new' training program can be created from the seeds of the old one. Such transformative change comes with a degree of risk, because training designers may transform the content so completely that it is unrecognizable and no longer meets its original training objectives. This type of risk is mitigated when gamifying method, because the content remains absolutely identical. However, here is also less potential impact when gamifying training method than when gamifying content. Thus, redesign needs must be carefully articulated before considering either approach in isolation or, more complexly, both approaches simultaneously" (Armstrong, Landers, 2018, pg. 164).

Learning Theories:

For this Literature Review I have chosen to focus on the following learning theories; Jean Piaget's Constructivism (1957) and Jerome Bruner's Discovery Learning (1966). In addition, we will look at John Carroll and Benjamin Bloom's theory of Mastery of Learning (1971) (Bates, 2016).

Piaget's theory of Constructivism states, in its simplest form, that people construct their knowledge of the world around them through the following four stages: one – sensorimotor, where learning takes place through touch, two – pre-operational, where information is arranged logically, three – concrete operational, where one has the ability to think in a logical structure,

and four – formal operation, where one can think and reason in the abstract (Bates, 2016). In their book Alessi and Trollip scrutinize multimedia in education and learning philosophies and state constructivism emphasizes active learning and discovery. Alessi and Trollip determine that "educators should use a variety of multimedia materials and approaches, and thus provide flexible learning environments meeting the needs of the greatest number of their learners" (Alessi & Trollip, 2001, pg. 40).

Jerome Bruner's theory of Discovery Learning can be summarized as not spoon feeding the learner, but instead developing the learners problem solving skills through actively engaging the learner in the learning process. This positions the teacher as the facilitator of the learning and information. "Bruner maintained that giving the individual the essential information they need to solve the problem, but not organizing it for them, is a critical aspect of discovery learning" (Bates, 2016, pg. 54-55).

As was discussed by other articles and books above, the need for mastery of content knowledge is critical. A basic understanding of Bloom and Carroll's theory of mastery of learning can be stated in that "opportunity is created by the teacher and perseverance is required by the learner" (Bates, 2016, pg. 238-239). Their theory is then organized into the four following steps: one – organize the subject matter, two – develop learning objectives, three – implement assessment measures, four – allow learners adequate time to reach the level of mastery (Bates, 2016).

Research Results and Limitations:

Each article and book makes some statement about the limitations of the research conducted. Although each researcher(s) strives for excellence in his or her work, there are some variable elements that are outside of his or her control and as a result a statement of the scope of

the research is given. Some research is limited because of the nature of the subject or subjects. For example, most of the literature states that its research was conducted by the means of comparing one group of students to another group. This kind of research is limited because student groups are made up of individuals and individuals are unique. However, below are a few qualitative summary statements giving an overview of the research completed on the topic(s) of simulations and gamifications through e-learning to facilitate active learning:

"Results from student surveys conducted at the beginning and at the end of a graduate course in civil engineering that employs simulation games as one of the teaching methods, show an increased level of student satisfaction. The increase in students' enthusiasm and understanding when participating in hands-on simulation explains the statistically significant results obtained" (Hamzeh, Theokaris, Rouhana, Abbas, 2017, pg. 18).

"Research suggests that lesser studied game elements like challenge, narrative and immersion, among others, also have potential for improving training design" (Armstrong, Landers, 2018, pg. 165).

"The objective of this paper is to access and examine the influence of gamification on students' motivation in using e-learning applications. Following this objective, two specific research questions are proposed:

1. Do e-learning applications used in this study produce statistically significant differences between the controlled group, and the experimental group in terms of students' motivation as measured by the overall summative score of the Instructional Materials Motivation Survey (IMMS)?

The results of the study: The e-learning applications use in this study produce statistically significant differences between the controlled group, and the experimental group in terms of students' motivation as measured by the overall summative score of the IMMS.

2. Do e-learning applications used in this study produce statistically significant differences between the controlled group, and the experimental group in terms of students' motivation based on the use of gamification?

The results of the study: It can be concluded that the category of confidence and satisfaction in the experimental group was statistically significantly higher than the control group. This difference was due to the use of gamification elements in the category of confidence and satisfaction" (Hamzah, Ali, Saman, Yusoff, Yacob, 2015, pg. 33).

Lastly, in the book *Make It Stick* the authors cite a study completed at Washington University in 2008. Within this study two groups were tested after having been given some content to read/learn. The control group was only allowed to read the content one time and the experimental group was allowed to read the content multiple times. After reviewing the results of the test it was found that the re-readers did score marginally higher than the control group. However, when retested on the same content a week later, the re-readers had no advantage in their scores. In fact, any gains of reading the content multiple times had worn off with the passing of time (Brown, McDaniel, & Roediger, 2014). The results of this study and the others noted above confirm the need for active learning.

