EXPLORING NEW TRAINING APPLICATIONS FOR EDUCATORS TEACHING STUDENTS WITH AUTISM SPECTRUM DISORDER

A Thesis

by

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ABSTRACT

The purpose of this study is to explore the potential benefits of simulation training technology as a supplemental tool for educators teaching students with autism spectrum disorder. Special educators have little to no access to simulations preparing them for a classroom environment prior to entering an actual classroom. Current methods for preparing special educators are mostly limited to traditional classroom and lecture material, followed by supervised student teaching. Simulation training is available in several industries, but is still predominantly lacking in the field of education. This author constructed two versions of a virtual simulation training module using visuals and text live action videos. The training modules were designed with branching pathways to allow users' decisions to affect outcomes. This study compared pre-service teacher performances using traditional training material followed by a supplemental text-based simulation.

The author recruited 28 graduate students to participate in this study. Participants completed three assessments, one prior to exposure to any subject-specific material, followed by traditional, text-based material and a second assessment. Participants were then introduced to a subject-specific, interactive, virtual text-based simulation training, followed by a final assessment. Assessments were graded on a 100-point scale. Overall, assessments revealed an average increase in performance scores of 8.93 points after exposure to traditional lecture material, and increased again by another 9.69 points on average after exposure to the simulation training. The lowest quartile showed little to no improvement in performance. However, most participants showed marked improvement in performance scores. Further research is needed to determine the statistical significance of these outcomes.

DEDICATION

This thesis is dedicated to the children and workers at Central Baptist Church who inspired me to pursue this research.

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NOMENCLATURE

AR	Augmented Reality
ASD	Autism Spectrum Disorder
DRA	Differential Reinforcement of Alternative Behavior
DRI	Differential Reinforcement of Incompatible Behavior
DRP	Differential Reinforcement Procedure
HCD	Human-Centered Design
VR	Virtual Reality

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1. INTRODUCTION

Simulation training is an educational method which utilizes procedures in environments designed to resemble real-world settings and situations. Such methods aid users in learning specific physical procedures which a person might actually be required to execute in real-life. Trainers in various fields select this method primarily because of the benefit of gaining experience in a low-risk practice environment (Badiee & Kaufman, 2015; Judge et al., 2013; Sharma, 2015).

While the field of simulation training is tested and proven in many technical, high risk industries, including medicine and the military (McGaghie et al., 2011; Wayne et al., 2008), educators have little to no access to simulations preparing them for a classroom environment prior to entering an actual classroom. This is especially true for those who teach students with disabilities (Dieker et al., 2014; Judge et al., 2013). Of the simulations that currently exist for the purpose of training pre-service teachers, it is important to note that while not all are fully-automated, they nonetheless serve to provide safe environments to practice classroom strategies without the possibility of harming a child (Badiee & Kaufman, 2015; Dieker et al., 2014; Dieker et al., 2016; Judge et al., 2013; Sharma, 2015; Stavroulia et al., 2014; Vince Garland, Vasquez & Pearl, 2012; Vince Garland, Holden & Garland, 2016). This should be especially true for pre-service training of future teachers in the field of special education.

Because more research is needed in this area, the author of this paper utilized a digital, interactive program which simulated a virtual classroom environment. The author created this program in order to answer the question:

Can a virtual training simulation designed to teach special educators of students with Autism Spectrum Disorder (ASD) about differential reinforcement procedures (DRP) positively affect these educators' knowledge and/or confidence concerning DRPs?

In order to focus the efforts of this research, the author's program simulated an environment which an educator teaching students with Autism Spectrum Disorder, or ASD, might encounter. In addition, the program included a training structure oriented toward enhancing the learning experience of future educators of students with ASD, and was designed to be used alongside traditional special educator certification training material. As such, this author's simulation training tool served as the basis of primary research with regard to the usefulness of simulation models for training pre-service teachers of ASD students. Furthermore, as a potential simulation model for training future educators of students with ASD, this model is not intended as a stand-alone educational tool, but instead is designed for use alongside existing traditional lecture-based course material. In short, this researcher's simulation should be part of a blended learning experience.

2. LITERATURE REVIEW

2.1 History of Training Simulation

Aebersold gives a brief review of the history of training simulations starting in the late 1920s. The main purpose of simulations at this time was to allow users to practice flying airplanes using only the cockpit instruments. This addressed an issue with pilots who might fly through inclement weather conditions with low visibility. The next step in simulation development occurred during World War II. “Team training” for aircraft personnel was developed in order to train each individual in a “team”, such as a bomber crew, on their roles with the proper instruments and tools while emphasizing team mission objectives. From this origin came nursing simulation training, which today focuses on honing nursing skills in high-stress situations while focusing on team building as well.

However, not all simulation training efforts have developed at the same pace. Aebersold notes that nursing simulation training remains far behind that of aviation simulation training, despite both developing over a similar time period (2016). Kaufman and Ireland state that the use of simulation training in teacher education is far behind that of medical simulation training (2016). However, because educator training involves interaction with students followed by feedback with mentors, a process which requires repeating multiple times (Ferry et al., 2005), simulation training for educators merits just as much research as the military and medical fields (Dieker et al., 2014).

Aebersold concludes that the environments that tend to benefit from simulation training are those where technical training is emphasized as well as communication in a complex situation. These training simulations focus on teaching information and skill assimilation, then proceed to demonstrate how to use the new information and skills. The information learned from these trainings will then be brought into the real world when the users return to their work environments (2016). Ferry and colleagues state that a large obstacle arises for designers of these simulation trainings because users can easily fall behind in their learning experiences if the training environment does not mimic a real situation (2005). Ferry and colleagues (2005) agree with Herrington and colleagues (2003) that the learning experience from these training simulations needs to be an authentic experience, which necessitates designers focusing on aspects of realism in specific portions of the training, including but not limited to user actions, system guidance, proper assessment methods, and task definitions. Until training simulations are successfully introduced into various fields, individuals must be taught in a traditional classroom environment through a case study or similar method where they develop problem-solving skills through discussion. Ultimately, each field develops training simulations which satisfy the needs of the learners and develop based on the funding and technology available to that field.

In terms of virtual training, Aebersold posits that there are advantages and disadvantages to choosing a virtual training simulation over a physical training simulation (2016). De Jong and Lazonder define a computer simulation as a virtual experience that presents a user with a realistic mimcry of a system, which allows the user to examine outcomes of specific changes in the system (2014). As computer simulation models provide more effective realistic experiences, they may become more useful as a form of education simulation training. Nonetheless, virtual training, currently requires more funds and production at the beginning of development than more traditional physical simulations. However, an advantage of virtual simulation training is that it does not necessitate a dedicated location for the training, nor does it need to be used as a stand-alone method. If designed properly, Aebersold states, virtual simulation trainings can give users many benefits also found in physical simulation trainings (2016).

Virtual simulation trainings can be divided into several categories: virtual reality (VR), augmented reality (AR), and interactive video or text-based simulations. The research for this paper focuses on the latter category. VR, according to LaViola and colleagues, exists as a combination of 3D visuals and inputs which allow the viewer to feel as if they are inside a virtual environment created by those visuals and inputs. VR allows users to feel more immersed in their environment and heighten the realism of the experience because of the real time computing and spatial mapping involved in the creation process (LaViola, Krujiff, McMahan, Bownman & Poupyrev, 2017). AR, on the other hand, involves overlaying virtual objects onto a real-world, 3D view, according to Azuma. The AR experience allows viewers to interact with the virtual objects in the augmented space in real time, allowing them to feel that the virtual objects exist in real space by manipulating them in a viewport (1997). Interactive video has no 3D mapping involved and exists as normal video, with the exception that at key points during the viewing process, a viewer can make a selection or a decision and alter the video's ending or continuation, or cause additional information to display (Interactive Video, n.d.). Similarly, text-based simulations, while having no video, allow the user to alter the story given to them in the simulation and still see the outcome of their decision in a chronological manner. The two latter methods are less intensive to produce and, as a result, are less expensive to develop, which makes them a more feasible option for the creation of virtual simulation trainings in fields which have not developed in the same manner as military or medical simulation trainings.

Another aspect of simulation training involves what van Merrienboer and Kester call simulation fidelity. Simulations are categorized as either low-, moderate- or high- fidelity simulation models. Van Merrienboer and Kester give an example of low-fidelity as online text formatted like a case study. They then define moderate-fidelity simulations as involving authentic digital characters that interact with the user, reserving physical environments for high-fidelity simulations. Because of their method in defining the difference between low-, moderate-, and high-fidelity simulations, any virtual simulation cannot be high-fidelity unless it is executed with VR. Van Merrienboer and Kester suggest that users should begin their learning experience in a lower-fidelity environment, especially if they have very little knowledge of the target information. Once the users have a greater mastery level of the target information, they can then proceed to a higher-fidelity environment, which introduces more details, not all of which are meant to be addressed for the target task. The users must filter out unnecessary information in these higher-fidelity environments, which increases the difficulty level and realism level of the task (2014).

2.2 Multimedia Learning

While traditionally, multimedia originally referred to text alongside illustrations, the term has now been expanded to include a variety of types of content, including videos and other interactive methods (Butcher, 2014). Mayer posits that learning through multimedia increases in efficiency when designers focus on how the users will best process information rather than simply focusing on creating a multimedia experience which will function properly. He also states that designers should strive to lead users through a balanced multimedia experience, taking care not to present the users with too much information in either the visual or auditory channel (2014). Butcher agrees with Mayer, that when designers present users with both auditory and visual methods of introducing information, the users can increase their ability to recall information (2014), which aligns with Norman's design theory as well (2013). Butcher (2014) and Norman (2013) concur that the capacity of working memory has a limit, which reduces the amount of information that users can process. However, if the information is split between the visual and auditory channels, the users can process the channels separately and then assimilate the gathered information, as long as the amount of information does not overload the channels, also known as the split-attention principle (Ayres & Sweller, 2014).

Ayres and Sweller define the split-attention principle as a situation in which users are confronted with a multimedia piece that forces them to focus simultaneously on information coming from more than one source at a given point in time. They contend that this can be avoided by designers and researchers deliberately aligning the various sources of information by utilizing either space or time, or both. Correcting this issue can lead to more cognitive resources, according to Ayres and Sweller (2014). In a similar vein, Low and Sweller explain the modality principle as the issue that arises when users are asked to process and assimilate new information but are overloaded with the lack of space in their working memory (2014), which correlates with Mayer and Pilegard's modality principle focusing on auditory learning instead of solely visual learning (2014). However, Kalyuga and Sweller (2014) and Norman (2013) caution that when using multiple channels, designers and researchers must be cautious to not present the same information over and over. Kalyuga and Sweller contend that this leads to the redundancy principle, which hinders users in their grasp of essential information. It overloads and weighs down a user's working memory with unnecessary information if the user has already mastered that concept. To combat this potential pitfall, Kalyuga and Sweller (2014) agree with Norman (2013) and suggest eliminating redundant pieces of information so that users do not have to focus on multiple sources of information, which assists designers and researchers in avoiding difficulties with Ayres' and Sweller's split-attention principle (2014).

