Virtual Environments for Education: An Empirical Study of Implementing Education into 3D Video Games and Applications

by

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Abstract

We live in a digital age and technology is constantly changing, therefore the way people learn and perceive information is starting to change. Hence, virtual learning environments may be a new and innovative way to stimulate minds. In the book *Virtually There,* Stephen Heppell explains,

> Learning is breaking out of the narrow boxes that it was trapped in during the 20th century; teachers' professionalism, reflection and ingenuity are leading learning to places that genuinely excite this new generation of connected young school students – and their teachers too. VLEs are helping to make sure that their learning is not confined to a particular building, or restricted to any single location or moment. [2]

One way to capture positive learning is through video game and three-dimensional representation. The term virtual is a common term in the 21st century, but what does it really mean? According to The American Heritage® Dictionary of the English Language the word virtual is used in various ways to denote things, activities, and organizations that are realized or carried out chiefly in an electronic medium [1].

The purpose of this research is to address the need of increasing student achievement in mathematics through virtual environments. The primary focus is to create an environment where students in K–12 education can learn mathematics while using a visual programming language at the same time. Furthermore, the study of visual programming tools as a means to increase student achievement in mathematics could possibly generate interests within the computer-

supported collaborative learning community. According to Jerome Bruner in Children Learn By Doing, “true learning is figuring out how to use what you already know in order to go beyond what you already think,” [29]. This research will focus on computer supported collaborative work, virtual environments, learning environments, virtual education, and visual programming.

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Table of Contents

List of Tables

List of Figures

Chapter 1

INTRODUCTION

Motivation

Millions of people play video games every day. Children would rather have fun, be interactive rather than listening to a boring, monotone teacher who attempts to force them to learn something they may find uninteresting. The research presented is not an attempt to discount traditional methods of teaching used by educators, instead the research is provided to offer an alternative to the traditional, instructional methods implemented. “Traditional teaching is concerned with the teacher being the controller of the learning environment. The teacher holds power and responsibility and they play the role of instructor (in the form of lectures) and decision maker (in regards to curriculum content and specific outcomes). They regard students as having 'knowledge holes' that need to be filled with information. In short, the traditional teacher views that it is the teacher that causes learning to occur” [50]. Web-based instruction or informal instruction is different. “Web based instruction may be employed to promote experiential learning, or learning "on site," so that the process of learning is integrated with the real world” [51]. Using video games to educate students will not only benefit students by introducing them to computer science, but it will benefit teachers and professors as well. Video games may offer an escape from reality and a change from the norm, and an alternative teaching tool is needed to keep students interested in a subject. If given the option, young people spend more time playing video games than they spend on school assignments. In “Artificial Intelligence as a Medium for Learning,” the paper discussed the different forms of artificial intelligence that young students use every day and how these episodes are utilized as learning experiences [31]. Other information about video games and how games such as Sims 3 and World of Warcraft can be augmented to create educational experiences is needed. For example, in disciplines such as mathematics or computer science, both Sims 3 and World of Warcraft will facilitate K–12 students learning basic math facts or algebra. This can provide a fun, yet stimulating learning tool for increasing mathematics achievement.

In Kurt Squire's "Video Games in Education," he writes how educators have long ignored games and downplayed them by only discussing the social consequences [33]. He mentioned how Pokémon has become a cultural phenomenon and indicated that many educators have taken an interest in what effects this game has on players. Squire also discusses what motives can be taken from the game and placed in an educational game to make them more interesting. He argues that video games are a popular and influential medium because of a combination of many factors. For instance, they get such an emotional reaction from players, such as fear, aggression and joy. He argues that it is impossible to replicate such a video game to educate children [33].

In Glassner's essay "Some Thoughts on Game Design", he speaks on some very important aspects of video game development and design [32]. To begin, Glassner separates games into four subcategories: arcade, puzzle, strategy and story. According to Glassner, arcade games are labeled as "real-time response and high-focus playing" [32]. These forms of video games, at that time, were rarely played across the Internet because of the difficulty in maintaining high-speed communications between players.

Puzzle games and adventure games run hand-in-hand in video game genres. Designing a series of challenges for the user to solve creates these games. These puzzles can range from winning a simple mini-game to advancing in the game to deciphering a cryptogram from earlier in the game [15]. Strategy games often call for some form of tactical planning and execution from the user. In modern gaming society, many first person shooter (FPS) games are considered strategy games. The final gaming category is story. Many movies and cartoon shows use this genre of video games, which attempts to create a narrative thread involving the player. On September 9, 2009, President Barack Obama launched a campaign called "Educate to Innovate" [30]. It is geared toward improving the technological, mathematical, scientific and engineering abilities of American students. This program presently allows young people across America to work with big companies, foundations, non-profit organizations and science and engineering societies to gain technological experience. President Obama enacted this program because although we have great schools, excellent teachers and successful students in America, it still seems that students should be doing much better in science, technology, engineering, and mathematics [30].

Video games are a huge entity in today's society. As we continue to strive in technology and in education separately, it is beneficial for the two disciplines to cross paths. Finding new and interactive styles of teaching youth causes students to become more involved in their learning instead of passively receiving information. Educational video games, Virtual Learning Environments (VLE), or "edutainment," can be an extremely effective form of teaching for both students and teachers.

