

Master's Thesis

**The Effects of Explore Learning's Math and Science Simulations on Student Engagement  
in a Rural High School**

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## **Abstract**

Students across the nation struggle to build a conceptual understanding of scientific phenomena. The complexity of scientific concepts is difficult for students to understand, and students struggle to visualize the processes that are taught in science. New approaches that incorporate digital simulations can be used to enhance student learning of biological processes. However, more research is needed to understand how digital simulations can be used in the classroom to improve student engagement, and ultimately improve student learning. This qualitative study invited secondary teachers at rural high school who use Explore Learning's digital simulations to teach math and science concepts. The teacher participants completed an online questionnaire which asked them to share their perspectives and opinions of Explore Learning's simulations and how it effects student engagement. Findings suggest that Explore Learning Math and Science Gizmos increases student engagement. Based on these findings, the student researcher suggests that further research be conducted to test the effect Explore Learning's digital simulations on students' engagement when learning in math and science.

# **The Effect of Digital Simulations Using Explore Learning Math and Science Simulations on Student Engagement in a Rural High School**

## **Introduction**

Digital simulations can be used in the classroom to improve student engagement. Students can be provided with meaningful learning opportunities by developing new ways to integrate technology into education. Children today have grown up in a world of advanced technology that is intertwined with their daily lives. We have a generation of learners who are excited and comfortable with using digital tools to collaborate and be creators. The new technologies available to educators allow students to have more control over their own learning, to think analytically and critically, and to work collaboratively. Understanding the impact that digital technology has on our students can help school districts decide which types of tools and programs they should invest in to enhance their students' social, emotional, and academic development. When educators use digital simulations as a tool in their curriculum, they will be able to engage students in the learning process using technology which will prepare them for an increasingly advanced technological future (Lin & Chen, 2017). The digital simulations available in the program Explore Learning Math and Science Gizmos can be used by educators to increase student engagement in the content they are learning.

## **Context**

The action research study will take place in a rural school district in New York. According to the 2020-2021 school report card provided by the New York State Education Department (2015), the demographic of the school district is 63% Caucasian, 32% Hispanic or Latino, 2.0% Asian or Native Hawaiian/ Other Pacific Islander, 2.0% Black or African American, and 1.0% Multiracial. There is basically an equal balance between males and females

at 53% and 47.0% respectively. 32.5% of students are eligible for reduced price lunch. Only 80% of students in this school district are scoring at proficiency level 3 or 4 on New York State assessments in science (U.S. Department of Education, 2015). The school district has a separate IT department to support teachers and students. The district provides teachers with professional development opportunities for new technological applications. All students have their own Chromebook and utilize the Google platform.

### **Problem and Purpose**

As the researcher, I have observed that students continue to struggle learning complex scientific phenomena. The National Assessment of Educational Progress (NAEP) science assessment measures students' knowledge of three broad content areas: Physical Science, Life Science, and Earth and Space Sciences, as well as how students use their scientific knowledge by measuring what they are able to do with the science content (National Center for Education Statistics, 2021). The (NAEP) achievement levels describe what students should know and be able to do. There is concern that in 2019, only twenty-two percent of twelfth-grade students performed at or above the NAEP Proficient level on the science assessment (National Center for Education Statistics, 2021). This data was not significantly different from data reported in 2015 or 2009. Knowing this, educators can conduct action research to discover ways to improve the nation's science scores.

The problem that this study focused on is the lack of student engagement when learning science. Digital simulations can be incorporated into the curriculum to increase student engagement and support student learning by reaching different types of learners such as auditory, visual, and kinesthetic. The purpose of this action research was to study the effect of Explore Learning's digital simulations on student engagement while learning complex scientific

concepts. Lack of student engagement can be a major contributing factor to the lack of students achieving proficiency in science across the nation. It is necessary to conduct a qualitative study that will show the positive impact programs with digital simulations have on student learning. This will also provide school districts with proof that the use of digital simulations in instruction can increase student engagement in the activity being performed, and ultimately lead to better academic achievement.