A potential aid to avoiding the previous three pitfalls in multimedia learning is the utilization of van Gog's signaling principle: users tend to have deeper comprehension of information in a multimedia learning experience when designers and researchers integrate signals to guide the users through the more relevant portions of the information. This method streamlines the experience and allows users' working memory to focus on the essential pieces of information (2014). This principle works alongside Mayer and Pilegard's segmenting principle. Designers can streamline and guide users through the experience by only displaying or introducing specific concepts to users in manageable portions instead of one continuous portion. Having smaller portions to review and explore allows users to assimilate new information properly the first time and not have to split their attention between multiple concepts, which could lead to misunderstandings and incorrect assimilation. This concept is consistent with Mayer and Pilegard's pre-training principle, which states that prior knowledge of basic components of a multimedia experience allows users to assimilate more complex ideas inside of a main program (2014).

This guiding method aids de Jong and Lazonder's theory on scientific discovery learning, which they contend is a more motivating and efficient method for users than traditional methods. Unfortunately, the main weakness of this principle is that designers must ensure that their users will be guided appropriately in order to learn the information correctly from a multimedia experience. Designers achieve this, de Jong and Lazonder contend, through reducing the complexity of the information presented to users at the beginning of their learning process. Once the users begin to master the information, the complexity can be increased over time. However, they suggest that designers should still use traditional methods of instruction when users do not have the experience or mastery necessary of fundamental information. Once the users have accessed the fundamental information through traditional methods, the discovery learning method can begin.

De Jong and Lazonder suggest several methods of decreasing the complexity of the discovery learning method in the design of a multimedia experience. They suggest using a performance dashboard to inform the users of their mastery over the information, which allows the users to then understand what they will be required to understand before achieving ideal mastery of the subject. However, the dashboard is only ideal for users who are able to expand on the information that they encounter through the multimedia experience (2014). Johnson and Priest posit that both informative and reviewing feedback aid users who may not understand the information as fully as designers may require. Users with little experience learn best through explanations of whether and why they understood or executed a piece of information correctly or incorrectly. This reduces the amount of working memory users must devote to this process (2014). Likewise, designers can use de Jong's and Lazonder's prompting methods to encourage users to complete an action which they may not realize they should complete at a given point. Then, designers can use heuristics to encourage further exploration of an action through specifically explaining how and when to complete an action. Finally, designers can use scaffolds to outline the method the users should take through a process, which reduces the working memory load required of a user during a complicated or new action (2014).

Butcher also cautions designers and researchers about over-relying on the multimedia principle, which involves the usage of text and images instead of solely using text, thereby improving the learning process. Butcher argues that elaborate visuals with richness of details can potentially detract from the learning process. However, she concludes that richer visuals have their merit, stating that while designers should use abstract images primarily for memorization purposes, detailed illustrations and more moderately-populated visuals have value and could lead to a more well-rounded learning experience (2014). In a similar fashion, Lajoie warns designers to choose the interaction inside of multimedia experiences wisely, since interaction can either speed up an individual's learning process or overload their working memory to the point that they miss the learning objectives entirely (2014), a principle which Norman cautions against as well (2013).

2.3 Current Training Methods for Special Educators

Educators understand that they need proficiency in specific areas in order to aid their students in the classroom or clinic environments where they work (Brown, 2017), which has led to the development of special education programs at institutions of higher learning which offer specialized courses on various subjects, such as interacting with a multicultural student body (Lehman, 2017). One such subject is differential reinforcement procedures (DRPs), which acts as a form of behavior reduction and can be used in a classroom or clinical environment. Cooper, Heron, and Heward describe Differential Reinforcement as a strategy used to diminish unwanted behaviors, which has become common practice due to its success rate (Cooper, Heron & Heward, 2007). Educators use DRPs with students with ASD because it has been shown to increase or decrease target behaviors such as hand-raising or self-injurious behavior without the use of punishment procedures or negative reinforcement (Cooper, Heron & Heward, 2007; Gongola & Daddario, 2010; LeGray et al., 2013; Thomas, Lafasakis & Sturmey, 2010). DRPs also allow educators to avoid accidentally reinforcing an undesired behavior, if carried out properly (Cooper, Heron & Heward, 2007; Pipkin, Vollman & Sloman, 2010).

However, simply discussing principles of special education including DRPs in a university or college classroom setting is not enough, argue Morrier and colleagues. They emphasize the importance of pre-service special educators experiencing a classroom environment with ASD students in order to understand what scenarios they may face once they begin their careers. Didactic training, they caution, may aid educators in basic understanding of principles, but it cannot take the place of experience with regards to students with ASD (2011).

The practicum and student teaching have grown from this need. Dieker et al. describe the practicum as an experience meant to allow pre-service educators to increase their knowledge and confidence in an environment with more experienced mentors and a safe setup for students of all kinds (2014). Prater and Sileo discovered through their 2004 survey effort of 115 special educator training programs at colleges or universities in the United States that pre-service special educators in practicum were generally supervised by a licensed educator mentor who would have "at least 3 years of teaching experience" and about six additional mentees to manage (p. 251). When pre-service special educators do obtain a practicum placement, they tend to feel that they improve from the experience, which Scott, Gentry, and Phillips show is mirrored in their expertise and knowledge upon successful completion of the practicum (2014). Additionally, Simonsen, Myers, and DeLuca discovered that educators exhibited new classroom management skills from receiving a combination of training on classroom and behavioral management techniques paired with feedback from mentors on their actions in an educational setting involving students (2010).

However, not every pre-service special educator can obtain a practicum placement easily. Dieker and colleagues posit that this is due to an inadequacy of willing and qualified mentors as well as an increased demand for practicum placement with a limited supply of practicum opportunities, especially for those pre-service educators outside of metropolitan areas (2014). Billingsley and Scheuermann point out that an issue with supply and demand limits the practicum, initially created to help educators gain experience in the classroom or clinic. Certain educators in training require more specialized environments than others, and at times very few practicum experiences are given to pre-service special educators, who need more experience than the average general educator. Special educators of students with ASD, for instance, tend to require specific information about the various behaviors and procedures generally seen in classrooms. The immensity of the spectrum itself requires a much longer period of time for training, Billingsley and Scheuermann posit, due to the low probability that pre-service special educators will encounter and understand each of these issues and solutions in a short time frame (2014).

This phenomenon is not new: even in the late 90s, special educators in rural areas acknowledged the need for the aid of educator training technology due to a shortage in trainers and other staff (Ludlow & Brannan, 1999). In fact, rural areas are some of the hardest hit by the practicum supply-demand issues, especially since special educators in rural areas are now being held to a rigorous set of standards to ensure quality education for their students, which necessitates more access to additional training for pre- and in-service educators in these rural areas (Courtade et al., 2010). Shortages of educators for special education along with the increased training requirements for educators have led to alternative training methods, few of which have been driven by research efforts, which has led to a diversity of methods, not all of which have worked together to provide insight as to the best method of training (Dai et al., 2007). In Morrier and colleagues' research on training methods for educators of ASD, the majority of respondents' trainings were at workshops no greater than one day in length, trainings involving direct contact with ASD students, or "self-taught methods," not the practicum or student teaching (2011, p. 125). This is potentially due to a different weakness of the practicum:

the inability of teacher educators to take the richness of the practicum experience and translate this resource into an experience which can serve a larger audience of pre-service educators (Ferry et al., 2005).

Dieker et al. contend that teacher educators need to consider integrating methods of augmenting the practicum experience with methods which will allow more pre-service educators to properly train without damaging the learning and behavior development of at-risk students, such as those with ASD. The important issue, they state, is to allow pre-service educators and in-service educators who require additional training to have access to an experience or environment which satisfies the requirements stated previously as well as enhancing these educators' confidence (2014).

Vince Garland and colleagues acknowledge that educators must prepare for any number of types of students and techniques, which can improve based on a variety of educator training methods. However, many educators lack the confidence and knowledge needed, which, Vince Garland and colleagues contend, signals for a reform of current pre-service educator training through research efforts. They suggest a greater integration of coaching methods into the practicum due to its ability to give immediate support and allow the educators to improve their skills more quickly and effectively (2016). Carroll et al. conclude in their study that further research is needed for pre-service special educator training due to the participating educators' lack of confidence when confronted with a situation about which they have little or no knowledge (2003).

Virtual tools can enhance a pre-service special educator's training because of their ability to expose educators to a variety of environments and experiences, which an individual can repeat and revisit as often as they require without the risk of interfering with a student's learning experience or behavioral development (Billingsley & Scheuermann, 2014). O'Brien and colleagues found that approaching special educator training through multimedia and interactivity allows the educators already familiar with such technology to more naturally absorb the information needed than through traditional methods. The virtual approach can also assist in training of special educators in rural areas where face-to-face methods may be less accessible (2011). Using a different method, Rock and colleagues created a remote instruction technology involving an online webcam and a wireless Bluetooth setup which was quantitatively beneficial for in-training educators to receive feedback on actions as they occur. Immediate feedback was shown to improve the students' educational experience (2009). Additionally, Parker and colleagues' research approached the pre-service educator training issue from a blended learning standpoint. The results from their study, both quantitative and qualitative, indicated an overall "positive learning environment" (2007, p. 50).

2.4 Blended Learning

The medical field has a history of well-established training simulations that speak to the matter of blended learning. Two articles from medical journals (McGaghie et al., 2011; Wayne et al., 2008) both reach similar conclusions on the matter of simulation training. Both Wayne and colleagues and McGaghie and colleagues agree that simulation training of education for the medical field is more efficient in achieving specific training objectives than traditional clinical-based education, especially when used in conjunction with traditional methods, which is referred to as blended learning. While clinical education exposes students to real-life situations, preparing them ahead of time through simulation exercises can avoid costly mistakes and perilous situations when students move to the clinic or hospital.