Goals, Approach, Contribution

The objective of this research is to explore virtual environments and how virtual environments can enhance learning for students and to develop a system that increases mathematics achievement in K–12 education. One particular way that virtual environments can enhance learning is through interactive video games. This study has identified Girls, Inc. members as the initial subgroups that will benefit from the results of this research. The main criterion for choosing members to participate in the study is a voluntary acceptance of middle school girls of Girls, Inc. to willingly subscribe to use the Edutainment website that we have developed to potentially increase mathematics achievement by using virtual environments. Participants will provide feedback on its usability and how easy it is to use by novice users for increasing mathematics achievement in K–12 education. This Edutainment tool is assumed to be a framework model of collecting quantitative data on using virtual environments to increase mathematics achievement. To extend this study, the research will focus on middle school students sharing and reusing the Edutainment software amongst other groups. Learning mostly occurs in a traditional setting, where the teacher presents the lesson in front of the classroom using a whiteboard. Many times, the teacher is the leader of the instructional process. Students are very engaged in gaming. In keeping with generation X, we have to engage students in a more interactive and entertaining manner. The students should be actively engaged in the learning process. We are proposing to create an environment that does the following: 1) leverage members of a community of practice understanding and high volume use of collaborative technology such Edutainment, 2) provide a medium that members can easily share information, and 3) provide a medium where members can freely collaborate and share content with a mechanism to support communities of practice in sharing and reusing information on specific topics.

This study did not focus on institutional issues. Our goal is to explore and study how the use of virtual environments can enhance mathematics achievement among the initial study group, Girls Inc. We will provide a user-friendly experience and a secure platform for collaboration. The study will be utilized in a collaborative environment. We anticipate that the participants of this study will have improved educational performance in mathematics. The participants will work individually and will utilize the Edutainment website and contribute to the learning environment. The results of this study will be used to further the support an environment that supports a community of practice in increasing mathematics achievement and sharing content materials in a virtual community. The environment will support improved use of materials within the virtual environment community leveraging the ease of use of the Edutainment website. Our hope is that this method of resource presentation and resource sharing will increase the use of educational materials and applications among a community of practice.

This research addresses the usability and user interface problems for web-based tools supporting informal learning through collaboration. We have determined through careful review of literature that collaborative tools must undergo a comprehensive usability test before adoption. The results of the system test are flawed when there is negligence. Thus, the system is not fully accepted and embraced by the target audient, i.e. user group.

This research is concerned with surveying a collaborative online tool, identifying the most applicable tool for our user population, Girls, Inc., the development of a minimal tutorial to support and improve usability for the self-reported novice users of the selected application with a main focus to develop a model to assist in increasing mathematics achievement while enabling users to collaborate effectively within the selected tool environment. The main goal is to motivate members of communities of practice mainly the Girls Inc. group to be content generators and remove the instructor type of structure and mitigate the technophobia among novice users by providing support through the tutorials to inexperienced web-content designers to contribute to the knowledge bank of mathematics and virtual environments.

The approach includes creating an environment where students in K–12 education can learn mathematics in a virtual environment that is fun and engaging. The virtual environment is developed using a visual programming language. This allows the study of visual programming tools to be used as a means to increase student achievement in mathematics.

This research has three objectives:

1. Survey online collaborative tools,
2. Develop a minimal tutorial that captures basic knowledge skills for the fundamental use of the online collaboration tool, and
3. Conduct a usability study with stakeholders of the online collaborative tool and utilize the feedback data to improve the tutorial.

The immediate contributions of this research will increase mathematics achievement in K–12 education. In addition, the results of this research may capture and generate interests within the computer-supported collaborative learning community.

Organization of the Dissertation

The remainder of this dissertation is organized as follows. Chapter 2 provides a review of literature. Following the introduction are topics on virtual environments, computer-supported collaborative work; learning environments; virtual education; and visual programming. Also discussed are multi-user virtual environments for teaching and learning. Chapter 3 defines the methodology, which includes the research questions, a detailed description of the proposed implementation. Chapter 4 presents the system implementation of the suggested method, along with a recount of the results from the preliminary experiment. Further experiment details and implementation approaches are discussed. The proposed research plan, timeline, and expected outcomes close the chapter. Chapter 5 discusses the experimental analysis and evaluation. Chapter 6 provides the conclusion.

Chapter 2

REVIEW OF LITERATURE

Computing has become an intricate aspect of our daily lives. Cell phones, iPads, and laptops only scratch the surface of how computing has influenced our society. Virtual Environments and visual programming are two tools that we use to promote diversity in computing in K–12 education. However, whether a student learns in a physical environment or a virtual environment, there will still be challenges regardless.

Virtual Environments, or VEs, combine engaging interactive locations, social networking, live webcasts and web-based collaboration tools. Many education institutions have shown interests in its application in teaching and learning activities. As M.R. Davis, the author of ‘Cracking the Code: Computer Coding Lessons Expanding for K–12 Students’ (*Education Week: Digital Directions*, 2003) wrote,

> South Hills High School teacher Saleta Thomas bills her class as a digital game-design program for students. But once students opt to take the class, they start learning computer coding through basic programs like Alice, then move on to Flash, JavaScript, ActionScript, and other coding languages. Since the students in the Fort Worth, Texas, school are focused on digital-game creation, often they don’t even realize they’re learning computer coding. 3D virtual environments can facilitate students in achieving learning outcomes through constructivist learning. Unfortunately, this also encourages cyber bullying and ostracizing in both the physical and virtual world.

Visual Programming is an innovative and entertaining way for people to learn how to code using free web-based programs like SCRATCH. The user can learn how to create certain things that we take for granted – e.g. calendars, clocks, and simple games. Several fractions including the Association of Computing Machinery (ACM) and IEEE-CS have worked tirelessly to achieve recognition for Computer Science. Everyone, regardless of age and profession, should have at least basic knowledge of Computer Science and what it could offer. Vinton G. Cerf, ACM PRESIDENT, argues that, as of August 2013, "…the idea is not necessarily to turn students into professional computer engineers and scientists, but to expose them to the richness of computer science and to help them appreciate the potential nascent in computers and programmable systems."