### **Research Question**

Based on what we know about students' lack of engagement when learning scientific concepts, this action research will be asking the following question:

- How does the use of digital simulations from Explore Learning Math and Science Gizmos impact student engagement in a rural high school?

Due to the increasing amount of school districts integrating more technology into their classrooms, new research should be conducted to determine if the new technology being used is in fact increasing student engagement when digital simulations are incorporated with the lesson. Technology evolves at an exponential rate, and by continuously conducting more research regarding this topic, more school districts will be able to see proof that the integration of digital simulations in instruction does increase student engagement and aid in student learning.

### **Framework**

The engagement theory is a fundamental idea that underlies the importance of students being meaningfully engaged in learning activities through interaction with others and worthwhile tasks (Kearsley & Shneiderman, 1998). In the conventional approach to teaching in high school science, the instruction of science is teacher-centered using lectures and direct instruction. There

is limited student interaction and students display a general lack of interest in the subject.

Traditional ways of teaching make it difficult for students to understand complex topics because students are not engaged in their learning (Lin & Chen, 2017). Technology integration supports classroom instruction by creating opportunities for students to complete assignments in a different way rather than the normal pencil and paper. Teachers can design lessons that engage students without the use of technology. However, technology can facilitate engagement in ways which are difficult to achieve if technology is not being used (Lin & Chen, 2017).

The interactive nature of the program Explore Learning Math and Science Gizmos is student-centered which will keep students interested and engaged in the topic. Digital simulations provide visuals of complex processes and enable students to see scientific phenomena in a way that is much different than normal paper-based activities. The engagement theory is a conceptual framework for technology-based learning (Kearsley & Shneiderman, 1998). When teachers incorporate technology in their instruction in a meaningful way, students can be intertwined with the learning process. Technology gives students the ability to have experiences that they would not be able to have if the technology was not being used. Explore Learning's digital simulations will enhance student engagement in science and ultimately increase student proficiency in science.

### **Significance**

Learning is being shaped by the technology infused in today's learners. Twenty-first Century Learners should experience different and unique lessons that utilize a variety of strategies and materials while incorporating technology. The purpose of this qualitative action research study was to explore how the digital simulations in the Explore Learning program impacts student engagement when learning about complex scientific concepts, such as genetics.

Through observations made in the classroom by the researcher, it has been determined that technology intrinsically motivates students to learn and keeps them engaged. Digital simulations promote active student learning and also gives them a new way of critically thinking about the material (Lin & Chen, 2017). It is necessary to conduct action research that will show the positive impact programs with digital simulations have on student learning. The action research approach is important to the research problem and question because implementing digital simulations into the classroom is a teaching strategy that is a testable scenario and can be improved upon based on results. It is hopeful that throughout this action research project, the data will show that incorporating Explore Learnings digital simulations into the curriculum will differentiate instruction and enable students to see scientific phenomena in a way that is much different than normal paper-based activities. This will increase their engagement and ultimately have a positive impact on their academic achievement. This action research will also provide educators with evidence that the digital simulations in the program Explore Learning Math and Science Gizmos contribute to an increase in student engagement.

### **Literature Review**

Current data on student proficiency in science shows that schools are currently failing students in science education (Lin & Chen, 2017). The use of traditional teaching methods such as direct instruction has shown to have a negative impact on student engagement and academic achievement. These traditional methods are only effective on 22% of students achieving proficiency in science (U.S. Department of Education, 2015). Students struggle with the traditional ways of teaching because they are not actively engaged in their learning, which makes understanding complex scientific concepts extremely difficult (Lin & Chen, 2017). This

literature review will focus on the integration of technology in education and the effect of digital simulations on student engagement.