Research from higher education affirms this perspective. Mothibi (2015) agrees that e-learning (learning using technology) within higher education can enhance the more traditional methods of lectures and assessment, which she analyzes through her own meta-analysis. Her results are consistent with the research of Al-Qahtani and Higgins (2013), whose study comparing traditional learning, e-learning, and blended learning supports the idea of e-learning as part of a blended process, where, as in medical simulations, part of the process is electronic and part is in a classroom situation. This blended process is already integrated in a certain sense into classrooms for children with ASD, and has been studied by Hayes and colleagues (2010), who concluded that interactive visual supports that prompt the children to achieve certain tasks are more efficient than traditional methods. They add that the supports not only apply to children with ASD but also would be just as effective in regular educational settings. Each of the authors, in the end, concludes that traditional methods are currently being, and should continue being replaced by more interactive methods of learning, especially since these approaches lead to a better understanding of the subject and more familiarity with recurring situations.

2.5 Educational Interactive Design

However, researchers discovered particular issues that many educators face when integrating traditional learning with e-learning. Whitton (2012) agrees with the findings of Stavroulia and colleagues (2014) when she notes that not every user of an educational simulation easily learns how to use the controls and understand the process behind the learning experience. Stavroulia and colleagues concur that the interface and setup of a simulation can be daunting for potential trainees to understand and master. This situation, according to design theory expert Norman (2013), is partially the fault of the methods used in the design of a product. He explains that designers prioritize certain disciplines in the production process and may choose these focuses with the end goal of learning in mind but only cursorily consider the theory and methods of how the users might arrive at that goal. Norman's solution for Whitton (2012) and Stavroulia and colleagues (2014) suggests a focus on human-centered design which structures the product around the human needs as if they were almost non-negotiable. This approach requires clear communication between the user and the product, detailing optional actions at any point in time when problems arise. In fact, Norman proposes that designers should construct the products around the problems the users will face rather than the hypothetical correct use of the product (2013), or in the case of this researcher's work, simulations for pre- and in-service teachers.

2.6 Current Simulation Technology for Educators

Billingsley and Scheuermann undertook an analysis of various studies of virtual technology for training educators and found that most of the virtual tool assessments for educator training allowed the users to significantly further their knowledge of specific procedures, disabilities, or concepts, or they increased the educators' confidence level regarding the disabilities which were the subject of the training tools. This could be due to the fact that simulation technology allows users to repeat their learning experiences as many times as they need or desire and experiment with the methodologies they use in a safe environment, supervised by experts (Billingsley & Scheuermann, 2014; Dieker et al., 2014; Ferry et al., 2005). Billingsley and Scheuermann also discovered that role-playing setups for the virtual technologies in their study enhanced the knowledge base of educator participants in case studies, although the largest advantage for participants came from having previous experience interacting with real students in a physical classroom environment. Ultimately, simulation technology cannot take the place of real teaching experiences, but it should be used to enhance the traditional teaching methods in order to produce educators who feel, and are, better prepared to interact with students. However, the newer technology methods for education training have not been made widely available, especially those involving newer tools, such as virtual, augmented, or mixed reality. As useful as these tools may be, research and development of educator training tools necessitates production of training simulations in a more accessible medium for teacher education (Billingsley & Scheuermann, 2014).

Dieker and colleagues posit that educational virtual environments are the next step in researching improvements for educator training, due to their ability to improve the educators' classroom skills in preparation for interactions with students. However, Dieker and colleagues state that simulated learning environments must allow users to fully immerse themselves in the scenarios presented to them and act as if the situations they work through are actually occurring (2014), even if the realism of the simulation is not high-fidelity (van Merrienboer & Kester, 2014). On the other hand, the educators who use these tools can only improve themselves using the simulation training method if they truly want to increase their knowledge, since virtual simulation trainings require users to consider why and how they arrived at certain results (Dieker et al., 2014).

One of the challenges of educator training is moving inexperienced educators from understanding after a situation what they should have done to understanding in the moment what they should do. This can only be achieved by multiple experiences of the same scenario, which does not happen often in everyday teaching experiences. However, simulation trainings offer educators the opportunity to do just that (Dieker et al., 2014; Ferry et al., 2005). Badiee and Kaufman contend that educator practicums may be augmented by the addition of classroom training simulations. This would result in educators experiencing high-risk situations before they actually occur in their practicum or education careers, which eliminates the risk of an inexperienced educator sabotaging a student's education because of a lack of experience with a particular situation. Additionally, educator training simulations could reduce the costs associated with individuals requiring supplementary practicum time (Badiee & Kaufman, 2015; Kaufman & Ireland, 2016).

Dieker and colleagues state that while learning environments for educators have been created in simulation trainings, these experiences are harder for educators to obtain due to their rarity, when compared with the alternatives of e-learning and traditional methods. One of the main reasons for this scarcity of simulated learning environments is the importance of immediate feedback in educator training, which for most learning experiences requires an expert or mentor to devote a specific amount of their time and effort to observing and interacting with the educators in training. From this position, an obvious solution would be to begin developing simulation trainings for educators which provide automatic feedback, but other issues arise when this method is selected (2014).

The issues involving feedback design correlates with Norman's theory of execution and evaluation (2013). He states that in every design there are two gaps in the knowledge of how the design functions regarding execution and evaluation. Norman posits that feedback is one of two major design elements that helps bridge the evaluation gap and relate to the user whether the expectations and intentions of the product were actually achieved. While Judge and colleagues' feedback method (2013) satisfies the requirements for bridging Norman's evaluation gap (2013), they state that further research in automated feedback is needed for assessing whether the pre-service teachers improve as they progress through the simulation. This research would lead to more customized learning experiences for each future educator that could eliminate the need for multiple reviews of simulator performance. Koenig and colleagues researched an internal simulator assessment function for firefighters on a naval ship to specifically identify the relationships between actions as well as the probabilities of various consequences based on each action or set of actions (2010). The goal of this research was to develop a method that would customize the user experience based on previous decisions in the simulation, considering order of operations, environmental conditions, and many other variables that would affect how the situation progressed in the real world. Their conclusions match that of Judge and colleagues (2013) when they state that successfully implementing a framework for multi-variable evaluation is a daunting task and that their method needs to be further refined. In both sets of research, proper feedback requires expert opinions on the user's performance regardless of discipline, which matches the conclusions drawn in the medical field as well (Judge et al., 2013; Koenig, Lee, Iseli & Wainess, 2010; McGaghie et al., 2011; Wayne et al., 2008).

Another potential issue with automatic feedback is the believability of the visuals and audio provided to the educators using these interactive trainings. If what the trainees see and hear does not match or closely resemble a real-world experience, then they may be broken out of their immersion and not fully absorb the necessary information (Dieker et al., 2014; van Merrienboer & Kester, 2014). However, if the automated feedback method works alongside training for particular procedures or skills, such as DRPs, Dieker and colleagues (2014) agree with Gibson and Knezek (2011), who suggest that this may be a better method for e-learning simulation trainings to aid educators. The visuals and audio do not need to be hyper-realistic for the educators using the simulation training to immerse themselves in the experience or to obtain the knowledge needed if that knowledge is a small portion of a larger skill set, such as DRPs (Dieker et al., 2014; Vince Garland, Holden & Garland, 2016).

Fully immersive simulation trainings have been developed in two examples: simSchool and TLE TeachLivE^{TM}. SimSchool is an online, educational gaming experience which focuses on specific aspects of teacher training (Badiee & Kaufman, 2015; Dieker et al., 2014), while TLE TeachLivE is a mixed-reality experience which focuses instead on classroom management of specific scenarios educators might encounter (Dieker et al., 2014; Dieker et al., 2015). In this case, mixed-reality is defined as a situation in which a virtual display is aligned with a physical environment, and the objects in the physical environment mimic a continuation of the virtual display into the real world. TLE TeachLivE^{TM} provided users with an opportunity to practice discrete trial-training (DTT) with virtual students, all of whom were modeled to mimic behaviors found in students with ASD, as well as other principles (Dieker et al., 2014; Dieker et al., 2015; Vince-Garland et al., 2012). In a later study, TLE TeachLivE^{TM} provided educators with a scenario to practice a specific preference assessment (Vince Garland, Holden & Garland, 2016), which aligns with Dieker and colleagues' assessment of limited simulation training scopes which focus on one particular skill (2014). Both of these assessments of TLE TeachLivE resulted in increased knowledge of the specific skills targeted by the simulation training sessions, and educators who participated in the research involving simSchool indicated they felt more confident and knowledgeable after their experience (Badiee & Kaufman, 2015; Deale, 2014; Dieker et al., 2014; Dieker et al., 2015; Vince Garland, Vasquez & Pearl 2012; Vince Garland, Holden & Garland, 2016).

Dieker and colleagues posit that an increase of simulation training options for educators can result in a similar increase for educator capability and confidence in their education roles once they enter their field. As the cost and effort associated with designing and producing simulation trainings decrease, educator simulation trainings become more and more feasible for integration into teacher training programs. The importance of well-trained educators is obvious: properly prepared educators can enter the field and create a more efficient and supportive learning environment for their students while avoiding sabotaging a student's education or behavioral development (Badiee & Kaufman, 2015; Dieker et al., 2014). Additionally, educator training simulations could reduce the costs associated with individuals requiring supplemental practicum time (Badiee & Kaufman, 2015; Kaufman & Ireland, 2016).

The existing technology for pre-service teacher simulations, while currently limited compared to military or medical training simulations (Aebersold, 2016), has been studied and reviewed (Badiee & Kaufman, 2015; Deale, 2014; Dieker et al., 2014; Dieker et al., 2015; Vince Garland, Vasquez & Pearl, 2012; Vince Garland, Holden & Garland, 2016). Despite issues such as user confusion and limited availability, Stavroulia and colleagues (2014), Deale (2014), Judge and colleagues (2013), Zibit and Gibson (2005), Badiee and Kaufman (2015), Dieker and colleages (2014), and Sharma (2015) all agree that the highlight of this type of simulation is the ability of the future educators to test problem-solving skills in a classroom environment without endangering real children. They each concur that virtual students interacting with the educator will never replace training in the actual environment, and the research of Al-Qahtani and Higgins (2013), Hayes and colleagues (2010), and Wayne and colleagues (2008) support the idea of keeping traditional education methods alongside new electronic learning methods. This concept allows the users of the proposed technology to have a reference that they understand while they immerse themselves in the simulation. If there is too much of a disconnect between real world activities and the simulation, such as Rayner and Fluck's reasoning for further research into aesthetics (2014), pre-service teachers who use this product will take longer to adjust their way of approaching the learning environment. Whitton posits that this learning curve interferes with the users' ability to understand and absorb the intended learning goals, which increases the simulation's cost-effectiveness (2012).