Computing in K–12 education has become more diverse as technology continues to evolve. Visual Programming and Virtual Environments are only two of the paths that could be used to introduce others to Computer Science. We live in a digital age and technology is constantly changing, therefore the way people learn and perceive information is starting to change. Hence, virtual learning environments may be a new and innovative way to stimulate minds. In the book *Virtually There,* Stephen Heppell explains,

> Learning is breaking out of the narrow boxes that it was trapped in during the 20th century; teachers' professionalism, reflection and ingenuity are leading learning to places that genuinely excite this new generation of students – and their teachers too [2]. Virtual learning environments (VLEs) are helping to make sure that learning is not confined to a particular building, or restricted to any single location or moment [2].

One way to capture positive learning is through video game and 3-Dimensional representation.

Virtual Environments

Virtual Learning Environments

According to Juan R. Pimentel in *Journal of Asynchronous Learning Networks*, “We define a virtual learning environment as one that allows learners to perceive the environment, assess situations and performance, perform actions and proceed through experiences and lessons that will allow them to perform better with more experience on repetition on the same task in similar circumstances” [3]. Basically the purpose of a virtual learning environment is to enhance education in ways that students can interact with professors, other students, and learn in new dimensions. According to Britain and Liber, who defined the framework for Virtual Learning Environments, the purpose of virtual learning environments is to “Accommodate a wider range of learning styles and goals, to encourage collaborative and resource-based learning and to allow greater share and reuse of resources” [4].

Design of Virtual Learning Environments

When most think of the term virtual learning environments, e-learning comes to mind; however, the term represents a wide range of features and is not just limited to distance learning. According to Dillenbourg, Schneider, and Synteta virtual learning environments are defined as “A range of systems that comprise features like a designed information space, a social space being a “place”, participants that are active and present actors” [5]. These authors also suggest that virtual learning environments can be identified by the following features [5]:

1. A virtual learning environment is a designed information space.
2. A virtual learning environment is a social space: educational interactions occur in the environment, turning spaces into places.

3. The virtual space is explicitly represented: the representation of this information/social space can vary from text to 3D immersive worlds.
4. Students are not only active, but also actors: they co-construct the virtual space.
5. Virtual learning environments are not restricted to distance education: they also enrich classroom activities.
6. Virtual learning environments integrate heterogeneous technologies and multiple pedagogical approaches.
7. Most virtual environments overlap with physical environments.

Virtual learning environments are designed to be very flexible and vary from situation to situation. They can include not only learning resources on compact discs (CD) or on the web, or both, but more traditional, paper-based resources as well [6].

A virtual learning environment (VLE) is a software system designed to support teaching and learning in an educational setting. A virtual learning environment normally works over the Internet and has several tools to help students learn the materials, communicate with other students, upload and download content, and even review and grade your peers [11]. VLEs offer a number of advantages for students and users. Creating pages is easy; you can even add interactive exercises without specializing in programming knowledge. Users can be tracked, and their progress can be checked. Integration within a particular course is easier, and as VLE sites are arguably more likely to receive hits than a library site, it provides a sure way of getting to the student [6]. There are several areas of education that this technology has been used in to see what the level of effectiveness is, and several countries that have delved into the usefulness of the technology as well.

One key element essential to the success and/or failure of any virtual learning environment is thought out design. The layout is to be clean and user-friendly design, with a light background for the text, which is aesthetically restful for the eye. The main navigation is through an easily accessible menu, normally found on the left of the window, with subsections opening up as sections are clicked on; shading and highlighting makes it clearer and guide the user through their interaction experience. As VLEs have been introduced more and more into education, it is imperative that they have a sound design that will meet the needs of several different types of students with various learning styles and educational needs, also keeping in mind students that have learning disabilities. Some of the areas that researchers have explored when considering the expansion potential of a VLE for practical education outside of the classroom are used for protective clothing, danger of lifting heavy weights, clearing up broken glass, first aid, safety when spraying, washing hands before eating food, and clearing up equipment just to name a few [5].

There are two groups that have differing viewpoints as it pertains to VLEs. On the one hand are the "democrats", they value practicality and ease of use. On the other are the "revolutionaries", they value new and exciting innovations [12]. These groupings typically align with two perspectives on the nature of pedagogy: the "broadcast" perspective (learning as reproducible content) and the "discussion" perspective (learning as communication) [12]. Rather than seeing these conflicts in terms of winners and losers, it is thought that they produce a mutually beneficial "creative tension" that keeps learning technologies (and VLEs in particular) striving to be both robust and functional for administrators as well as personal and open to customization by learners.

There has been a wealth of research to join VLE with it training. The focus was placed on basic information technology (IT) skills for several reasons. Technology savvy students and instructors are early adopters of technology and represent a high proportion of users of web-based [8]. Technology courses were among the first to appear on the web and are still among the most popular online offerings. An important motivation for teaching web-based courses in many universities, particularly those funded by public sources, often arises from the search for an efficient delivery vehicle for introductory courses. Particularity in information systems education, with its shortage of faculty and growing student demand, web based courses may help relieve the pressure. As faculty and administrators become more familiar with the potential applications of Internet technologies in education, their use in higher-level courses will likely increase. We chose to focus on basic IT skills because of their fast obsolescence and because of the growing need for training in both academic and business environments. It could be argued that students in the VLE spend more time interacting with the computer and, as a consequence, develop higher computer self efficacy. A correlation between time spent in the VLE and computer self-efficacy would provide evidence corroborating this explanation. However, while we cannot definitely rule out this possibility due to our investigation of IT-related subject matter, the available evidence does not support it. Students reported spending considerably more time on task during the second half of the semester because of widespread unfamiliarity with the material [8]. Overall, for IT basic skills in entry-level college courses, students who are trained in the new environment develop the confidence in their skills that is instrumental in making them successful computer users.

Another area that VLEs have been used in is for language learning. The creation of a virtual environment for language learning is a major undertaking that requires extensive planning and a considerable investment of time on the part of practitioners. Before embarking on a project, the designer should also be prepared to undertake an extensive needs analysis in order to achieve optimum learning outcomes [9]. The process of successful site development is also dependent on extensive piloting.