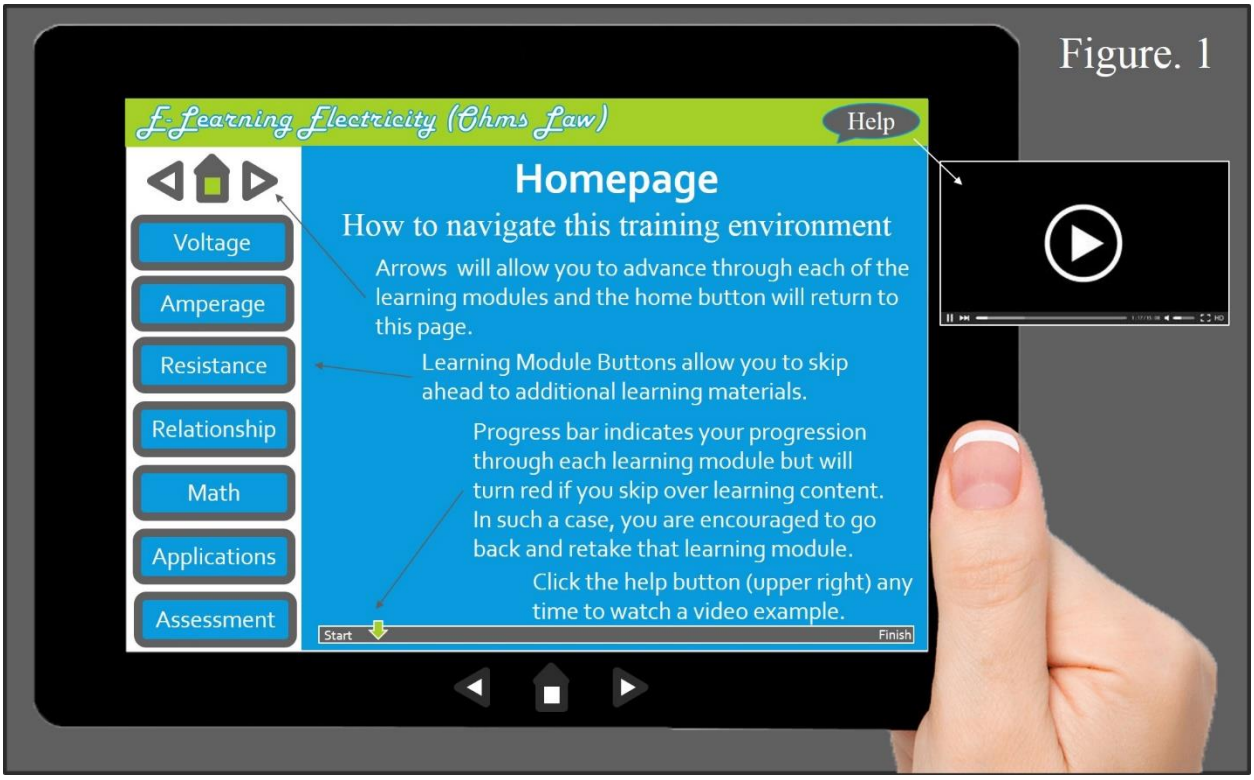
Project Overview

E-learning is an effective platform/mode of delivery for a vast number of instructional tools. It is for this reason, that I will be utilizing e-learning to propose the creation of an interactive cognitive learning program that will captivate the learner and draw him or her into the learning content. As a result of participating in this proposed e-learning program, the learner will have grasped the fundamental principles of the science of electrical theory and application or what is also known as Ohm's Law. This will be accomplished by utilizing Piaget's theory of Constructivism to achieve the following learning objectives (Bates, 2016). After completing this proposed learning program, the learner will be able to meet the following learning objectives:

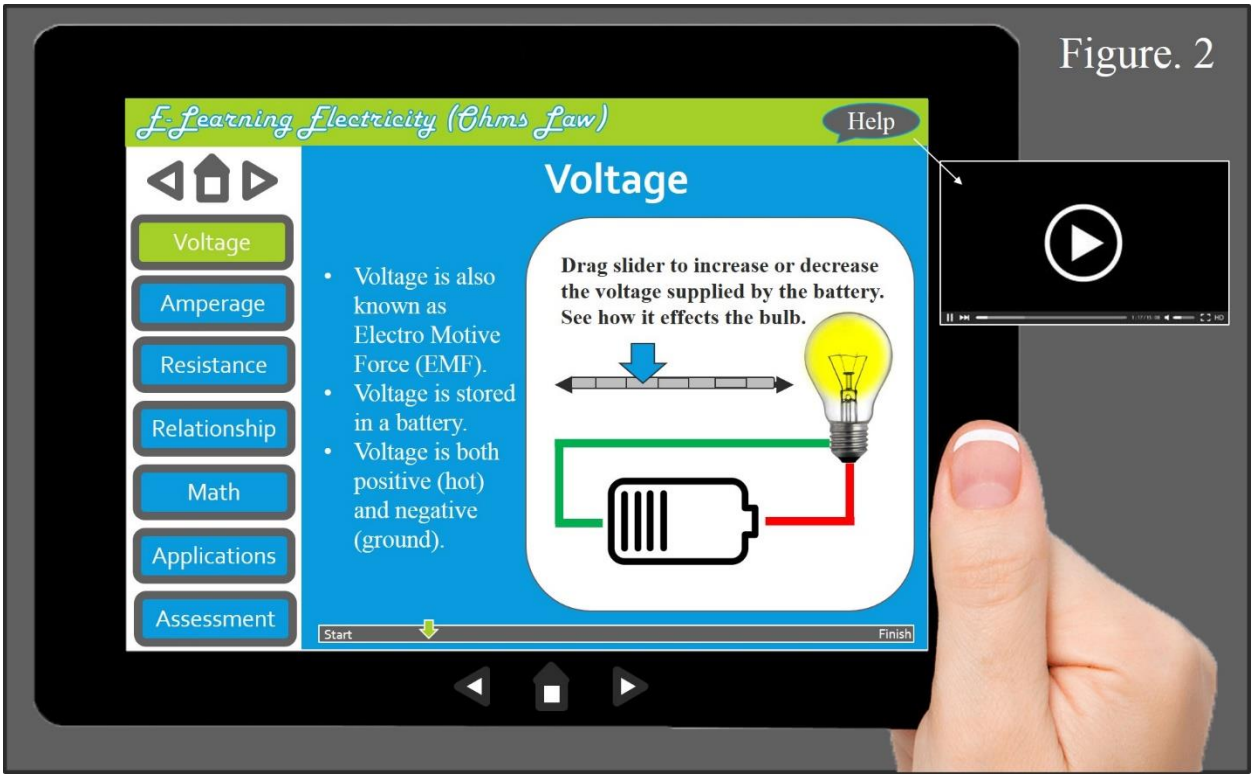
- Ascertain the fundamental units of electricity.
- Demonstrate an understanding of the functions of the units of electricity.
- Exhibit a fundamental knowledge of how voltage, amperage, and resistance function with relation to one another.
- Comprehend the mathematical relationships between the fundamental units of electricity.
- Solve basic electrical problems utilizing the mathematical relationship between the electrical units.