Considering budgeting as a factor, Whitton (2012) expands her explanation of when simulations and interactive educational experiences should be implemented to match Norman's position on the competitive nature of product development (2013). Norman contests that companies favor speed and price instead of quality in terms of design and production, which creates a difficult environment for improving a product continually based on user feedback. If the designs were never human-centered in their development, making new progressive iterations after finding problems between the users and the interface is almost impossible. In his revised and expanded appeal to designers and engineers to create well-designed products, Norman states that the solution to users' frustration with products is his concept of human-centered design (HCD), which, instead of focusing on the end result as the method for constructing a product, discovers the target users' abilities and desires in order to create an effective and useful experience. He emphasizes that designers must study problem areas of products primarily, then discover why the design of the product may have caused issues. But, Norman warns, HCD is a way of life, not simply a solution for discovered problems. Designers must constantly study and understand their predicted users and what they need from the product, which the users themselves may not be able to explain completely. Without this understanding of users, designers will continue to find themselves creating products that users repeatedly fail to use properly because the products were never initially designed for them. To create a product that achieves what its creators originally planned, the design of said product should be continually tested to make certain that the users are acquiring the intended knowledge, experience, and end results. For instance, one of Norman's seven design principles, feedback, requires that users be constantly able to discover whether their actions are actually doing what they expect. Norman states that electronic devices are particularly susceptible to issues with faulty or delayed feedback. He gives an example of touching or pressing on a device and how, if the device does not signify that the user input was received, users can conclude that the device never understood their intentions. This can lead to a user clicking or pushing or touching the device repeatedly out of frustration, even though all of the user's inputs are actually recorded by the product. The result of this increased user input can add to their frustration, which no designer wants. Eventually, a user can fall into what Norman describes as learned helplessness, and the user gives up on a task with the product because they erroneously decide that the fault is with them, not the product itself. Once a user stops using the product, the design has failed, unless the purpose of the design is to explicitly force the user to stop using it (2013).

With this in mind, Whitton proposes in her research (2012) that simulation and educational interactive experiences should not be used in all portions of education but instead should be carefully inserted into educational curricula where the technology is most effective. Whitton says that currently, educational gaming is too focused on content rather than teaching methods, making them less human-centered in terms of design (Norman, 2013). Until teacher educators formulate new positions and outlooks on the learning process, simulation training technology should be doled out sparingly, and only placed in curricula where the product will effectively and efficiently add to the students' learning experience (Whitton, 2012).

2.7 Conclusion

While simulations exist currently to educate future teachers concerning classroom environments, their focuses are not completely aimed at special education, even if they cater to important issues of disabilities in the learning environment (Rayner & Fluck, 2014). In addition, these simulations are not widely available or integrated into general higher education even though each piece of research previously mentioned indicates that the results of specialized training is beneficial to pre-service teachers. In order to create a successful training simulation for pre-service teachers with a focus on classrooms involving students with ASD, the researcher needs to integrate a model of blended learning, human-centered design considerations, reasonable mimicry of real-world aesthetics, limited curriculum coverage, and minimal relevant feedback from the program alongside traditional observation. Omission of any of these aspects would detract from the learning experience and possibly hamper the users' ability to effectively use the product (Judge et al., 2013). Designing and producing a simulation training requires a heavy emphasis on Norman's theories of successful human-centered design, with special focus on the evaluation gap, memory retention, and error-based design (Norman, 2013). However, the researcher hopes that the result of this research will enhance and create a learning experience that, in agreement with Rayner's and Fluck's conclusion, will benefit both the pre-service teachers and their future students (2014).

3. RESEARCH METHODS

3.1 Intervention Design

It seems clear that more research into the efficacy of simulation training for educators is needed, especially for those teaching students with ASD. In Texas, as in other states, special educators may receive training and certification toward an ABA certification. Currently, such training only utilizes traditional, non-interactive content methods alongside classroom or clinical fieldwork. Even if a university includes a simulation training as an optional exercise, no interactive virtual simulation training is currently available in Texas for the purposes of special education certification ("Becoming a Classroom Teacher in Texas", 2007; "TLE TeachLivE™ Partners", 2018). Therefore, this author proposed to assess whether or not simulation training could be beneficial as a supplemental resource in the training of special educators of students with ASD.

For research purposes, this author designed and created a virtual, interactive multimedia learning experience. This tool was designed to assess whether pre- or in-service educators of students with ASD might benefit from supplemental simulation training rather than solely using traditional methods. Content for the learning experience focused on applied behavior analysis. The Behavior Analyst Certification Board (BACB) is the premier applied behavior analysis certification authority and this project included content experts who assisted in aiding the author's understanding of this board. Thus, the author designed the simulation to focus on content required for novice educators to become Registered Behavior Technicians**™** (RBT®). Content required for this credential includes these seven categories: (a) behavior reduction, (b) measurement, (c) assessment, (d) skill acquisition, (e) professional conduct and scope of practice, (f) ethics, and (g) documentation and reporting (Behavior Analyst Certification Board, 2018). This simulation covers differential reinforcement procedures (DRPs), one strategy in the Behavior Reduction category. Because DRPs are divided into six types which can be difficult to differentiate, these procedures were selected to easily identify improvement over time. The author hypothesized that this simulation would positively affect the users' test scores on the knowledge of DRPs and give them greater confidence concerning the subject.

The first step in designing the simulation training tool required determining the simulation’s level of fidelity. Van Merrienboer and Kester suggest researchers should focus on increasing the level of aesthetic realism in educator simulation training (2014). With this in mind, the author considered both 3D animated and live-action videos for the proposed simulation training. The author chose to use live-action videos instead of 3D animation with virtual avatars, primarily because educator trainers are less likely to possess 3D animation skills to produce potential training simulations. However, live-action videos require less technical skill and are more familiar to most educators’ training experiences. It should be noted that the author created both a text-based simulation and a video-based simulation, but data was only gathered from the low-to-moderate level of fidelity text-based simulation training due to issues with recruitment.

The author created scripts mimicking real life situations requiring DRPs. She consulted experienced special educators who related stories of actual situations with ASD students, allowing the author to provide more realism in the training videos. The next step was to develop flowcharts to envision how the training might progress with particular behaviors and DRPs. This method condensed the user decision-making cycle to three basic principles: event, disruption, and decision. Differential reinforcement procedures attempt to address undesired behaviors in a classroom environment (Cooper et. al., 2007). The author noticed a pattern in the stories related by her clinical consultants. Each instance in which DRPs were required involved an event and a disruption, followed by a decision to resolve the behavioral difficulty. The author chose to create simulations which followed these patterns. The flowchart found in Figure 1 visually depicts this cycle.

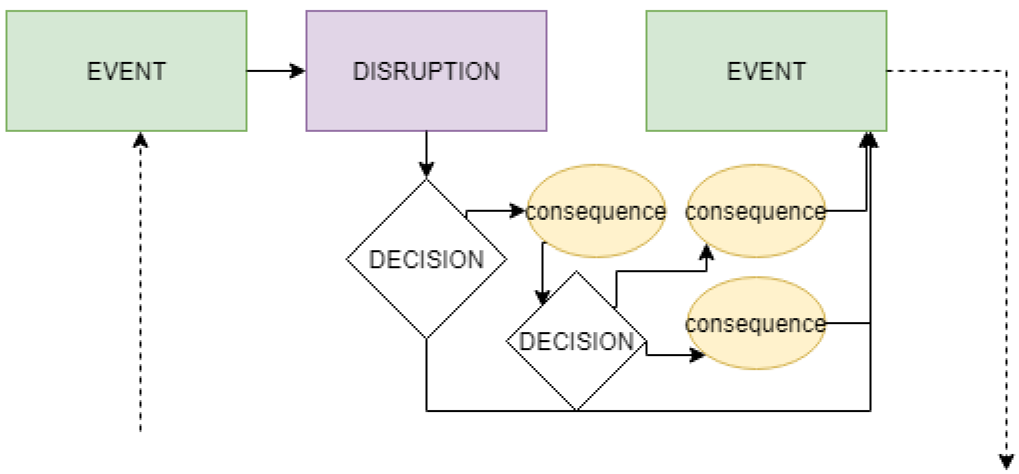

Figure 1: Cycle of Event-Disruption-Decision

In order to mimic the event-disruption-decision pattern, the author created a timeline for each "day" in the training so that educators could understand how far they had progressed and how many more opportunities they might have to implement the DRP before the target student went home. This was mainly to ensure that educators would not hesitate at the prospect of a 1:1 ratio of real minutes to virtual minutes. Showing a simplified timeline allows the users to understand that the ratio of real to virtual minutes is significantly less than 1:1. The users can also anticipate what issues may surface with different classroom activities. For example, a user who sees that an independent work period for the students is approaching may anticipate that the focus student will probably be asking for help more often than simply disrupting class in order to obtain attention. Using the timeline in this manner mimics how an educator in a classroom environment would review their lesson plan with the target student in mind and plan accordingly. See Figure 2 below for an example of the user timeline.