### **Educational Technology in Schools**

Countless amounts of school districts are continuously adopting more technology-oriented equipment, hiring educational technology specialists, and making sure that teachers are integrating technology into their lesson plans (Sheninger, 2019). Schools adopt educational technology to increase student engagement and improve learning. Educational technology enables schools to close the digital divide, increase relevance of material, use real-world application of academics, and build twenty-first century skills (Sheninger, 2019). School districts have seen based on numerous studies that the multi-modal aspects of technology are integral to increasing student success in the classroom and can aid in their journey to becoming successful twenty first century learners. The number of students that have access to a technology device and access to internet is the highest it has ever been and educators are empowered to utilize this technology in innovative ways (Song, 2021). When computers are used in a way that is consistent with what we know about best teaching and learning practices, students will be more likely to achieve higher order thinking and be able to demonstrate learning gains (Sheninger, 2019).

The use of technology in education could change the way teachers teach and students learn. According to the latest information on how students today prefer to use technology and how their learning is impacted if they use technology, the use of modern equipment technology and tools increases student learning and interactivity (Raja & Nagasubramani, 2018). Students today make use of internet connectivity, use projectors and visuals, create a digital footprint, and obtain degrees online with technology. Technology can be used in education as a part of the

curriculum, as an instructional delivery system, to aid in instructions, and also as a tool to enhance the entire learning process (Raja & Nagasubramani, 2018).

In August 2013 the Los Angeles Unified School District's Common Core Technology Project (CCTP) invested in technology for every teacher and student to examine the implementation and outcome of the program. The goal of the project was to provide educators and students with devices, to close the "digital divide", and support the implementation of the Common Core State Standards (Margolin, et al., 2014). During the first year, the study found that only two of the 245 classrooms observed were using technology collaboratively with their students (Margolin, et al., 2014). Important factors of the program include curriculum, professional development, and technical support. School staff reported certain barriers such as technical issues, lack of technical skills in both students and staff, software or hardware issues, and lack of communication and guidance from the district (Margolin, et al., 2014). The data shows that this large-scale educational technology initiative is a process that requires significant effort from school leaders and teachers, and it is not just the digital device that will transform education.

Any school-based technology initiative must focus on improving teachers' content, instructional and assessment skills, and help teachers recognize how computers can be used as support in their instructional practices. There is a difference between just using technology in the classroom and teaching the content with technology. The integration of standards along with the technology that the school has can maximize the effectiveness. There is no agreement on the best method of instruction. The International Society for Technology in Education (ISTE) standards give parents, teachers, and administrators ways to rethink traditional approaches to education at local, national, and international levels. According to the ISTE Standards (2016), students should

be interacting with technology for them to be a competitive member of society in this generation in terms of their decision-making and problem-solving skills amongst many others. Educators can review the statistics and recommendations found from research studies, conduct action research in their classroom, work with other educators and school administrators, and attend professional development to learn how to effectively implement educational technology in the classroom in a way that successfully increases student engagement.

### **Student Engagement and Attitude in Science**

Technology now plays a significant role in education, and has the potential to engage students in a variety of ways. Researchers have been trying to gain a deeper understanding of how educational technology can affect student engagement in particular (Castañeda & Selwyn, 2018). Widely accepted areas of engagement include cognitive, affective, and behavioral engagement (Bond, & Bedenlier, 2019). “Cognitive engagement relates to deep learning strategies, self-regulation and understanding; affective engagement relates to positive reactions to the learning environment, peers and teachers, as well as their sense of belonging and interest; and behavioral engagement relates to participation, persistence and positive conduct” (Bond & Bedenlier, 2019, p. 2). A range of indicators can be used to measure student cognitive, affective, and behavioral engagement.

Many factors such as gender, teachers, curricula, cultural and other variables influence students' attitudes towards science (Bae & Lai, 2020). According to Zubrzycki (2016), AmGen Foundation (formerly Applied Molecular Genetics Inc.) and Change the Equation reported findings that teenagers are interested in subjects like physics, biology, and engineering, but they find little enjoyment in their in-school classes. The report is based on an online survey of more than 1,500 teens from around the United States. According to this data, 81% of teens were

interested in science. However, only 37% of students reported enjoyment in their science class (Zubrzycki, 2016). This study demonstrates that in many schools, science education is not being implemented in a way that genuinely engages students in the content they are learning.