Project Design

This proposed e-learning platform will be broken down into three main functional areas for the learner to view: first, the primary content area – will be the most prominent and central portion of the e-learning platform and in this space the learner will be able to interact with content such as videos, text, animations, simulations, games, etc. The primary content area is the central portion of the page with the blue background. Second, the progress indication section – will function as a tool to help the learner see his or her progress as they navigate through the learning content. The progress indicators are represented by the tabs on the left-hand side of the page and the progress bar along the bottom of the page. Third, the help section – will be a section of the e-learning platform that can be selected by the learner at any time for additional information or a help option will popup if/when the learner has answered a question wrong more than once. See figure 2 as an example of an interactive page with all of the functions listed above.



Additionally, figure 1 is an example of the homepage for this proposed e-learning platform and is intended to inform the learner how to navigate through each of the learning modules.



Attention of the learner is captured and retained by the use of short learning modules that will keep the learner interested in the lesson. Additionally, (as seen in figure 2) the attention of the learner is retained by using small amounts of text in each of the learning modules.

Active learning takes on many forms within this proposed e-learning program and examples will be given below. The learner is both encouraged and in some cases required to engage with many of the interactive aspects of the learning material. According to Alessi and Trollip; “One of the essential features of interactive multimedia, in contrast to traditional media, is its capacity to require learner actions and act on them” (Alessi & Trollip, 2001, p. 24). The learners’ comprehension of the content is also enhanced by allowing the learner to experiment

with one of the variables in an electrical circuit. When the learner observes changes (as a result of experimentation) to the example electrical circuit, the learners' theoretical knowledge is then applied it to a real-world scenario. An example of active learning within this proposed e-learning program is the interactive nature of the simulations given throughout the learning material. Learners actively participate in learning by altering the variables within the electrical circuits resulting in a real-world response from the example electrical circuit. Seeing this real-world response results in activating and stimulating the problem solving portions of the learner's mind. The learner is given the opportunity to adjust individual elements within the electrical circuit, thus fostering active learning.

As seen in figures 2, 3 & 4, the learner is able to make changes to the simulated electrical circuit and observe the results. In figure 2 the learner is given the opportunity to move the blue arrow on the slider bar to increase or decrease the voltage supplied to the electrical circuit. In a similar fashion, in figures 3 & 4 the learner can change the amount of amperage and resistance in the electrical circuit. This learner driven simulation encourages the learner to explore and engages the learner resulting in active learning. Active learning is experienced by the learner throughout this learning material and the learner is not penalized for exploring and playing with these features of the learning material. Additionally, active learning can also be experienced by the learner actively taking part in learning by making changes to and observing the cause and effect relationship between elements of electricity.

Comprehension is also achieved throughout this e-learning program by giving the learner multiple interactive experiences resulting in active learning: for example, as seen in figure 5, by changing the relationship between the two variables. The learner can click on the blue arrows to move the balance beam and alter the relationship between the resistance and the amperage. This

allows the learner to directly see the effects on the light bulb when changing the resistance and amperage, resulting in deeper comprehension for the learner. This simulation helps to overcome the challenge stated above; the learner cannot see electricity but only the effects of electricity on an electrical circuit. Alessi & Trollip say; “Information we perceive must be interpreted and integrated into our current knowledge of the world” (Alessi & Trollip, 2001, p. 23). This gives the learner the real world understanding as to why some light bulbs are brighter than others and how changes in the electrical circuit effect the function of the electrical circuit.