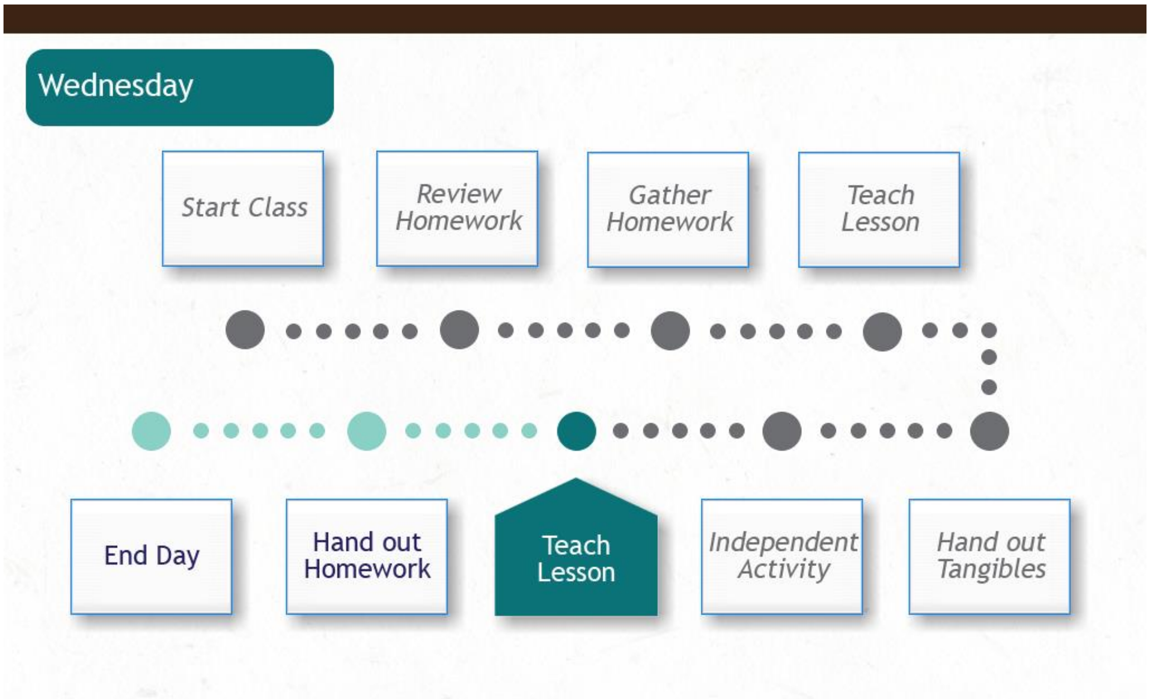

Figure 2: The User Timeline

The author designed the simulation to include multiple events in each day's user timeline. For instance, during the Monday timeline the user would be informed that after beginning the class, the user would be taking up homework, beginning a lesson, and so on. Essentially, events would correspond to elements in a lesson plan. Users would then choose whether to anticipate the target student's behavior in those events. Disruptions would not be displayed in the timeline. This mirrors a typical classroom scenario where the educator intuits based on past experiences of a student's reaction to certain antecedents. Each event in the training would contain one to five disruptions, after which the educator would make a decision. This decision would affect either the target student's immediate behavior, long-term behavior, or a combination of the two. The cycle (event, disruption, decision) continues throughout the entire training. Once the flowcharts were created, the author further refined the scripts to reflect the cyclical nature of the flowcharts' repetition of certain disruptions and events, such as a student asking for the educator's assistance during an independent work period. This allowed the author to reuse situations and videos multiple times inside the simulation training.

The flowcharts also aided the author in discovering how to alter the video timeline according to a user's decisions. She included checkpoints in the design logic, which would change the target student's behavior according to whether the user was correctly executing the requested DRP. For instance, if the target student had earned three or more tokens on Monday, more of their disruptions on Tuesday would include the desired behavior. This would then give the user more chances to execute the requested DRP, which would increase the desired behavior from the target student on Wednesday. The design mimics a real example of educator-student interaction from the correct execution of a DRP: as a student receives the desired reinforcer, they will repeat the behavior that allowed them to obtain this reinforcement (Cooper, Heron & Heward, 2007).

The initial concept for the video-based simulation training was a more cinematic experience in which the user would view different situations from an observer's perspective, then respond. This changed to a first person perspective in the visuals for both versions of the training so that the user would feel less like an observer and more like a participant, which aligns with Dieker and colleagues' (2014) and van Merrienboer and Kester's (2014) findings of the importance of mimicking a real-world experience. Additionally, the other educator training simulations which are prevalent for classroom management include first person perspective in their designs (Badiee & Kaufman, 2015; Dieker et al., 2014; Dieker et al., 2015; Vince Garland, Vasquez & Pearl, 2012; Vince Garland, Holden & Garland, 2016). Adding an extra variable which could muddle the interpretation of results was not desired. To simplify the final interpretation of the data and compare it to existing simulation trainings for educators, the author continued with conventional design in the visual perspective for both simulation training versions.

The author included a review portion at the beginning of the training so that users can remind themselves of the DRP definitions. She considers this aspect important because the users are asked to execute a specific type of DRP for the given prompt. If the users take a larger break than expected between the lecture material and the training, the information loss may be greater than desired. Therefore, the author added a small definition review in order to reinforce the concept and allow the users to make the right decisions in the training. Executing the incorrect DRP based on faulty knowledge could confuse the users as they progress through the training, causing them to lose confidence, mistake one DRP for another, or quit in frustration. However, it should be noted that the review makes this information optional, because users can skip the review screen if they choose to do so.

The author created a tutorial after the DRP review to familiarize the users with the mechanics of the navigation and decision making in the training. This tutorial briefly introduces the timeline, the question/answer layouts, and the summary screens. At the end of the tutorial, users have the option to repeat the tutorial or continue to the main training.

For each storyline in the tutorial and the main training, the program presents the users with a text-only case study introduction, with similar wording to how it might be presented in a classroom experience. The case study introduction includes the target student, the undesired behavior(s), and hints for the user to predict how to successfully reinforce the target student. It also tells the user what time of day they will be working with the target student, which in a real educational setting would be essential for educators. As an example, edible reinforcers lose effectiveness if the student has just eaten, and other reinforcers may only be appealing to a student at a certain time of day. Educators build successful reinforcement strategies around details such as this. Finally, the storyline introduction explicitly states which DRP the user is to execute. If the DRP is a Differential Reinforcement of Alternative Behavior (DRA) or Differential Reinforcement of Incompatible Behavior (DRI), the desired behavior is stated as well.

For each event and disruption in the main training storyline, the user views a visual in the first-person perspective, from the point of view of the educator. The visual establishes the context of each event, with the target student interrupting or disrupting the class. The program then overlays a small text-blurb explaining the situation and a menu over the visual and asks the user a question about the current situation. The questions always ask what the user will do in regards to the disruption or the target student, which allows them to execute a DRP. There are no more than two questions for each disruption. Once the user answers the questions by clicking on their desired reaction, the training continues with another visual or a switch to the timeline screen, where the user can see that the next event will be a different part of the lesson plan. At the end of each "day" inside the training simulation, the visual switches to a summary screen, which informs the users of their progress in the training. The information displayed on this screen includes which DRPs the users enacted, how many times they enacted each DRP, how many times the user successfully prompted the target student, how many times the student performed the desired behavior, and how many tokens the student earned for performing the desired behavior. The token count is influenced by the first question of each “day”, which allows the user to decide whether they want to give the target student a token sheet. In the simulation training, the target student cannot earn tokens if they do not have a token sheet. Educators use token sheets widely in reinforcement techniques with students with ASD because these sheets train the students to anticipate a reinforcer at the end of a period of time in exchange for performing a desired behavior a certain number of times. There are a wide range of potential techniques that educators can use with tokens. This allows them to tailor reinforcements for each student without having to distract the student from the task (Kazdin & Bootsin, 1972).

Finally, once the user has reviewed the summary screen, they are asked to choose whether they want to continue in the training or repeat a “day.” If they choose to go back and repeat a “day,” they lose all progress attained during that “day.” To clarify, the target student’s behavior will reset for the “day(s)” that the user chooses to repeat. For example, if the user has completed the second “day” of the training, repeating that “day” will erase their progress for that second “day.” However, they will not lose their progress from the first “day” unless they choose to repeat that “day” as well. Once the user has completed each “day” in the training (three in total), a final summary screen displays their progress from each “day.” This allows the users to see the connection between executing DRPs and the increase (or lack thereof) in desired behavior. At this point, the user can choose to repeat one or more parts of the training or exit the simulation completely, which will erase all of the user’s progress. Feedback from users in this research indicates that they would prefer for the program to remember their progress on previous days. Implementing this will require a save/load feature and potentially a user identity setup.

Prior to constructing the first prototype, the author created wireframe sketches to guide the filming process and the program's aesthetic development. Because this intervention was inserted into an online continuing education program with Texas A&M University, the author followed accessibility standards for aesthetics according to the Web Content Accessibility Guidelines (WCAG) regulations from the World Wide Web Consortium (Web Accessibility Initiative, 2016). These guidelines aid individuals with visual, auditory, and physical impairments in their navigation of online resources. Knowing this, the author made sure that the contrast between text and backgrounds maintained a sufficient contrast ratio. The author chose to use a limited color palette for the simulation training, which included white, brown, blue, green, yellow, and red. However, no red-on-green or green-on-red color combinations were used to avoid inhibiting individuals with colorblindness. The author also did not solely use color to prompt or instruct the participants. Using drop shadows and rollover animations for interactive items as well as occasional underlining of text allowed the author to ensure that the users knew which objects were interactive. The author also contained text inside of shapes in the simulation training, which fulfilled the WCAG regulations for using "spacing to group related content."

The author then constructed a prototype simulation training without videos. After the creation of this basic prototype, the author recruited actors and actresses for the filming process. Participants included special education teachers from a local elementary school and their ASD students. Also involved were several typically-developing age-appropriate elementary students. Unfortunately, the author's plan for filming the scripts did not account for the limitations of ASD students as actors and actresses. As a result, the author abandoned this approach and recruited actors and actresses, both parents and students, from a local acting club. All but one were typically-developing students. One student involved in the filming had been diagnosed with ASD.

Using the pre-designed scripts based upon the wireframe sketches and prototype program, the author directed and filmed forty-eight brief episodes corresponding to the three-fold patterns of event, disruption, and decision, as mentioned above. Based upon the filming, the author completed a simulation training prototype which included screenshots from the videos only, accompanied by textual descriptions. An example of a screenshot used in the first prototype can be found in Figure 3 below. This prototype was then used in an initial testing session. See experimental design section below. The final simulation prototype included videos. However, due to insufficient participation, the assessment of this prototype was not completed.

Figure 3: Example of a Screenshot in the First Prototype

3.2: Experimental Design

In order to explore whether simulation training might beneficially supplement traditional training methods for pre- or in-service educators of students with ASD, the author designed a double pre-test, single post-test experiment. Because the users were not hand-picked or recruited for this experiment, the researcher could not assign a control group or additional experimental groups, which limited the potential conclusions for this research. However, this was combated by conducting two pre-tests to show how the other factors in the training contribute to the user's ability to complete the testing. The intended purpose of using a double pre-test before the intervention according to Cook, Campbell, and Shadish was to reduce the possibility of a bad interpretation of the data expressing a cause-effect relationship, or even a conclusion of a stronger relationship than was actually the case (2002). Each participant completed a pre-test before they accessed the lecture material which consisted of randomized questions pulled from a moderately large question bank, designed to test their basic knowledge of the different types of DRPs as well as best practices for executing these procedures. Once they completed the pre-test, the users accessed the lecture material and proceeded to read through the information provided. They then took another pre-test created from the questions from the same question bank in a random order immediately before the intervention.