VLE has been particularly effective for those with learning disabilities. Approximately twenty people in every thousand have mild or moderate learning disabilities and approximately three or four per thousand have severe learning disabilities [5]. There are several key factors that go into play when considering this special audience. First, virtual environments create the opportunity for people with learning disabilities to learn by making mistakes but without suffering the real humiliating or dangerous consequences of their errors. Secondly, virtual worlds can be manipulated in ways in which the real world cannot be. A simple world can be constructed within which the task could be performed, and, as the user becomes more familiar with the task, the world can become more complex. Features to which the learner needs to pay attention can be made more prominent [5]. Thirdly, in virtual environments, rules and abstract concepts can be conveyed without the use of language or other symbol systems. Virtual environments have their own "natural semantics" [5]; the qualities of objects can be discovered by direct interaction with them. They can thus be used to facilitate concept attainment through practical activity, bypassing the need for dis-embedded thinking, which people with learning disabilities often find difficult to acquire and use.

In the U.K., the Open University's (OU) Safari course (Skills in Accessing, Finding & Reviewing Information) describes itself as "a guided expedition through the information world" and deliberately plays on the idea of an expedition with icons of various wild animals distinguishing the seven sections [6]. In 2007, it was extensively rewritten to include online resources and skills for the information age and is based on principles set out by various library education bodies, such as SCONUL's (Society of College, National and University Libraries) seven principles of information literacy. Since the OU students are entirely distance learners, the course has to be totally online. Also, in Europe, the usefulness of virtual learning environment and computer-mediated communication is tested to enhance the ability to relate words, a task often found in English classrooms [1]. Computer-mediated communication tested in higher education. The virtual learning environment as a tool not only benefits students, but also teachers and their assistants.

VLE has even found its place in educating employees. It has been used to educate nurses. In using the online simulation in child health nurse education, the whole learning process starts with a two-hour induction session in the computer laboratory [10]. The purpose of the session is to ensure that all students have a reasonable understanding of the game environment and blog technologies before they have access to the virtual ward. On completion of the quiz, the student has the first of four opportunities to reflect on learning using blog technologies that allow the student to pose questions to peers or lecturers. This is a vital component of the simulation where the student seamlessly breaks out of the virtual environment into an area for discussion and peer review. Once the response has been posted and the student has had an opportunity to comment on colleagues' reflective accounts, the virtual sister directs the student to Demi's bedside. Here, there is the opportunity to have a short conversation with child and mother while analyzing vital signs and prescription charts. By asking questions of the family and examining observation charts, the student has to decide a course of action. These pieces of information are supplemented with the latest literature on the use of antipyretics and the current debate on dual pharmacology. This activity culminates in a second blog task requiring the student to compare the virtual care they have just delivered with fever management in the clinical environment [10]. The next activity involves the student making decisions about the child's environment. The purpose of this simulation package is to foster the application of theory into clinical practice. Questions on this topic were posed in the questionnaire and formed part of the focus group. It is through simulations that educators can show the complexity of nursing care. The project team spent a tremendous amount of time scripting and revising action to ensure the simulation accurately portrays clinical practice [10].

It is always important to note that the developments in internet technology and the emergence of the new English as a Foreign Language (EFL) site require regular revision of the VLE website. New links must be added when required and old links replaced or updated. This process can be time-consuming. However, the use of an online robot has dramatically reduced site maintenance times. The Doctor Html site may be used to check web pages for dead links, as well as providing feedback on errors of syntax and grammar as well as html coding [6]. Attention to user and visitor feedback is critical to making sure the VLE is friendly to all. Feedback using student surveys and other tools provide necessary innovations that are generally seen as an improvement. Since student performances are likely to be determined more than anything else by their ability to cope with the demands of time spent learning at a distance from tutors, students' development of adequate time management skills is crucial in maximizing learning effectiveness within a VLE.

Learning Styles for Students

Richard M. Felder states "students learn in many ways—by seeing and hearing; reflecting and acting; reasoning logically and intuitively; memorizing and visualizing and drawing analogies and building mathematical models; steadily and in fits and starts" [7]. The learning styles vary from person to person. There are many different models that represent learning styles, but the most common and widely-used is the Fleming's VARK model [8]. This model classifies four different types of learners which include:

1. **Visual learners –** reference for seeing (think in pictures; visual aids such as overhead slides, diagrams, handouts, etc.)
2. **Auditory learners –** learn best learn through listening (lectures, discussions, tapes, etc.)
3. **Reading/writing-preference learners** – learn best through writing (essays, reading books, etc.)
4. **Kinesthetic learners or tactile learners –** learners prefer to learn via experience—moving, touching, and doing (active exploration of the world; science projects; experiments, etc.)

Many educators use this model to determine their students preferred learning styles. According to Emily Giles, Sarah Pitre, and Sara Womack, "Most people are classified as visual learners" [9].

Virtual Environments in Education

Virtual environments can play a vital role in education. Virtual reality is powerful because people perceive images faster than they do reading text [10]. Perception is a very important part of the learning experience. Virtual environments are engaging and they allow students to visualize information. The most practical use of virtual reality can be for training and stimulation. In the classroom they can be used to increase students' participation because they motivate the students to learn. For example, virtual environments can be utilized for a student to explore different countries virtually, instead of just reading about it in a text book. Virtual environments can also be used for learning mathematics.