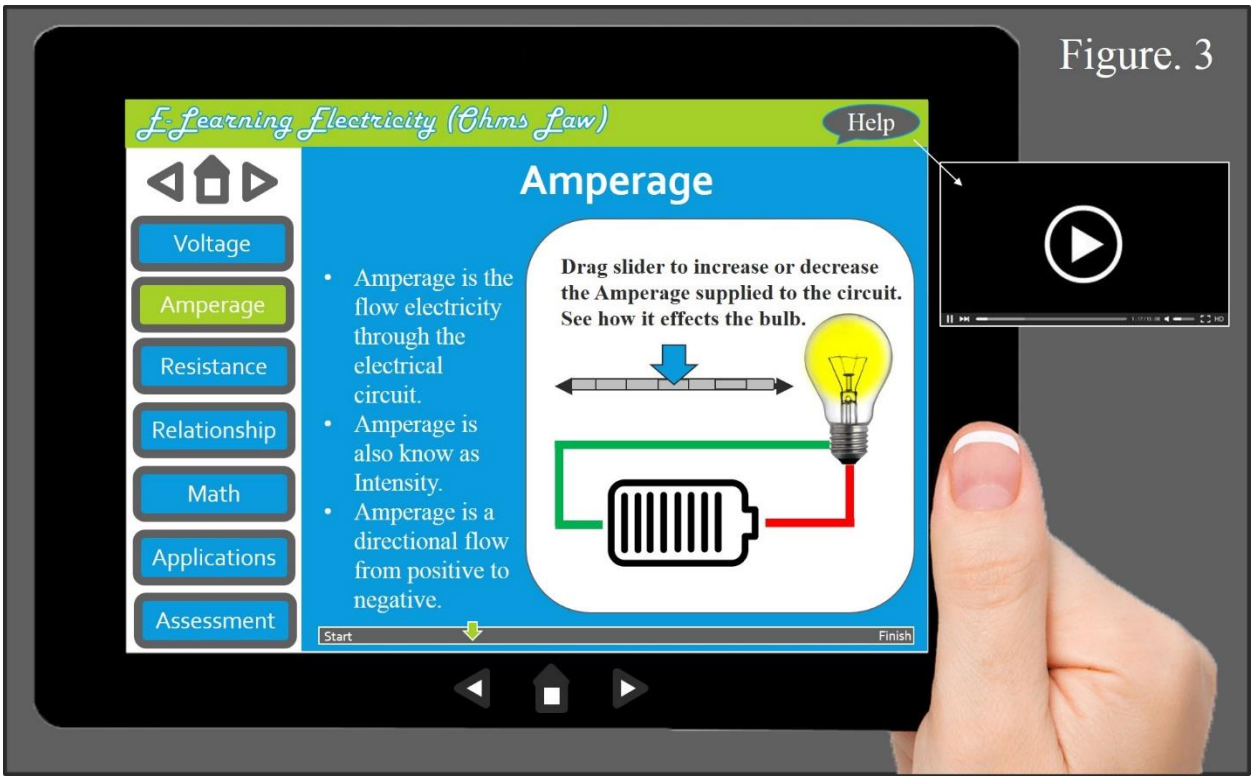


Figure. 3

This e-learning program is designed to keep the learner motivated and moving ahead by being constructed of many short learning modules. This also helps to retain the attention of the learner. Alessi and Trollip state; “For perception of lesson elements to occur, the attention of learners must be not only initially attracted but maintained throughout the lesson” (Alessi & Trollip, 2001, p. 21). An additional example of retaining the learners’ attention is the use of the

help video clips. These are designed for the learner that needs more help and more time to work through the content at a slower pace. If a learner needs additional help, he or she can simply click on the help function and view the short video clips that will help the learner better understand the material and result in better comprehension of the content. This will allow the learner who needs more time to reach his or her level of mastery of the content. This also allows a stronger student to move through the content faster by choosing to skip over the help video clips and as a result maintains his or her attention by avoiding boredom.