The participants then proceeded through the text-based simulation training program described previously. They had the opportunity to repeat this simulation as many times as they chose before a final post-test and questionnaire. The post-test consisted of randomly ordered questions drawn from the same question bank as the pre-tests, and the questionnaire recorded the users' gender, age range, ethnicity, role in education (in-service teacher, paraprofessional, administrator, pre-service teacher, or other), residence area (rural, suburban, or metropolitan), and level of education. It also provided questions using a Likert-scale measurement to assess whether users felt they improved by using the simulation as well as ease-of-use, and realism. An open-ended question at the end of the survey allowed the user to make suggestions for improving the intervention.

3.3 Data Analysis Methods

Data analysis involved comparing the data from the two pre-tests and one post-test. The author analyzed each participant's personal scores according to percent increased or decreased from one assessment to the next, called $\Delta 1$ and $\Delta 2$, and also calculated the overall change in scores, called Δ. Means and standard deviations were calculated for all Δ, $\Delta 1$, and $\Delta 2$ data.

The author also examined the quantitative data gathered from the 19 participants who completed the questionnaire. This data included the participants scoring 9 statements according to how much they agreed or disagreed with the statements. The author collated this information to determine whether the simulation training succeeded in its construction and whether the users felt they gained experience and confidence in the use of DRPs. Finally, the author determined whether the data was statistically significant concerning test score changes from one to the next using a t-test and drew a conclusion for the research question: whether the simulation will improve their test scores and confidence or not.

4. RESULTS

4.1: Participants

Participants included 28 Master's degree-seeking students from the Special Education program in the College of Education at Texas A&M University who were either pre- or in-service educators to participate in this experiment. Professors at Texas A&M University were approached in order to recruit their students to test the effectiveness of the training program material. The author drew from this larger population to obtain participants who would test the simulation training.

Of these participants, only 19 completed the questionnaire (see Appendix B) in addition to all three assessments. Of the 19 who completed the questionnaire, 17 identified as white, one identified as Native American, and one identified as Asian/Pacific Islander. 13 of the participants were teachers while 6 responded as "other". All of the participants had previously obtained a Bachelor's degree. 15 participants reported as female, two reported as male, and two reported as unspecified. 4 of the 19 respondents reported to live in an urban area, 9 in a suburban area, and 6 in a rural area. In terms of age ranges, 4 selected the 18-24 year age range, 10 selected the 25-34 year age range, 2 selected the 35-44 year age range, and 3 selected the 45-54 year age range. This data is reflected in Table A-1.

While the author's participant population was limited to 28 individuals, this number is not unprecedented in other studies for educational simulation trainings. Many studies obtained participants from entire cohorts of university students or they spanned more than one year, which allowed the researchers to gather participant populations of up to 186 individuals (Gregory and Masters., 2012; Kervin et al., 2006; McPherson et al., 2011; Randell et al., 2007). However, other user studies obtained four to eight individuals for the purposes of exploring a product's usefulness (Keskitalo, 2011; Mason et al., 2013; Muir et al., 2013; Vince Garland, Vasquez & Pearl, 2012; Vince Garland, Holden & Garland, 2016). Even though smaller population sizes limit the researchers' ability to generalize completely, they explore the potential for the tested training programs and can inform and shape future research.

Because this experiment is a pilot study, the author anticipated that she might obtain a smaller population size. Even though she attempted to gather participants from both the graduate and undergraduate Special Education programs at Texas A&M, response rates from the undergraduate program were fewer than expected, leading to a smaller population size overall. The lack of response in the undergraduate program could potentially be due to the recruitment time being at the end of a semester. Recruitment from the master's program, however, was in the middle of a summer course, which gave potential participants more time to complete the material while not having as many other courses require their time and energy.

4.2: Data

Participants' scores after the first pre-test averaged 50.00 points out of a possible 100 points. After being introduced to traditional lecture material on the subject, participants' scores increased 8.93 points ($\Delta 1$), or an average increase in performance of 17.86%. After experiencing the author's text-based training simulation, participants' scores increased an additional 9.69 points ($\Delta 2$), or a 16.45% increase in material mastery. Overall change between pre-test 1 and the post-test (Δ) averaged as an increase of 18.62 points. These results seem to indicate that test scores are likely to increase when the participants are exposed to traditional educational material, and that students further benefit from supplemental simulation training. This information is reflected in the box and whisker plot in Figure 4. This chart depicts the point spreads for all 28 participants in the three assessments. The middle two quartiles are depicted as blue boxes while the top and bottom quartiles are displayed with error bars. Means are signified by a yellow circle. The top 75% of each set of assessments as well as the means for each testing session is shown to increase each time. The bottom 25% of test scores is evidenced to vary more, with two outliers in the bottom 25% of the assessment before the training simulation exposure. However, even with the outliers, the average remains consistent.

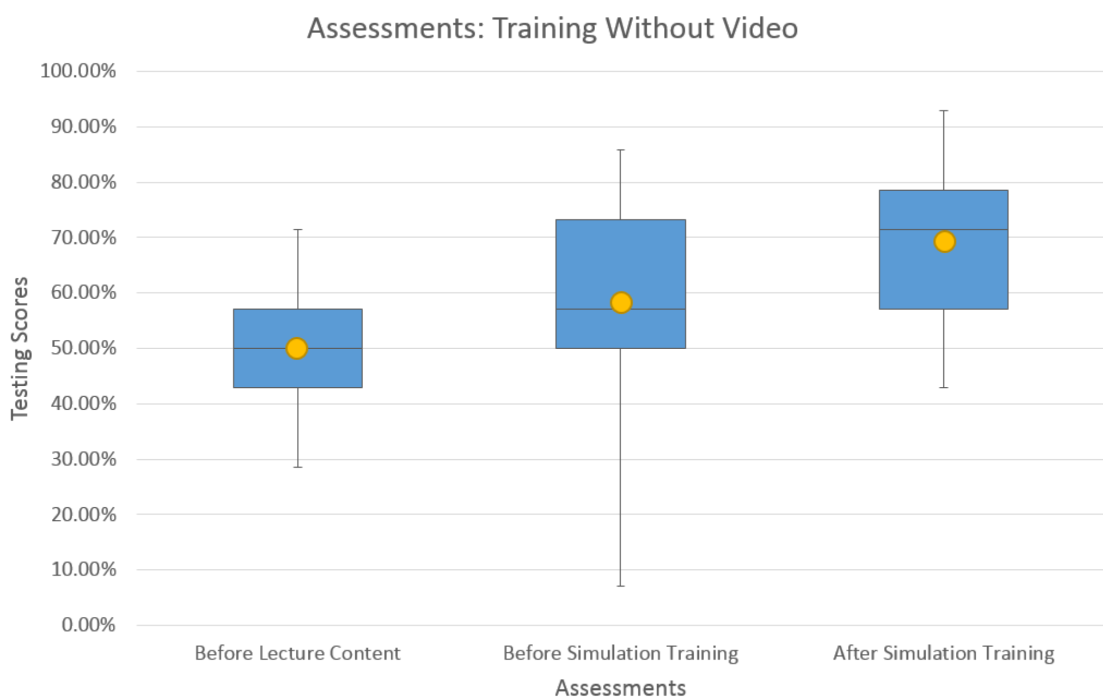

Figure 4: A box and whisker plot displaying assessment point spreads for each testing session

Due to a small experimental population, t-tests were conducted with regard to participant pre-test 1, pre-test 2, and post-test values. A two-tailed, paired t-test was performed on experimental population assessment scores to determine whether there was any statistical significance between pre-test 1 and the post-test, pre-test 1 and pre-test 2 as well as pre-test 2 and the post-test. The t-test for the difference between pre-test 1 and the post-test resulted in a p-value of 7.16E-12, corresponding to a statistically significant data set. The t-test for the pre-test 1 and pre-test 2 difference as well as the difference between pre-test 2 and the post-test resulted in p-values of 9.931E-05 and 5.83E-06, respectively. These also indicate statistically significant differences.

Due to homogeneity in the population, analysis of the assessment tools is not possible with gender, ethnicity, role in education, and education level. However, two categories may reveal some interesting trends: age range and residence area. The data spreads for these categories can be seen in Appendix A. When the results are categorized by age range, participants' score increase or decrease was shown to vary between categories. The participants in the 18-24 year age range increased their test scores between pre-tests 1 and 2 by 3.57 points on average out of 100 points, corresponding to a 7.4% increase in score. However, between pre-test 2 and the post-test this age range's scores increased by an average of 16.07 points, or a 31.0% additional increase. In the 25-34 year age range, which included 10 out of 19 participants, the test scores between the pre-tests increased an average of 13.57 points, or a 26.8% increase in material mastery. This was followed by a smaller increase between pre-test 2 and the post-test of 3.57 points on average, or a 5.6% increase after being exposed to supplemental simulation training. The two individuals in the 35-44 year age range contributed to the outliers in the second pre-test, which resulted in a decrease of 10.71 points, or a change of -20% in content mastery. Because of the unusually low scores for the second pre-test, the $\Delta 2$ value average for this section was a 28.57 point increase, corresponding to a 66.7% mastery increase. Because of the small population size for this category as well as the nature of the pre-test 2 scores, this data is not statistically significant. Finally, the participants in the 45-55 year age range had an average △1 of 11.9 points, or a 29.4% increase, as well as a △2 of 7.14, a 13.6% increase. This data is reflected in Table 1.

Table 1: Data Categorized by Age Range

Age Range	**Pre-Test 1**	**Pre-Test 2**	**Post-Test**	**△1**	**△2**
18-24	48.21	51.79	67.86	3.57	16.07
25-34	50.71	64.29	67.86	13.57	3.57
35-44	53.57	42.86	71.43	-10.71	28.57
45-54	40.48	52.38	59.52	11.9	7.14

When the results are categorized by residence area, the variation in participants' test scores showed an overall increase between assessments, but those increases varied by residence area. In the rural participants' test scores, their average difference between pre-tests was 13.1 points, or a 25.6% increase in content mastery. Their testing scores after exposure to the simulation training resulted in an additional increase of 7.14 points, an 11.1% increase. However, the 9 suburban participants showed an increase in △1 of 7.14 average points, a 15.5% increase, while their △2 rose to 9.52 points, or a 17.9% increase. Finally, the urban participants only had a 5.36 point increase between their pre-tests, a 10.3% mastery increase, contrasting with their 12.5 point increase after experiencing the simulation training, corresponding to a 21.9% increase. Similar to the age-related data, there were score improvements in both △1 and △2 for urban, suburban, and rural categories throughout, indicating consistent improvement in both $\Delta 1$ and $\Delta 2$ scores. This information on the testing averages can be found in Table 2.