### **Digital Simulations and Student Engagement**

Educational technology programs that incorporate digital simulations encourage students to explore scientific and mathematical ideas in a new way. There are many forms of technology that provide students with unique interactions with classroom content and curriculum that cannot be achieved using traditional techniques. “Teachers have to use educational technology selectively, efficiently, and effectively” (Turel, 2014, p.132). Research has demonstrated that technology can provide support for students when it incorporates digital simulations. Hillmayr et al., (2020) reported on studies published since the year 2000 which investigated how the use of technology can enhance learning in secondary school mathematics and science (grade levels 5–13). These studies observed the learning outcomes of students using digital tools compared to being taught without the use of digital tools. Overall, digital tool use had a positive effect on student learning outcomes because students were actively engaged when involved in interactive learning environments. When students interact with digital simulations they can actively and directly influence their own learning processes (Hillmayr et al., 2020).

A study conducted by Sausan et al., (2020) explored how chemistry multimedia could increase student curiosity and engagement in three different 7th grade science classes. According to the study, “it is difficult for them to visualize the interactive and dynamic nature of chemical processes by looking at symbols and equations and for making three-dimensional (3D) images by visualizing a two-dimensional (2D) structure” (Sausan et. al., 2020, p. 258). Data collection methods included classroom observations, questionnaires, and student interviews. The chemistry

multimedia made it easier for the teacher to introduce chemistry through a podcast and digital simulations. This study documented that the appearance of this multimedia could make the students attracted and curious about chemistry (Sausan et al., 2020).

Explore Learning Math and Science Gizmos enables educators to enhance their lessons and teach with technology which will differentiate instruction and make lessons more engaging to students. Explore Learning is a part of Cambium Learning® Group which develops online programs to improve student learning in math and science (Explore Learning, 2020). The website was developed by professionals with advanced degrees in a variety of fields, is a reliable resource that is easy to navigate, and provides educators with lesson plans that are aligned with online interactive math and science Gizmos. Explore Learning Gizmos are simulations for grades 3-12 that can help educators bring powerful new learning experiences to the classroom (Explore Learning, 2020).

Extensive research has shown that this inquiry-based approach to learning is a highly effective way for students to build conceptual understanding of scientific phenomena. According to a study by Navales (2019) using Gizmos simulation as a tool in teaching science was effective in enhancing the academic performance of students in tenth grade. Interestingly, the study also noted that using simulations has limitations. They found that when using this, it requires more explanation before the exercise and when completed, requires an explanation of what has been learned. However, the researcher reported how these simulations can be considered as a very effective approach in engaging students in an interactive science teaching (Navales, 2019). Therefore, it is reasonable to believe that Explore Learning's digital simulations will transfer into the students' engagement, and ultimately their academic performance.

Based on these findings, research increasingly notes the relationship between student computer use and increased academic performance. There is a direct connection between the integration of this type of technology and student engagement in school. When students can interact with and manipulate the digital simulations it keeps students engaged compared to traditional methods of learning science. By incorporating digital simulations into the curriculum, increased engagement leads to a better understanding of different concepts that are taught with the program and students will gain a deeper understanding of the content they are learning.

### **Methodology**

The participants in this study currently teach secondary education at a rural high school in New York. These teachers use Explore Learning's digital simulations to teach math and science concepts. The study asked educators to complete a digital questionnaire focusing on student engagement when using Explore Learning's digital simulations. The teacher participants all work in the same school district and were invited to complete an online questionnaire which was emailed to them. Due to the qualitative nature of this study, the data analysis was used to determine if students are more engaged when using Explore Learning's digital simulations, and if more engagement helps students to better understand the content.

Each teacher uses the lesson materials provided by the program that work cohesively with the Explore Learning simulations. Each activity in the interactive program takes between 1.0 to 1.5 hours to finish. The student activity sheet required students to follow step-by-step instructions to complete the activity, find information, and answer questions relating to the specific content of the digital simulation. The assessment questions support the retention of content obtained from the simulation, and enables students to make predictions, gather data, and draw conclusions from what they find. Due to the qualitative nature of the study, teachers were

asked to observe student interactions and report how they respond to the digital simulations, as well as how much they were engaged and understood content when using the program.