Computing in Education

Everyone, regardless of age and profession, should have at least basic knowledge of Computer Science and what it could offer. Vinton G. Cerf, ACM President, argues that, as of August 2013, "…the idea is not necessarily to turn students into professional computer engineers and scientists, but to expose them to the richness of computer science and to help them appreciate the potential nascent in computers and programmable systems" [2]. Several factions such as ACM and the IEEE Computer Society have worked exhaustively to make Computer Science be regarded in the same light as Science, Mathematics, and Social Studies. This effort was evidenced by a letter from the chair of ACM, Dr. Andrew McGettrick. The letter was published in and August 2013 article in an issue of *Communications*. As written in the notes section of the article, "Andrew McGettrick (andrew.mcgettrick@strath.ac.uk) is Professor Emeritus at the University of Strathclyde, Glasgow, Scotland, U.K. and the chair of ACM's education board and education Council." Gettrick discussed what the U.S. ACM is doing to reform kindergarten through 12th grade (K–12) education. Topics include the promotion of computer science education at all levels by ACM's Education Board, the CS 2013 curriculum guidance document published by ACM's Education Board and the U.S. Institute of Electrical and Electronics Engineers (IEEE) Computer Society, and massive open online courses (MOOCs).

Professionally speaking, students of various ages could and would benefit from learning more about the technology that is an intricate part of our daily lives. Of course, the Computer Science field is more than just knowledge of computers and what they can do in our lives [2].

Each student will have the choice of what they will do with their newfound knowledge. They could create the newest, hottest role-playing game, design the world's strongest supercomputer, produce a program that could compile a three dimensional image of a building and calculate its structural stability, and more!

The possibilities are endless and there is no limit to what could happen regardless of the famous quote about our limits as humans. After all, we've flown through the sky, we've landed on the moon, and we have a rover on Mars. So, what's the limit of our determination and will?

Vinton G. Cerf argued that, as of August 2013, computer science should be incorporated into elementary and secondary education to the same extent that other sciences such as biology, chemistry, and physics are taught, exposing students to the field of computer science. The Association for Computing Machinery is mentioned for several times in accordance with one of their main initiatives: to make computer science acceptable as a core science along with mathematics, physics, biology, and chemistry.

Cerf maintains "…the idea is not necessarily to turn students into professional computer engineers and scientists, but to expose them to the richness of computer science and to help them appreciate the potential nascent in computers and programmable systems." One does not have to be a Computer Science major to learn about the abilities of computers and programmable systems. As stated by Cerf, "Many of our members received degrees in disciplines other than computer science simply because their academic years preceded the creation of computer science departments." We can conclude that learning about computer science benefitted rather than hindered the growth of the members. Therefore should students in K–12 classes learn about computer science, but gain an interest in another subject, then no harm no foul. These conclusions may be presumptuous, but they are also possibilities of what could have been or could be. However, in order for any profession to truly move forward, those with more experience must be willing to give back. Cerf wrote, “Reforming K–12 education to incorporate serious computer science seems vital to producing an informed public that has a deeper appreciation for the power of computing than video games and social networking. There are, no doubt, countless opportunities for computing professionals to engage in this effort, by lending their support and time to the effort to reform K–12 curriculums content and to make visible to young people the excitement of discovering what computing can accomplish. The discipline of writing and debugging software, of creating simulations or interactive applications has the potential to draw many into the profession, or at least to provide even more with a sense of the core role computing is playing and will play in the decades ahead. As the Internet of Things becomes reality and software appears in every appliance, building, and vehicle, we have a societal interest in promoting understanding of and interest in our discipline.” [2]

Progress in K–12 Education

Programming is an intricate aspect of computer science. That does not necessarily mean that if one does not know how to program, then they cannot practice computer science. Several visual programming games have been created with the sole purpose of encouraging students in K–12 education to learn about coding. M.R. Davis presents information on expanding interest in Computer Science by developing creative ways to teach coding through gaming using programs like Scratch, a free program for students that allows them to create interactive stories, digital games, and animations while learning the basics of computer coding.

Figure 1: Freshman Darius Smith works on a project in Craddock's computer science class at Monticello High School. [10]—Matt Roth for Digital Directions

Basically, the teachers lure the students in with the promise of learning how to create their own game. From there the students willingly, albeit unknowingly, learn coding as shown in Figure 1 and 2. Such a course wasn't popular with the students at first, but as time passed and the students gained interest, so did the class attendance. As written by Davis, 'South Hills High School teacher Saleta Thomas bills her class as a digital game-design program for students. But once students opt to take the class, they start learning computer coding through basic programs like Alice, then move on to Flash, JavaScript, ActionScript, and other coding languages. Since the students in the Fort Worth, Texas, school are focused on digital-game creation, often they don't even realize they're learning computer coding, Thomas says. The "marketing" ploy of labeling the course digital-game design has had an impact, she says. Computer science wasn't a popular course at the low-income school, which has struggled over the past few years to bring test scores up, but the digital-gaming elective has gone from 22 students its first year to 45 this school year, and 81 are projected for the next school year [10].

Figure 2: Students work on coding at Monticello High. Teacher Michael Craddock says learning how to code helps students appreciate the value of developing math skills. [10]—Matt Roth for Digital Directions

"If we get the hook into them through gaming, then when they go to college they can see there's a whole lot more offered in computer science," Thomas says. "If you major in computer science, your world is really open." Computer programmers and software engineers are urging that K–12 students be introduced to computer coding—designing and writing source code for computers—earlier in their educational careers, even as early as elementary school. Organizations such as Association of Computing Machinery (ACM) and the Institute of Electrical and Electronics Engineers – Computer Society (IEEE-CS) would be thrilled to realize that their efforts to encourage and introduce an interest in Computer Science in K–12 education have been baring fruit and gaining favor. However, certain university teachers of various majors have conducted, not so much a social experiment as an educational one.

Computing in Colleges and Universities

José Guilherme from Santa-Rosa of the Federal University of Rio Grande do Norte, helped research on the development, under the approach of participatory design, a virtual teaching-learning of Histology in which students and teachers participated actively in all stages of development. J. Santa-Rosa wrote that Histology is "the study of the tissues of living organisms." The experiment had two theories towards the evaluation of new technologies in the classroom: either "the systems are usually developed without considering the user as the centerpiece of development" or that "the adoption of the use of a virtual environment by the teachers is a determining factor of use by students." The experiment was implanted in several phases:

Phase1: Evaluation of Virtual Environments for Teaching Histology – cooperative evaluation, heuristic evaluation. It was found, in evaluations of existing problems of usability, information architecture and terminology inappropriate for audience of students, which leads us to conclude that probably, the systems are usually developed without considering the user as the centerpiece of development.