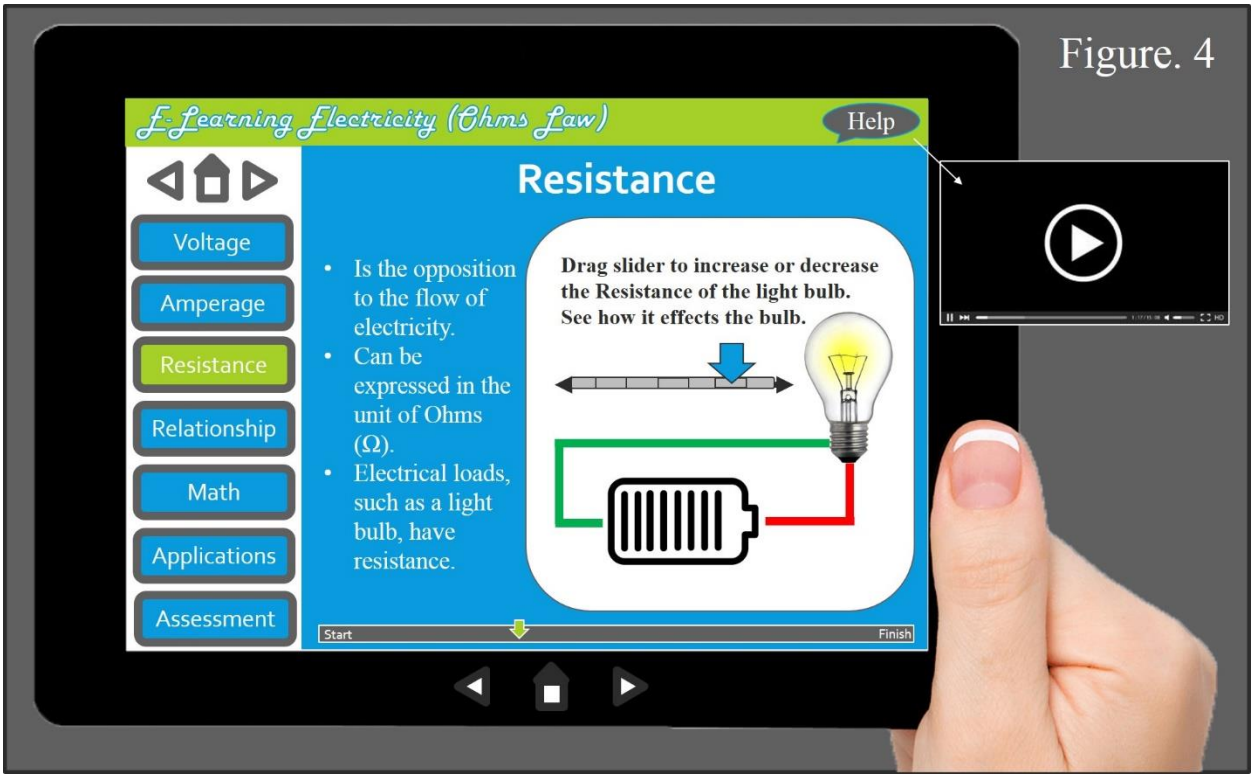
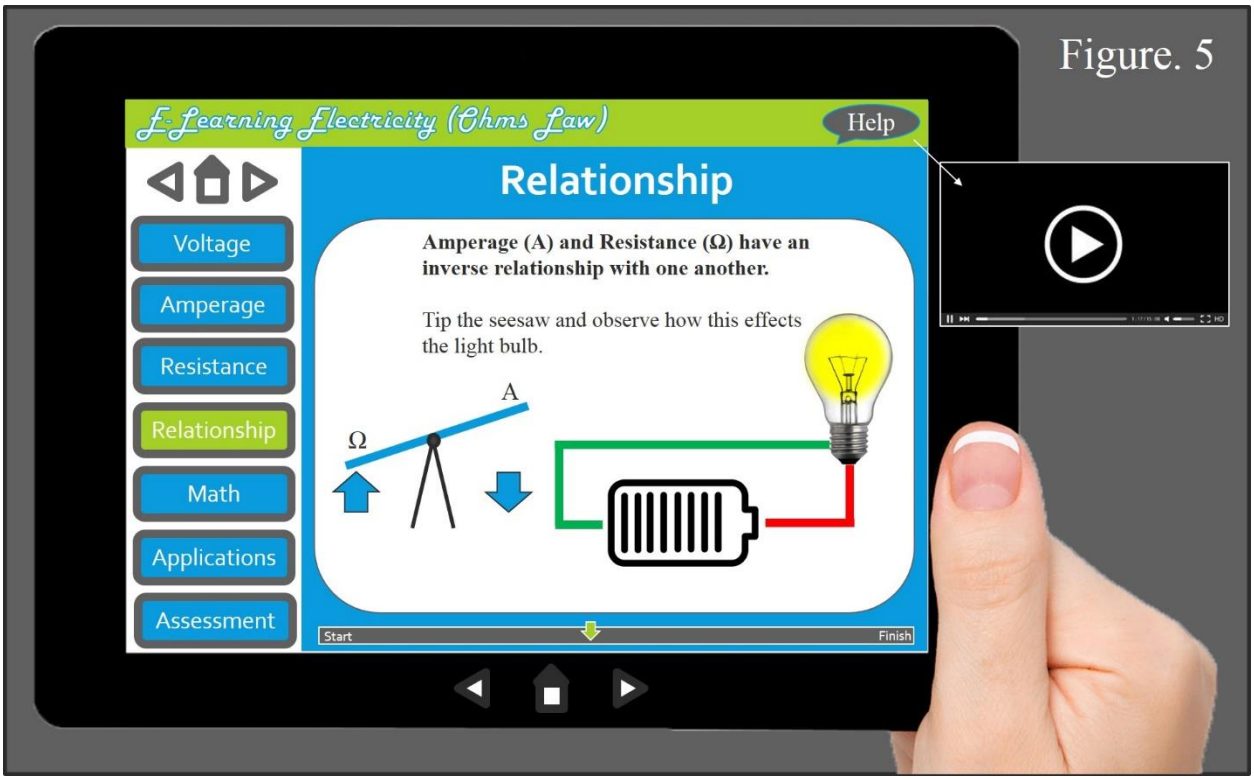


Figure. 4

In figure 5 the learners' knowledge of electrical theory is explained further by being introduced to the relationships between the individual elements of electricity. For example, if the resistance in the circuit is increased, how does this effect the amperage? This is an additional example of active learning as the learner is encouraged to change the relationships by clicking on

the blue arrows and tipping the balance beam. The learner can then observe the result on the electrical circuit as the light bulb becomes brighter or dimmer.



Transfer of learning is achieved within this e-learning program by asking the learner to complete tasks associated with the information presented within the previous modules and measure how well the learner can transfer this new knowledge to an associated topic to that which was previously learned. “Learning in a multimedia lesson is often a precursor to using that knowledge in the real world” (Alessi & Trollip, 2001, p. 29). An example (seen in figure 6) is the use of the mathematical relationship between the units of electricity. In this math game, the learner is asked to fill-in the dotted boxes within the relationship pie (by clicking and dragging) with the units of electricity as they would apply in the real-world relationship. Additionally, learners are asked to take the information they have been learning throughout the modules and apply it in a game problem that has multiple variables. This will require the transfer of

knowledge from that which they already know to something they have not before seen or experienced. As the learner interacts with this learning game this may result in mistakes by the learner, but with this method of guided discovery learning, mistakes are expected. However, if the learner does not solve the learning game correctly on the first try, he or she will be redirected to the help video clip that correlates to the information on which the learner is being tested in the learning game.