Table 2: Data Categorized by Residence Area

Residence Area	**Pre-Test 1**	**Pre-Test 2**	**Post-Test**	**$\Delta 1$**	**$\Delta 2$**
Rural	51.19	64.29	71.43	13.10	7.14
Suburban	46.03	53.17	62.70	7.14	9.52
Urban	51.79	57.14	69.64	5.36	12.50

4.3: Participant Feedback

At the conclusion of the study, the author provided an opportunity for subjective feedback from participants. The questionnaire contained three sections: demographic information, guided feedback, and additional open-ended feedback. The guided feedback section included nine statements with five possible responses: strongly agree, agree, neutral, disagree, and strongly disagree. The list of nine statements and the table of results may be found in Table A-3. The nine statements covered three general categories: realism, perceived knowledge of DRPs, and mechanics. None of the participants strongly disagreed with any of the statements. Roughly 10% of participants disagreed with three statements, one in each category. Those statements were: “I felt like I was in a real classroom situation,” “I understand DRPs better than I did before the training,” and, “The training was easy to use.” One participant disagreed with the statement, “The tutorial was helpful for operating the training.” It should be noted that none of the participants disagreed with more than two statements.

With the exception of one statement, “I understand DRPs better than I did before the training,” a majority of participants agreed with each statement. Fifteen of the participants selected “agree” for the statement, “The tutorial was clear in its instructions,” which had the highest number of “agree” selections out of the statements, followed by “The tutorial was helpful for operating the training,” which received 14 “agree” selections out of 19. This is reflected in the rating count for these two mechanics statements, which received the most positive responses out of all of the statements in addition to the sentences, “The students were similar to how students would be in actual classrooms,” and “I know how much effort it takes to execute a DRP with a student in a classroom.” However, all statements obtained a positive rating from a majority of the participants. The statement, “I understand DRPs better than I did before the training,” received the least amount of positive ratings, due to 5 of the participants giving it a neutral rating, although it still maintained 12 out of 19 participants’ positive ratings.

Three of the 19 participants who completed the questionnaire offered feedback in the open-ended section. One participant suggested reducing the amount of colors and “cartoonish icons”, but noted that “the game feel is welcoming.” Another participant thought the tutorial was helpful but said that they require more practice to master the six types of DRPs. The third participant’s response declared that they found the differential reinforcement material to be the hardest in the section on behavior reduction inside the larger training program.

4.4: Discussion

Overall, the average testing scores from all 28 participants demonstrated an increase in content mastery over the three testing periods after exposure to both lecture material as well as the simulation training (Δ=18.62 points). It should be noted that the standard deviation for Δ is 17.21 points, which might cast doubt onto the significance of the improvement represented by Δ.

However, six of the 28 participants showed either no change or a decrease in assessment scores, which may account for the sizeable standard deviation. If further studies show these cases to be outliers, then one would expect marked improvement in overall scores with exposure to educational materials. In addition, average participants' scores increased by similar margins after experiencing the simulation training ($\Delta 2 = 9.69$ points) when compared to scores after progressing through the traditional material ($\Delta 1 = 8.93$ points). T-test results of participant scores reveal that simulation training may provide statistically significant improvement in content mastery. The two-tailed, paired t-test of pre-test 1 and post-test values showed greater than a 99.9% confidence that the results of the intervention are statistically significant. Despite the small population size, this indicates that simulation trainings targeting specific principles can aid pre- or in-service educators of students with ASD in their content mastery, even if the training itself does not focus on rote memorization. Further research is needed with larger and more diverse populations in order to verify this claim.

Interesting trends revealed themselves when data was organized according to age range and residence area. Larger standard deviations for pre-test 2 in the 18-24 and the 35-44 year age ranges prevent any conclusions of statistical significance from being drawn, but $\Delta 1$ was revealed to consistently be smaller than $\Delta 2$, indicating greater improvement after experiencing the simulation. However, in the 25-34 and 45-54 year age range, participants' margins of improvement were greater in $\Delta 1$ than in $\Delta 2$, suggesting that these groups of participants benefited more from exposure to the lecture material than to the simulation training. It should be noted that the 25-34 year age range contains 10 of the 19 participants, which may reflect a result correlating closer to reality than other age ranges' scores. Nevertheless, each age range still benefited from repeated exposure to the simulation training. This data is reflected in Figure 5.

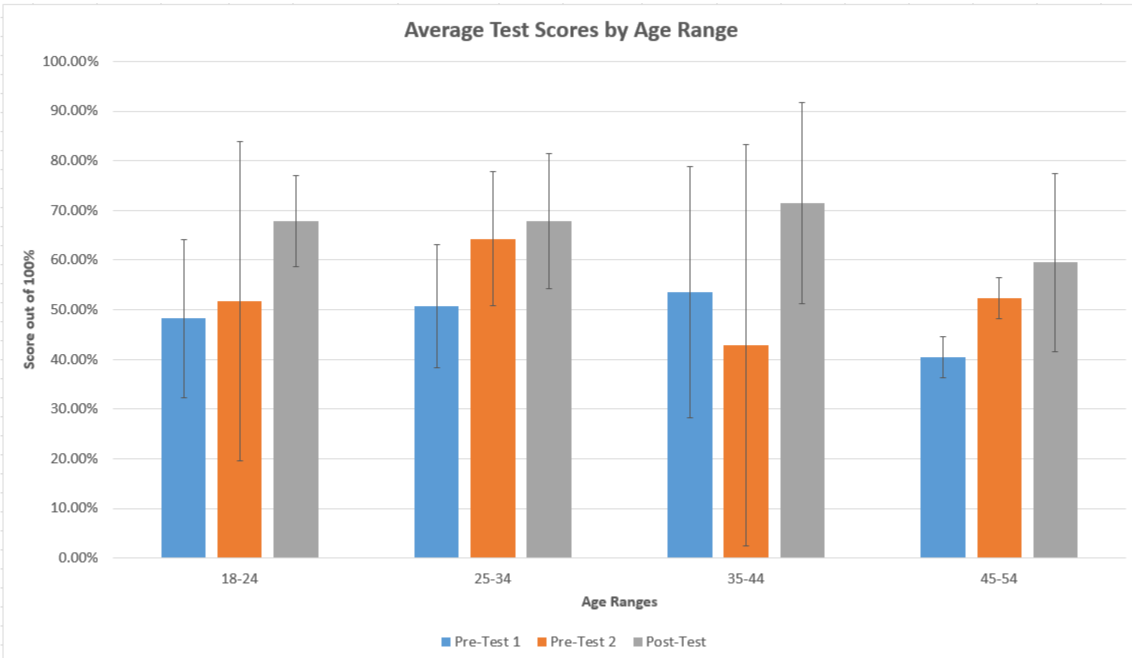

Figure 5: A bar chart displaying test scores according to age range. Error bars indicate standard deviations.

Similarly, when the data is organized according to residence area, the average test scores suggest a positive correlation between exposure to the simulation training and a higher content mastery. This is especially the case in the urban population, which has a higher ∆2 average than their ∆1 average. The ∆1:∆2 ratio switches in the rural category, with a higher ∆1 to ∆2 average. The suburban population appears to have a steady rate of content mastery increase. These correlations are reflected in Figure 6.

Figure 6: A bar chart displaying test scores according to residence area. Error bars indicate standard deviations.

When this information is combined with the participants' responses to the nine subjective statements, the overall indication of content mastery improvement enhances the participants' positive impressions of the simulation training. The author concludes from the data that in addition to the simulation training aiding users in their understanding of DRPs, it can also help users gain experience and confidence in their ability to perform these procedures in a classroom environment.

5. CONCLUSIONS, LIMITATIONS & FUTURE APPLICATIONS

This study did not obtain large populations, which limits any potential conclusions to be drawn from the data gathered. Additionally, the amount of time participants were exposed to both the lecture content as well as the simulation training was not regulated or extended beyond one to two weeks.

Because the population size obtained for this study is not diverse enough for generalization, the author's simulation training versions, both with and without videos, should be tested further with a larger, more diverse population to verify or disprove the findings from this study. Recruitment for any further studies could take place inside of a university setting or from school districts in Texas. Having a greater span of education level as well as current roles in education could reveal which populations would benefit most from simulation training as well as where the budgeting could best be implemented. Once this knowledge has been obtained, simulation trainings dealing with other vital procedures for educators should be tested to discover which subjects best cater to simulation training integration. If special educators can gain knowledge and experience in a variety of content material through a supplemental simulation method, a larger training program might be created and tested, with varying levels of difficulty. This could then offer solutions for augmenting certification programs as well as extending accessibility for these trainings to rural locations.

Additionally, comparisons of levels of fidelity with the same content would be helpful in discovering whether the level of realism aids users' understanding or confidence levels. Knowing how and when to use higher-fidelity training methods could increase special educator training efficiency as well as reduce costs associated with broad training programs with only one or two levels of fidelity. From this point, research should begin in the production of simulation trainings with live action or animated videos. 3D virtual environments could be produced for the purposes of creating procedural, virtual reality simulations. These training environments could provide a greater array of potential decisions for users, which may assist educators in adjusting their methods of integrating specific procedures, such as DRPs, into a real-time classroom or clinical experience. As the intricacy of the decision-making process increases, users will encounter more experiences which closely resemble situations they might address with real students.

In order to successfully produce higher-fidelity simulation trainings, research into automated feedback is vital. Without immediate feedback from live or delayed review by experienced educator trainers, the time gap between action and feedback could hamper the assimilation of new concepts or adjustments required by the educators in training. In the case of the author's research, the simulation training provided participants with low-level feedback at the end of each day as well as adjustments in the target student's behavior according to the strategies used. Further research into more complex automatic feedback is needed if the training is to be advanced and widely disseminated for educator training.

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APPENDIX A

ADDITIONAL TABLES

Table A-1: Demographics of all 19 participants according to the questionnaire.

Participant	**Age Range**	**Ethnicity**	**Role in Education**	**Residence**	**Gender**
1	18-24	White	Teacher	Rural	F
2	45-54	White	Other	Suburban	F
3	25-34	White	Teacher	Rural	F
4	35-44	White	Teacher	Suburban	M
5	25-34	White	Other	Urban	F
6	25-34	White	Teacher	Suburban	F
7	18-24	White	Teacher	Rural	F
8	18-24	White	Teacher	Suburban	F
9	18-24	White	Other	Urban	F
10	35-44	Asian/Pacific Islander	Teacher	Suburban	F
11	45-54	White	Teacher	Rural	F
12	25-34	White	Teacher	Rural	M
13	45-54	White	Other	Suburban	U
14	25-34	White	Teacher	Suburban	F
15	25-34	White	Teacher	Urban	F
16	25-34	White	Teacher	Suburban	U
17	25-34	Native American	Teacher	Urban	F
18	25-34	White	Other	Rural	F
19	25-34	White	Other	Suburban	F

Table A-2: Participants' age range and residence area with testing results, ∆1, and ∆2.