Phase 2: Prototype Design of Virtual Learning Environment (using methods and techniques of Participatory Design)

Participatory design techniques such as cardsorting [figure 3], brainstorming and prototyping were used to define system requirements, information architecture, layout and graphical appearance of the interfaces and interaction model in order to adapt the built environment in participatory needs. As a result, it was realized that more than half of the class enrolled in the system and those most believe that the system has contributed to the learning of Histology.

Figure 3: Card sorting with students [3]

Phase 3: Evaluation of the Virtual Prototype Environment

Even the students who did not sign up stated that the system will allow further consultation and review of discipline in the earliest stages of the course. It was noted, however, that most students used in the week of examinations, and although possible, no inserted their own micrographs, which indicates the consultative use of the virtual environment." As a side note, Figure 4, although slightly out of focus, is an example of the prototype that they had created.

Phase 4: Monitoring of the adoption of the Virtual Environment

Regarding the environment developed in this research, it is worthwhile to mention that despite of all the students´ participation during the phases of design and development, after the publication of the web environment, we noticed a low frequency of use, which refutes the hypothesis H1.

Figure 4: Histoexplorer's Interface [3]

It is noteworthy however that, from the time that teachers began to adopt the environment as a teaching tool in the classroom [figure 5], a significant increase in extra-study through the learning environment developed, confirming hypothesis 2 which states that the adoption virtual environment by teachers is a determining factor of use by students.

Figure 5: Virtual environment used as a teaching tool in the classroom [3]

Santa- Rosa concluded that "… the virtual environments for teaching and learning should not be built only from the need to reduce costs and teaching materials available hourly load reduction for the course. The learning objectives must be clearly established and the needs and characteristics of students must be mapped. We conclude that include students and teachers in the development process of the learning environment is essential; however, the paper highlights the importance that teachers reflect on their strategies of adoption of environment. So, the students could build knowledge from student-teacher and student-student interactions" [3]. Basically, everyone would learn from each other on the usage of the environment and, should anyone confront a roadblock during the learning process, either the student or the teacher could clarify any misunderstandings.

Computing in Social Environments

Virtual environments, or VEs, combine engaging interactive locations, social networking, live webcasts and web-based collaboration tools. Virtual Environments are not limited to the classroom. Several of these environments can be found online on gaming, learning, and social websites. These environments give the user a choice of whether or not they would prefer to keep the same persona in the virtual world as they have in the real world.

Social Interaction on a Virtual Level

Simon Evans of the London School of Economics and Political Science, Evans took information about normal social sites and/or gaming sites such as forums, Facebook, and Massively multiplayer online role-playing game (MMORPGs) and classified them based on their characteristics. He chose a topic outside of his original sources of Integrative Psychological & Behavioral Science and delved deeper into the subject of virtual environments then most students whom have an interest in the subject matter would. Evans "…highlighted the role of symbolic mediation in the emergence of Self in virtual environments and postulates that, while emergence of Self is interactive in nature, virtual environments are particular sites for a Self where the specific role of social interaction must be foregrounded."

After a thorough evaluation of Evans' work, we can conclude several theories based upon the knowledge and information provide for us. First, the 'Self' that he continually speaks of would be the person within oneself that is hidden in order to conform to society's rules and preconceptions. Whereas in a virtual environment, the user can create a character to become whoever they wish to be, e.g. a socially awkward person can become the reigning royalty of popularity and an introverted person could be the most creative.

Evans stated that, "…this paper uses the term "virtual environment" to refer to any space facilitated by the Internet and accessed via electronic media such as computers, mobile telephones and tablets, where participants interact with one another." Evans [4] "seeks to explore how we may theorize the Self in the context of virtual environments. While other aspects of experience of Self in virtual environments are highlighted, for example the relationship between an avatar and its user, its main focus is on the role of interactions between online participants in virtual settings. It demonstrates how any emerging theory that considers the Self in virtual environments must foreground the role of interpersonal relationships and interactions. In particular, one aspect of the exploration is to consider the extent to which the experiences in contemporary virtual environments are novel and unique, or in fact exhibit continuities with other environments, both contemporary and in history."

This is not to say that a virtual environment does not have its own share of similarities with reality. Matthew Kassner, Dr. Eric Wesselmann, Alvin Ty Law, and Dr. Kipling D. Williams created a social experiment to research whether or not ostracism in a virtual environment would have similar effects on the human psyche as reality would. As illustrated in Figure 6: Virtual Environment, the one holding the ball shown in the picture is the user, or rather the volunteer in the experiment. Kassner et al. stated that, Electronic-based communication (such as Immersive Virtual Environments; IVEs) may offer new ways of satisfying the need for social connection, but they also provide ways this need can be thwarted. Ostracism, being ignored and excluded, is a common social experience that threatens fundamental human needs (i.e., belonging, control, self-esteem, and meaningful existence). Previous ostracism research has made use of a variety of paradigms, including minimal electronic-based interactions (e.g., Cyberball) and communication (e.g., chatrooms and Short Message Services). These paradigms, however, lack the mundane realism that many IVEs now offer. Further, IVE paradigms designed to measure ostracism may allow researchers to test more nuanced hypotheses about the effects of ostracism. We created an IVE, in which ostracism could be manipulated experimentally, emulating a previously validated minimal ostracism paradigm. We found that participants who were ostracized in this IVE experienced the same negative effects demonstrated in other ostracism paradigms, providing, to our knowledge, the first evidence of the negative effects of ostracism in virtual environments."