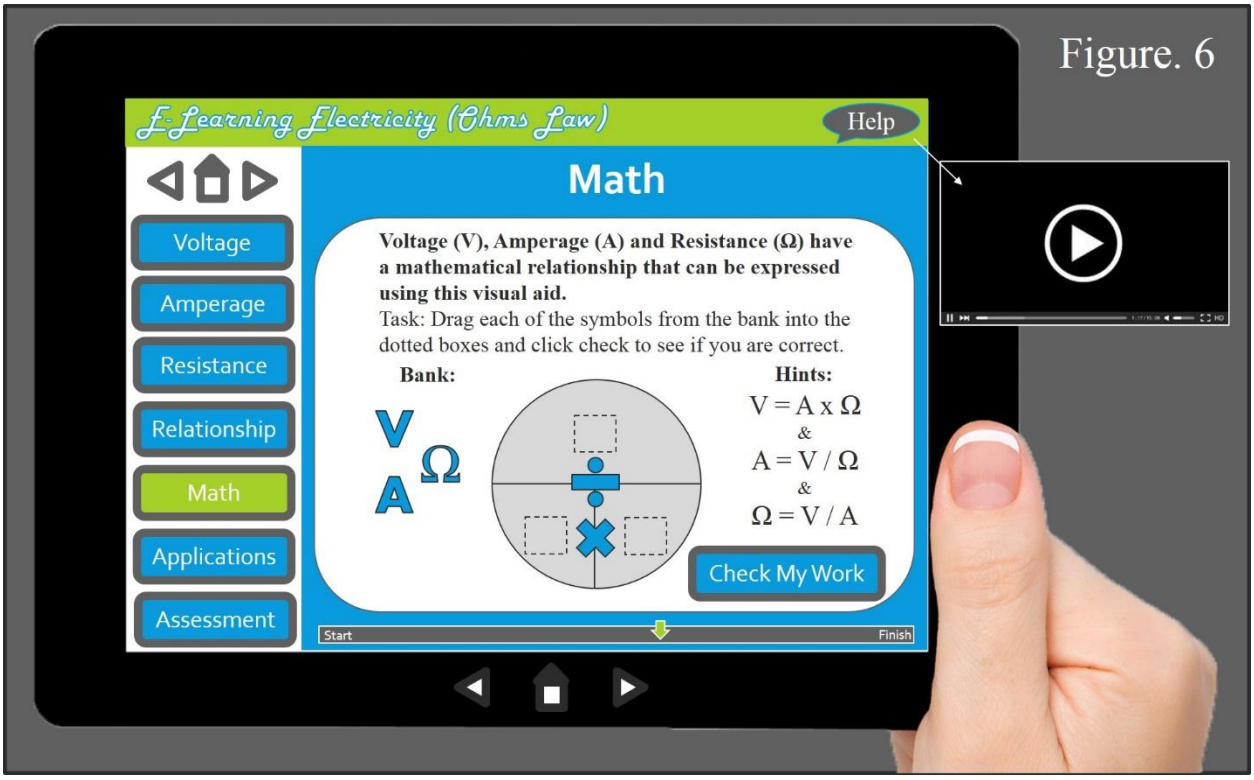


Figure. 6

The learner's memory is improved by providing the learner a brief textual explanation of each of the units of electricity, but this is also accompanied by a visual and interactive element aiding in memory retention. This is consistent with the implementation of guided discovery learning theory. The learner is given all of the essential pieces and he or she are required to discern how the pieces work together (Bates, 2016). The learner's memory is also improved within this e-learning module by repetition. Alessi & Trollip state that the two primary principles

of memory enrichment are organization and repetition (Alessi & Trollip, 2001). Within this learning material, the same example electrical circuit is given to explain the principles of voltage, amperage and resistance, thus giving repetition and aiding in memory. In the future this fundamental information will need to be transferred by the learner to other more complicated circuits. The learner's memory is enhanced further by the activity shown in figure 7 where the learner will need to recreate the electrical circuit. The learner is once again involved in active learning through a learning game as he or she works to remember which components construct the parts of the electrical circuit. As stated above, if the learner does not correctly assemble the electrical circuit on the first try, he or she will be redirected to view the help video clip.

Figure. 7

In figure 6 & 7 you can see that the learner is required to check his or her work after finishing the learning games because he or she will be scored on his or her answers; this motivates the learner to do his or her very best. The learner will then receive feedback on how

close he or she is to the correct answer and (as stated above) after viewing the help video, the learner is then given additional attempts to ascertain the correct answers for the learning games.

Motivation of the learner is an extensive topic that is difficult to capture because learners are unique individuals, and for this reason learners are unique in their motivation. Alessi & Trollip speak to a number of different motivators: challenge, control, fantasy, etc. (Alessi & Trollip, 2001). However, there are some universal motivators utilized by learning games, such as the following: grades, scores, badges and leader boards that most learners find motivating. Like any learning material, motivation is an important aspect to engage the learner in active learning and learning games are no exception. One of the ways in which motivation is addressed within this e-learning program is through the use of grades and scores. Each learner is scored on his or her ability to ascertain the correct answers to the learning games and assessment questions. A learner can improve his or her score by re-answering the learning game questions correctly only after he or she are redirected to view the help videos.

Lastly, as seen in figure 8, learners are required to show that they can transfer their new knowledge of electricity to answer the questions in a multiple choice assessment quiz. The quiz is a measure of the effectiveness of the practical knowledge the learner is acquiring about electricity through active learning and transferred to some basic textual questions. The quiz questions will be drawn from a question bank and assigned at random to keep the assessment content fresh, even if the learner reviews this e-learning program multiple times.