### **Participants**

The participants in the study are four high school teachers. The teachers were purposefully selected for this study because they have used the Explore Learning Math and Science Gizmos program in their instruction. All participants are New York State certified secondary education teachers and the subject areas taught by each teacher includes middle school science, special education/ science, Spanish/ENL science, and special education inclusion for math and science.

### **Procedures**

Qualitative research methods were used to gather data to analyze the effect of Explore Learning's digital simulations on student engagement in a rural high school. The data source for this study was a digital questionnaire (Appendix A). The teacher participants were invited to complete the Google Form online questionnaire which asked them to share their perspectives and opinions of Explore Learning's simulations and how it effects student engagement. The online questionnaire was accessed via email and took about 20-30 minutes for the participants to complete. Coding was used to find common themes in teacher responses to the online questionnaire (Mills, 2018). The research instruments were developed and designed to achieve a common goal throughout the action research project.

### **Data Results**

The data obtained from the digital questionnaire revealed two key themes regarding the effect of Explore Learnings digital simulations on student engagement: visuals in digital

simulations give students a better understanding of abstract concepts and digital simulations that are interactive make students active participants in learning.

*Visuals in digital simulations.* Digital simulations increase student curiosity and helps students gain a deeper understanding about science concepts (Sausan et al., 2020; Navales, 2019; Lin & Chen, 2017). Explore Learnings digital simulations allows students to visualize processes that they cannot see happening with their own eyes. A specific example reported in the data is the simulation of cell division. Cell division is an abstract concept, but when student see it happening in the digital simulation there is a better chance of student retention on how cells divide. They are able to see things presented in a way that a simple video cannot, and are able to satisfy some of their natural curiosities. The visualizations in the digital simulations causes students to begin to have conversations about what they are seeing. The visual information in the digital simulations helps with understanding and students more inclined to ask questions based on what they are interacting with visually rather than sitting through a lecture that is mostly auditory.

*Interactive digital simulations.* When students interact with digital simulations it increases engagement and learning (Raja & Nagasubramani, 2018; Hillmayr et al., 2020). With Explore Learnings digital simulations, interactive opportunities are presented when learning and more engagement and understanding happens. Teaches reported that Explore Learning engages students by providing scripts and directions to follow which helps to focus students' attention to the concept at hand. It provides students with guidance in following procedures as well as the ability to access the knowledge and content numerous times until they are able to understand it. When students are just mindlessly writing notes they do not retain much of the content. The ability to interact with the digital simulations makes a difference and is imperative to

understanding the concepts. The controlled data collection is the most helpful when it comes to engaging students. Seeing the actions take place in front of them in the simulations while being able to slow down, speed up, and repeat actions allows students to acquire and retain knowledge into their long-term memory. When using Explore Learnings digital simulations they are actively engaged using all modalities of their intelligence.

### **Data Analysis**

I used a qualitative data collection technique in the study by asking questions in the form of a digital questionnaire (Mills, 2018). The specific research question helped to guide the qualitative data collection technique used in the study. The questions asked in the digital questionnaire were designed to be a qualitative indicator about changes in students' engagement when using digital simulations to learn (Mills, 2018). The qualitative data was collected using Google Forms and organized and analyzed using Microsoft Word to categorize the responses of teachers. The data analysis began by identifying major themes in the literature review and in the data that was collected. This was done observing patterns and identifying key words and phrases to the responses of the digital questionnaire (Mills, 2018). The data was examined to determine if incorporating Explore Learnings digital simulations into the curriculum increases student engagement because it enables students to interact with and see scientific phenomena in a way that is much different than normal paper-based activities.