Participants	Age Range	Residence Area	Pre1	Pre2	Post	∆1	∆2
1	18-24	Rural	64	71	64	7	-7
2	45-54	Suburban	36	50	43	14	-7
3	25-34	Rural	43	79	71	36	-7
4	35-44	Suburban	36	14	57	-21	43
5	25-34	Urban	50	57	79	7	21
6	25-34	Suburban	50	64	79	14	14
7	18-24	Rural	43	79	79	36	0
8	18-24	Suburban	29	50	71	21	21
9	18-24	Urban	57	7	57	-50	50
10	35-44	Suburban	71	71	86	0	14
11	45-54	Rural	43	50	57	7	7
12	25-34	Rural	71	50	71	-21	21
13	45-54	Suburban	43	57	79	14	21
14	25-34	Suburban	43	50	43	7	-7
15	25-34	Urban	57	86	71	29	-14
16	25-34	Suburban	36	50	50	14	0
17	25-34	Urban	43	79	71	36	-7
18	25-34	Rural	43	57	86	14	29
19	25-34	Suburban	71	71	57	0	-14

Table A-3: Data from all participants.

Participant	Pre-Test 1	Pre-Test 2	Post-Test	Δ1	Δ2	Δ
1	43	57	79	14	22	36
2	50	29	71	-21	43	21
3	71	71	86	0	14	14
4	36	14	57	-21	43	21
5	50	64	79	14	14	29
6	57	79	93	21	14	36
7	50	57	79	7	21	29
8	43	79	79	36	0	36
9	36	50	43	14	-7	7
10	50	79	64	29	-14	14
11	50	64	86	14	29	43
12	43	57	86	14	29	43
13	50	50	71	0	21	21
14	57	86	71	29	-14	14
15	43	50	57	7	7	14
16	71	50	71	-21	21	0
17	43	50	43	7	-7	0
18	71	71	57	0	-14	-14
19	29	50	71	21	21	43
20	36	64	71	29	7	36
21	57	86	79	29	-7	21
22	57	7	57	-50	50	0
23	36	50	50	14	0	14
24	43	79	71	36	-7	29
25	71	50	43	-21	-7	-29
26	43	79	71	36	-7	29
27	50	57	71	7	14	21

28	64	71	64	7	-7	0

Table A-4: Statements from the questionnaire with participants' responses.

Statements	**Strongly Agree**	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
The training was realistic.	6	10	3	0	0
I felt like I was in a real classroom situation.	5	10	2	2	0
The decision-making process mimicked daily decisions in real classroom situations.	6	10	3	0	0
The students were similar to how students would be in actual classrooms.	5	12	2	0	0
I understand DRPs better than I did before the training.	3	9	5	2	0
I know how much effort it takes to execute a DRP with a student in a classroom.	6	11	2	0	0
The training was easy to use.	4	11	2	2	0
The tutorial was clear in its instructions.	3	15	1	0	0
The tutorial was helpful for operating the training.	3	14	1	1	0

APPENDIX B

QUESTIONNAIRE

Please respond to the statements below with a value of 1 to 5, each value having the meanings of:

1 = Strongly Disagree 2 = Disagree 3 = Neutral 4 = Agree 5 = Strongly Agree

1. I feel that the previous simulation training was realistic. ________
2. The previous simulation training made me feel like I was in a real classroom situation. ________
3. The previous simulation training contained a decision-making process that mimicked decisions made daily in an actual classroom situation. ________
4. I think that the students in the simulation training were similar to how students would be in actual classrooms. _______
5. I feel that I understand differential reinforcement procedures better than I did before the simulation training. _______
6. I feel that I know how much effort it takes to execute a differential reinforcement procedure with a student in a classroom. ________
7. The previous simulation training was easy for me to use. _______
8. The tutorial for the previous simulation training was clear in its instructions. _______
9. The tutorial for the previous simulation training was helpful for operating the training itself. _______

Please provide any additional feedback about the previous simulation training that you feel is relevant:

Please answer the following questions about your demographics:

1. Select the range of ages below that contains your age.
    a. 18-24 years old
    b. 25-34 years old
    c. 35-44 years old
    d. 45-54 years old
    e. 55-64 years old
    f. 65-74 years old
    g. 75 years or older

2. Please specify your ethnicity:
    a. White
    b. Hispanic or Latino
    c. Black or African American
    d. Native American or American Indian
    e. Asian/Pacific Islander
    f. Other
3. Please specify the highest level of education you have completed. If you are currently enrolled, what is the highest degree you have already received?
    a. Some high school, no diploma
    b. High school graduate, diploma, or equivalent (for example: GED)
    c. Some college credit, no degree
    d. Trade/technical/vocational training
    e. Associate degree
    f. Bachelor's degree
    g. Master's degree
    h. Professional degree
    i. Doctorate degree
4. What is your role in the Texas education system?
    a. Paraprofessional
    b. Teacher
    c. School Administrator
    d. University student planning on becoming an educator
    e. Other: ____
5. In what type of area do you reside?
    a. Rural
    b. Suburban
    c. Urban
6. Specify your gender:
    a. Male
    b. Female
    c. Unspecified

APPENDIX C

QUESTION BANK

1. Differential reinforcement uses which two principles of behavior?
    a. Extinction and reinforcement
    b. Reinforcement and punishment
    c. Punishment and extinction
    d. None of the above
2. Why is using differential reinforcement a preferred instructional strategy?
    a. It uses extinction and punishment procedures to reduce challenging behavior
    b. It uses extinction and reinforcement procedures to reduce challenging behaviors
    c. It allows the individual to earn reinforcement for a more appropriate behavior
    d. Both B and C
3. Which differential reinforcement strategy reinforces the omission of behavior after a set time.
    a. Differential Reinforcement of Other Behavior
    b. Differential Reinforcement of Alternative Behavior
    c. Differential Reinforcement of Incompatible Behaviors
    d. Differential Reinforcement of High Rates of Behavior
4. Which differential reinforcement strategy reinforces behaviors that cannot occur at the same time of the challenging behavior?
    a. Differential Reinforcement of Diminishing Rates Behavior
    b. Differential Reinforcement of Alternative Behavior
    c. Differential Reinforcement of Incompatible Behaviors
    d. Differential Reinforcement of Low Rates of Behavior
5. Which differential reinforcement strategy reinforces an appropriate behavior that can also occur at the same time as the challenging behavior?
    a. Differential Reinforcement of Other Behavior
    b. Differential Reinforcement of Alternative Behavior
    c. Differential Reinforcement of Diminishing Rates Behaviors
    d. Differential Reinforcement of High Rates of Behavior
6. Which differential reinforcement strategy reinforces behavior if it occurs a set number of times during an increasing time frame?
    a. Differential Reinforcement of Other Behavior
    b. Differential Reinforcement of Alternative Behavior
    c. Differential Reinforcement of Incompatible Behaviors
    d. Differential Reinforcement of Low Rates of Behavior
7. Which differential reinforcement strategy reinforces behavior if it occurs a fewer number of times during a steady time frame?
    a. Differential Reinforcement of Other Behavior
    b. Differential Reinforcement of Alternative Behavior
    c. Differential Reinforcement of Incompatible Behaviors
    d. Differential Reinforcement of Diminishing Rates of Behavior

8. Alexa does not like to participate during reading class. She will get out of her seat, throw her book, and distract other students to try to get sent out of class. Her teacher decided to implement a differential reinforcement strategy. Identify which strategy her teacher used: Alexa will receive reinforcement for every time interval (increasing by 5 minutes each time she is successful) during which she sits and reads her book with the class.
    a. Differential Reinforcement of Other Behavior
    b. Differential Reinforcement of Alternative Behavior
    c. Differential Reinforcement of Incompatible Behaviors
    d. Differential Reinforcement of Low Rates of Behavior
9. Alexa does not like to participate during reading class. She will get out of her seat, throw her book, and distract other students to try to get sent out of class. Her teacher decided to implement a differential reinforcement strategy. Identify which strategy her teacher used: Her teacher will reinforce her when she is sitting and looking at her book.
    a. Differential Reinforcement of Other Behavior
    b. Differential Reinforcement of Alternative Behavior
    c. Differential Reinforcement of Incompatible Behaviors
    d. Differential Reinforcement of Low Rates of Behavior
10. Alexa does not like to participate during reading class. She will get out of her seat, throw her book, and distract other students to try to get sent out of class. Her teacher decided to implement a differential reinforcement strategy. Identify which strategy her teacher used: Her teacher will reinforce her when she is sitting and reading the book aloud to the class.
    a. Differential Reinforcement of Other Behavior
    b. Differential Reinforcement of Alternative Behavior
    c. Differential Reinforcement of Incompatible Behaviors
    d. Differential Reinforcement of Low Rates of Behavior
11. Alexa does not like to participate during reading class. She will get out of her seat, throw her book, and distract other students to try to get sent out of class. Her teacher decided to implement a differential reinforcement strategy. Identify which strategy her teacher used: Her teacher will reinforce her on a predetermined time schedule for not engaging in the challenging behaviors.
    a. Differential Reinforcement of Other Behavior
    b. Differential Reinforcement of Alternative Behavior
    c. Differential Reinforcement of Incompatible Behaviors
    d. Differential Reinforcement of Low Rates of Behavior
12. Saying acceptable forms of curse words such as darn, drat, fudge instead of curse words is an example of:
    a. DRI, because the words serve the same purpose
    b. DRA, because the words are still bad words to some people
    c. DRI, because the words cannot be said at the same time as the curse words
    d. DRA, because the words are an alternate curse word
13. Keeping hands in your lap to stop a student from pushing is an example of:
    a. DRI, because you have to use your hands to push someone
    b. DRA, because you can still push someone if your hands are in your lap
    c. DRI, having hands in your lap will stop someone from pushing

    d. DRA, because keeping your hands in your lap has nothing to do with pushing

14. When teaching behaviors using differential reinforcement, it is important that: (select all that apply)
    a. The student can demonstrate the replacement skill
    b. Behaviors that need to be replaced are annoying
    c. Appropriate behaviors are reinforced immediately
    d. Reinforcement is always withheld from the challenging behavior