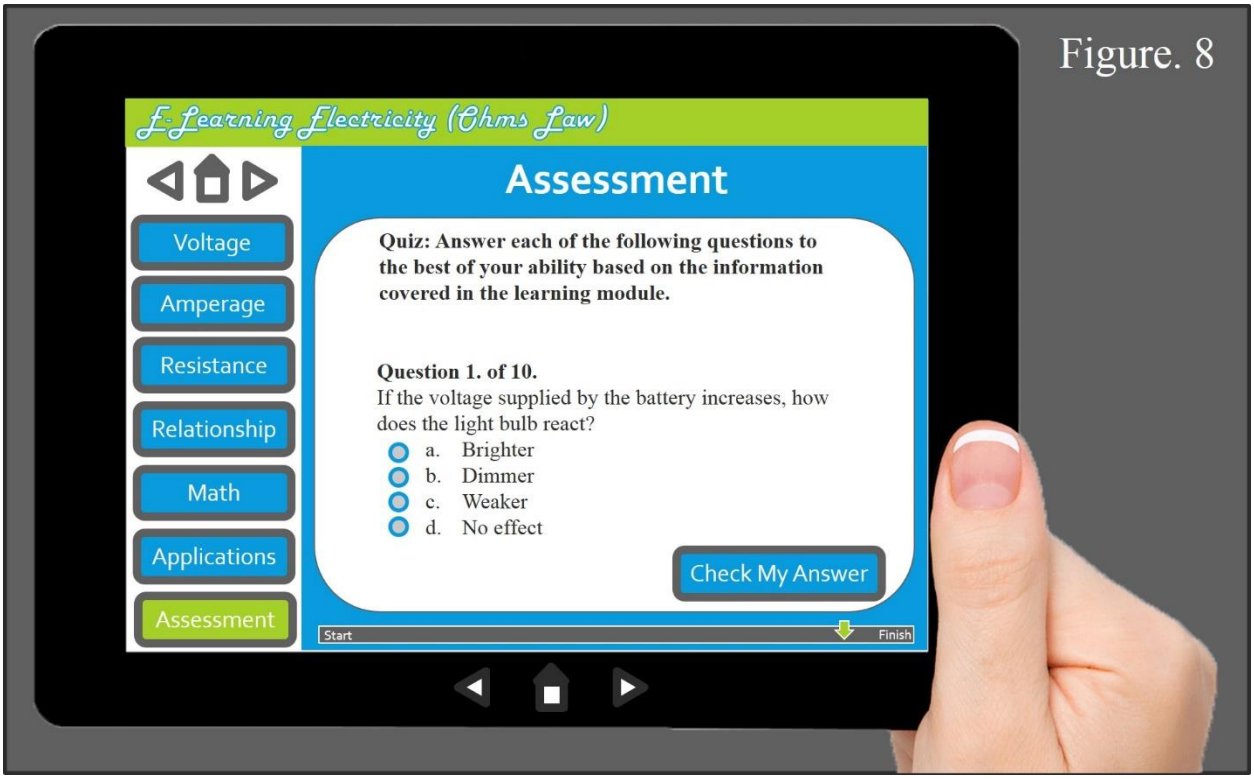

E-Learning Electricity (Ohms Law)
Assessment
Voltage
Amperage
Resistance
Relationship
Math
Applications
Assessment
Quiz: Answer each of the following questions to the best of your ability based on the information covered in the learning module.
Question 1. of 10.
If the voltage supplied by the battery increases, how does the light bulb react?
a. Brighter
b. Dimmer
c. Weaker
d. No effect
Check My Answer
Start
Finish

Figure. 8

Project Implementation

This e-learning program, E-Learning Electricity, is currently in the proposal stage of development. The next stage would require the software to be developed and coded to become a functional prototype. After the prototype has been created, it would need to be assessed in a trial study where learners would be given access to use the prototype, after which the learners would be given a survey to give feedback on their experience with the prototype of the e-learning program. Adjustments would then be made to the e-learning program, taking into account the feedback given by the learners during the trial study. This process would continue until the developers and designers deem the e-learning program fit for use.

The next step in the implementation process is the assimilation of this e-learning program into existing curricula. It is my intention to implement this new e-learning program as an integral element of my curriculum at SUNY Morrisville. This e-learning program would be a strong asset to the basic automotive electrical class that I teach and would fill the gap between classroom and lab learning.

The final step of the implementation process for this e-learning program is to consider the scalability. This is only the commencement of the application of this kind of e-learning program. By expanding the scale of this e-learning program it can be applied as a platform for learning other subjects. This will allow the same principles and advantages of active learning and mastery of learning to be applied to other topics and in other areas of study.

Implementation of this proposed e-learning program will not be without its potential obstacles. An example of a potential obstacle is the software development and the creation of a functional prototype. I do not personally possess the skills and abilities needed to code and create at this level of programing and web development. As such, my vision for this proposed e-

learning program will need to be conveyed clearly to a design firm who would undertake the tasks of coding and creating the prototype of the program. Within the transfer of vision, there is the possibility of a breakdown in communication which could be an obstacle. Additionally, the design firm will without doubt take some liberties as they design and create the functional prototype. A second potential obstacle is the learners' perception and use of this proposed e-learning program. The learners need to perceive this proposed e-learning program as helpful and beneficial to them as part of the learning process. If the learners perceive this proposed e-learning program as too easy or simple they will likely consider it a waste of time. On the other extreme, if the learners perceive this proposed e-learning program as too challenging, they will likely give up and not complete the program. Both of these negative perceptions are real potentials if the proposed e-learning program is not carefully designed and created with the learner in mind. A third potential obstacle to the creation of this proposed e-learning program is not related to the implementation, but instead the sustainability of the program. As technology progresses forward and new developments are made often older technology is left behind and becomes nonfunctional. An important element of the implementation plan for this proposed e-learning program would be to work with the design firm to create a sustainability plan. This would consist of forecasting the future needs to keep this proposed e-learning program relevant and functional even as technology changes in the future.