Fig. 6: Virtual Environment [5]

Kassner et al. gathered willing and naïve participants to conduct the experiment on. Normally, when a person first hears about ostracism they think social cliques that are generated in school and continue through life. To actually see and experience it in practice in an Immersive Virtual Environment (IVE) such as Facebook, Twitter, and/or online massively multiplayer online role playing games (MMORPGs) is a minor culture shock. It's easy to say that socializing isn't easy, but for some people to go to such an extent just to make themselves feel better about their place in society makes one wonder if anyone truly grows up or do they just put on a new face?

After conducting the social experiment, Kassner et al. discovered that regardless of the social setting – be it school or work, reality or fiction – ostracism is a permanent aspect of society. As such, the ramifications of such a stigma towards the human mind are vast and detrimental to one's health. In a general discussion Kassner and company reported that, "Our data indicate that ostracism in an Immersive Virtual Environment threatens four basic fundamental needs (i.e., belonging, control, self-esteem, and meaningful existence) and also has a negative impact on affect."

Computing in Various Careers

Just as computing is not limited in education, neither is it limited in careers. Numerous careers use computer science in a variety of innovative ways.

Using Virtual Environments in the Medical Field for Rehabilitation Methods

"Virtual reality (VR)-based games and environments are recognized as an effective therapeutic approach in rehabilitation of individuals with acquired brain and spinal cord injuries. A key component of VR applications is their ability to model almost any type of environment and to manipulate visual perception, thereby influencing motor performance." Amanda Y Schafer and Ksenia I Ustinova decided to conduct a different experiment that could or would increase benefits of using virtual environments on patients, especially in individuals with traumatic brain injuries (TBI). Schafer and Ustinova noted that, “Although numerous virtual reality applications have been developed for sensorimotor retraining in neurologically impaired individuals, it is unclear whether the virtual environment (VE) changes motor performance, especially in patients with brain injuries. To address this question, the movement characteristics of forward arm reaches during standing were compared in physical and virtual environments, presented at different viewing angles.” [6]

Schafer and Ustinova conducted a physical experiment with several patients with traumatic brain injuries and the same number of healthy sex- and age-matched volunteers using a virtual environment (VE) and the physical environment (PE).

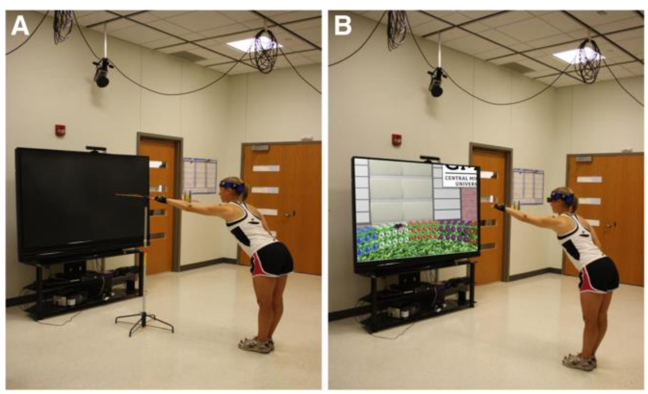


Figure 7: Experimental setup with the control subject reaching forward in the physical environment (A) and in the virtual environment projected onto a screen at 10° (B). [6]

Schafer and Ustinova designed this experiment with two goals in mind: “The first goal was to investigate whether the VE changes motor performance in patients with TBI…. The second goal was to test an effect of viewing angle of the VE projection on movement performance in patients with TBI. We hypothesized that depending on the viewing angle, patients with TBI and healthy participants will be able to reach farther in the VE, compared to the reaching in the PE.” After conducting the experiment several times, they noticed that a definite pattern in reaching distance was slowly being established between using the PE and the VE.

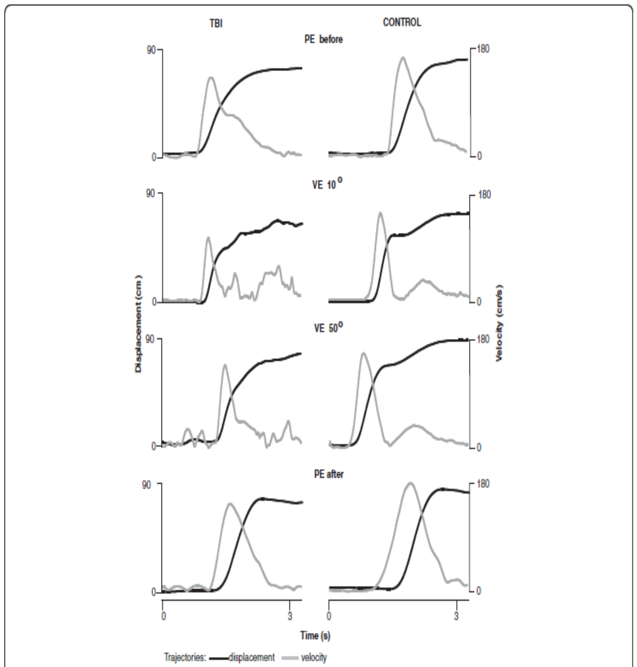


Figure 2 Trajectories of the arm displacement magnitude (black) and velocity (gray) in a representative participant with TBI (left panel) and in a control individual (right panel). Reaches were done in the VE presented at 10° and 50° and in the PE before and after virtual reaches.

Figure 8: Trajectories of the arm displacement magnitude (black) and velocity (gray) in a representative participant with TBI (left panel) and in a control individual (right panel). Reaches were done in the VE presented at 10° and 50° and in the PE before and after virtual reaches. [6]

As evidenced by Figure 8, Schafer and Ustinova concluded “Our findings confirm the hypothesis that the VE increases reaching distance in patients with TBI, depending on the viewing angle. The results may suggest that visual perception in the VE differs from real-world perception. Accordingly, the viewing angle is a critical parameter that should be adjusted carefully to adapt motor performance and to achieve maximal therapeutic effect during practice in the VE. This observation is important, considering that about 50% of TBI survivors exhibit visual perceptual problems [18, 19]. More research needs to be done, with studies including patients with severe sensorimotor and visual perceptual deficits.” [6]

Using Computing in Marketing to Gauge Information

M. Hardy ‘offers opinions on marketing research. The creation of visual representations of complex data is said to be one of the most significant elements of marketing research, particularly its ability to incorporate the techniques of statistical cluster analysis into visual information. The company Experian is used as an example to support the contention that an industry devoted to the classification and conceptualization of data has become an integral part of the world economy. Marketing researchers are urged to incorporate data visualization in their work.’