### **Discussion**

The study was conducted to explore the effect of Explore Learning's Math and Science simulations on student engagement. This action research study asked following question: How does the use of digital simulations from Explore Learning Math and Science Gizmos impact student engagement in a rural high school? Based on teacher responses to the questionnaire,

student engagement increases with the incorporation of digital simulations using the program Explore Learning Math and Science Gizmos in the classroom. These results are consistent with the literature and initial research problem that was proposed in the study.

### **Multi-Modal Approach**

The Explore Learning program incorporates images, manipulative interactives, multimedia, and many different forms of learning styles are accommodated. One teacher reported that Explore Learning's simulations provide a multi-modal approach to learning. The interactive nature of the program as well as the models, diagrams, and clear images results in students being more engaged and having a better understanding of the concept being taught.

### **Importance of Simulations**

The simulations are imperative to understanding the concepts, and the ability to manipulate the simulation for data collection is a big factor that contributes to student engagement. The Student Exploration worksheet makes it easy to navigate the simulation. The instructions are clear and easy to follow which makes students stay engaged.

The data found in this action research, as well as reports found in literature related to the research problem provides educators and school districts with more evidence regarding the integration of digital simulations into the classroom and its positive effects on student engagement, thus driving schools to purchase this type of technology in the future

### **Action Plan**

By conducting a qualitative study using the digital simulations in Explore Learning Math and Science Gizmos, the researcher was able to provide evidence about the integration of this type of technology into the classroom thus driving the education system forward. The qualitative

data obtained from this study can help school districts in their decision-making process when it comes to investing more money into technology that incorporates computer-based simulations. Technology costs money, and without the data showing that a program is successful, a school district is more likely to be reluctant taking the risk of investing in it. With the data obtained by this action research study, we have evidence that shows this technology tool works to increase student engagement, and teachers can confidently make an educated decision based on the research conducted.

If more time was to be devoted to this study, it would be more accurate to use both qualitative and quantitative data. Using a mixed method approach, the research can use qualitative as well as a quantitative methods in order to achieve the most accurate results. This would allow for the triangulation of data by utilizing multiple methods of data collection to develop a common outcome. The triangulation procedure in a future research study can use qualitative and quantitative data methods to determine how digital simulations effect student engagement. The researcher can expand the research by making the activities distinguishable from one another to aid in the research. Teachers can include both the Explore Learning version of a lab, as well as a hands-on laboratory activity that is similar to the computer-based activity. Then give students the option to choose which activity they would like to do to give them more control of their learning. Results will be more accurate by increasing the sample size, or expanding the research to other classes and subject areas.

### **Conclusion**

The use of technology in education has numerous benefits. It is important for teachers to use technology effectively in their classroom to create meaningful learning experiences for students. Students benefit when teachers apply technological, pedagogical, and content

knowledge to lessons. The educational technology tool Explore Learning Math and Science Gizmos is aligned to the science standards and deepens students' thinking and understanding of scientific phenomena. The program can be used to measure student progress authentically and thoroughly and can be used by educators to increase student engagement in the content they are teaching. By conducting this qualitative study using Explore Learning Math and Science Gizmos, the researcher was able to provide evidence about the integration of this type of technology into the classroom and its positive effect on student engagement. When teachers use digital simulations, students become active learners and are engaged in the learning process.

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## Appendix

### Appendix A: Digital Questionnaire

1. What grade level do you teach?
2. What subject area do you teach?
3. What does Explore Learning Math and Science Gizmos simulations do to make this class engaging? Please provide an example.
4. When using Explore Learning in your class, do the students appear involved? Please explain.
5. In your opinion, how does student engagement benefit their learning?
6. What is the value of students being able to engage with digital simulations in math and science?
7. Are students more likely to collaborate with one another when using this Explore Learning?  
Please explain.
8. How does Explore Learning's simulations engage students in the material?
9. What do you like/dislike about how Explore Learning engages students?
10. What kind of comments and feedback have your students shared with you about Explore Learning's digital simulations?
11. How has Explore Learning's simulations made a difference in teaching difficult or abstract concepts?
12. Is there anything else you would like to share about Explore Learning's Math and Science Gizmos?