Discussion

As stated above this proposed e-learning program, E-Learning Electricity, is designed to engage the learner in such a way as to motivate him or her to active learning and subject mastery. This is to partly address the misunderstanding that learning is a passive action by the learner or that the learner will be able to learn and master content without conscious effort and hard work. However, an additional misconception is that repetition is all that is needed for the learner to succeed in learning and content mastery. The authors of *Make It Stick* say that "people commonly believe that if you expose yourself to something enough times you can burn it into memory. Not so" (Brown, McDaniel, & Roediger, 2014, pg. 9). Repetition is not adequate to reach a mastery level of subject content knowledge. Effective learning requires the learner to be motivated. When the learner is motivated the learner is then engaged in the learning process. If the learner is engaged, he or she will be actively learning and as a result, he or she is one step closer to achieving a mastery level of subject content knowledge.

A second consideration to discuss is how this proposed e-learning program applies to the principles of quality information design. When designing information for learner use, the design must be learner centered. This learner-centered design is vital to capturing and retaining the learners' attention. However, the unfortunate nature of the traditional classroom design of lecture and textbooks does not capture the attention of most of today's learners. E-learning programs (such as the one proposed in this thesis) utilizing principles of simulation and gamification are more effective designs that capture and retain the attention of the learner. Hamzeh, Theokaris, Rouhana & Abbas state that this is distinctly different from the traditional classroom where the learners' are reduced to "neutral agents receiving information from the lecturer and recording it in their own notes without a cognitive assessment of the information in their minds" (Hamzeh,

Theokaris, Rouhana, Abbas, 2017, pg. 3). By applying the principles of simulation and gamification to this proposed e-learning program, the information within will be packaged and presented utilizing quality information design.

The third and final point of discussion is how this thesis project is applied to learning theory. Piaget's theory of Constructivism states that people construct their knowledge of the world around them as a progressive process that is compounded and built-up over time. The content within this proposed e-learning program follows this principle. This proposed e-learning program starts with the most basic knowledge of electricity and builds from there. This requires the learner to make mental connections from one topic to the next and builds the learners knowledge like building blocks stacked one on top of the other. Jerome Bruner's theory of Discovery Learning is also applied within this proposed e-learning program and can be summarized as not spoon feeding the learner, but instead developing the learner's problem-solving skills through actively engaging the learner in the learning process (Bates, 2016). The principles of Discovery Learning can be seen through the learning games built into the proposed e-learning program. As the learner makes both successes and mistakes, he or she discovers the correct answers and his or her knowledge of the subject matter and problem solving skills mature.

Conclusion

Educators continue to seek out new methods to engage and motivate their learners to active learning and subject mastery. The goal of utilizing simulations and gamifications is to motivate learners to actively engage in the learning process and as a result strengthen problem-solving skills and achieve a mastery level of learning. Within this proposed e-learning program, the learners experience active learning throughout the learning material by utilizing elements of simulation and gamification. One example of active learning within this proposed e-learning program is when the learners are given the opportunity to adjust individual elements within the example electrical circuit. As a result of this active learning, the learners' attention is retained and their knowledge is improved by observing the cause and effect relationship between elements. By using real-world examples through simulation and gamification, this proposed e-learning program is designed to span the gap between the theoretical and real-world applications, resulting in a deeper level of learning and leading learners toward subject mastery.

Subject mastery is achieved when the learners reach their greatest potential as it relates to subject knowledge. This requires the educator to arrange the content into a meaningful order and provides the learners the means to actively engage with the content for as much time as is necessary to reach their level of mastery (Bates 2016). One of the ways in which learners can achieve subject mastery is by being allowed to experiment with the variables in the example electrical circuit. By changing the relationship between the variables, learners can directly see the effects on the light bulb in the example electrical circuit, resulting in deeper comprehension and drawing closer to subject mastery. This gives the learners the real world understanding as to why some light bulbs are brighter than others. This experimentation allows learners to discover

the cause and effect relationship between the individual elements of electricity. Thus taking the learners theoretical knowledge and applying it to the real world.

Additionally, learners are asked to take the information they have learned throughout this proposed e-learning program and apply it to a relationship learning game in which the problems have multiple variables. This will require the transfer of knowledge from that which they already know to something they have not seen before or experienced. After completing the relationship learning game, learners are given the option to check their work and as a result they are motivated to do their very best. The learners will then receive feedback on how close they are to the correct answer and if necessary, learners are then given additional attempts to gain the correct answers after viewing the help video clips. By requiring learners to apply their new knowledge to this kind of learning game, it shows that the learners have constructed their knowledge to a level of applying their knowledge to the abstract.

Lastly, throughout my research and writing of this thesis project I have come to the following realizations: first, the need is real for learners to be actively engaged in learning. Over my years of teaching I can only imagine how many of my students have been disengaged in the learning process as I would lecture in front of the class with little thought of whether or not my students were engaged in the class content. As a result of my work creating this thesis, I have resolved to keep active learning as one of my primary considerations when preparing lessons or teaching. Second, the learners' problem solving skills are born out of the need to solve problems by discovering the solutions. This sounds simplistic and obvious; however, it is my intention to foster the improvement of my students' problem-solving skills by giving them problems to solve and not just teaching them solutions. Third, all instruction should be given with the intent to help learners reach a mastery level of subject content knowledge. As a teacher, it is important to

neither overestimate nor underestimate the capabilities of my students. As the result of my work on this thesis, I am compelled to no longer feel obligated and fill the time with my students by lecturing continually to justify our lecture and lab hours. Instead, I intend to create the means for every one of my students to reach his or her level of mastery. One of the ways I intend to accomplish this is by integrating learning resources, such as this proposed e-learning program into the classroom and laboratory. This will actively engage and lead each of my students to having adequate time to reach his or her level of subject mastery.

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