Technically, this subject matter used to find this subject was visual programming; however this article can be used as a comparison. As noted by Hardy, “In other words, complex data is rendered more or less understandable by tapping in to our visual senses and cultural knowledge about, for example, consumers like Dean or Chloe, as well as 'new systems' that incorporate geodemographics.’ This statement is true for all careers that utilize complex data and find that it is easier if the data is put in a visual format.”

According to Hardy, “There is a new craft within marketing that is devoted to the creation of visual representations of complex data. These ‘visualizers’ are the new craftsmen (and often women) of marketing, who work on large and often emergent flows of data in the digital back office. Their product is inserted into the marketing reports and documents of all kinds and does much to shape our view of the world.” As Computer Scientists could we also be called ‘visualizers’? It could be something innovative and new to help cement our place in the world as more than just gamers and programmers. Or are these ‘visualizers’ a new term given to those who may have utilized both a Business and Computer Science degree in their line of work?

Hardy concludes his article with, “Looking ahead, information will become increasingly complex, rich and visual (see Wilson 2009; Elwood 2011). The awareness of different sources of data, the content of data visualizations and analytical process adopted will need to be incorporated into all elements of market research. Where the visualizers may offer new visions of data capture, their role, associations and insights need to be carefully considered. Indeed, as craftsmen/women, they offer productive ways of working with information that is built on a tradition of visual practices that offer new ways of knowing and seeing the world.”

Computing in Chemistry

Computational Chemistry: Utilizing Computer Science and Chemistry to the Fullest Extent

As one can infer, computational chemistry is a combination of chemistry and computer science used to increase the potential and possibilities of such a merger. Martin Gütlein, Andreas Karwath and Stefan Kramer summarize that, “Analyzing chemical datasets is a challenging task for scientific researchers in the field of chemoinformatics. It is important, yet difficult to understand the relationship between the structure of chemical compounds, their physico-chemical properties, and biological or toxic effects. To that respect, visualization tools can help to better comprehend the underlying correlations. Our recently developed 3D molecular viewer CheS-Mapper (Chemical Space Mapper) divides large datasets into clusters of similar compounds and consequently arranges them in 3D space, such that their spatial proximity reflects their similarity. The user can indirectly determine similarity, by selecting which features to employ in the process. The tool can use and calculate different kind of features, like structural fragments as well as quantitative chemical descriptors. These features can be highlighted within CheSMapper, which aids the chemist to better understand patterns and regularities and relate the observations to established scientific knowledge. As a final function, the tool can also be used to select and export specific subsets of a given dataset for further analysis."

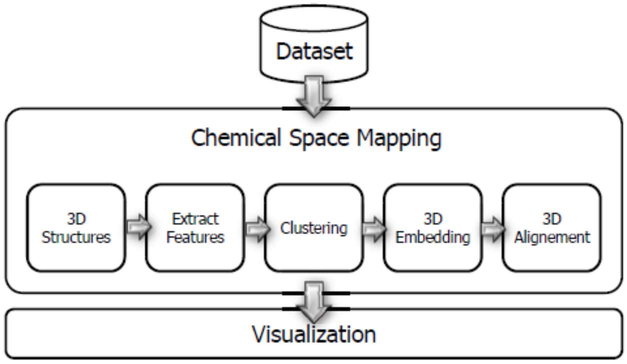


Figure 1 The CheS-Mapper Workflow. The CheS-Mapper application workflow is divided into two main parts: Chemical Space Mapping (can be configured with a wizard) and 3D Visualization.

Figure 9: The CheS-Mapper Workflow. The CheS-Mapper application workflow is divided into two main parts: Chemical Space Mapping (can be configured with a wizard) and 3D Visualization.

Gütlein et al. deliver yet another demonstration of the diversity of Computer Science field. The main topic of the article is included in Computational Chemistry, which is a combination of Chemistry and Computer Science, but it is more than just that. As discussed by Dr. Holmes of the Fort Valley State University Science Department, "Computational chemistry is a branch of chemistry that uses computer simulation to assist in solving chemical problems. It uses methods of theoretical chemistry, incorporated into efficient computer programs, to calculate the structures and properties of molecules and solids."

Gütlein et al. wrote, "Visualization can be vital to examine the dataset for possible interdependencies between compound structures, compound features, and endpoint values." [8]

Computing in Human Resources

Using Virtual Environments as More than a Learning Tool

Eric Vidal is the director of product marketing for event services at InterCall (www.intercall.com), the world's largest conferencing and collaboration services provider. He discusses "how human resources (HR) personnel can create a more user-friendly and engaging atmosphere in the workplace through virtual environments. He states that employing virtual-environment technology in the creation of virtual job fairs can help improve brand impression while examining applicants more efficiently. He suggests using the technology to provide the organization with a little mystic from the film *Avatar*."

Vidal used a well-known movie, *Avatar*, to demonstrate a connection of how to capture the audience's attention. He stated, "Whether you liked the storyline to the movie Avatar or found it rather thin and predictable, one thing most people agree on is that the visual depiction of Pandora really held your attention. Being thrust into an environment that had similarities to the one in which we live (trees, bridges, buildings, etc.) yet was so completely different (and let's face it, cooler) created an experience that left most of us thinking about what we saw long after we left the theater."

Naturally, we are curious people and even the slightest hint that there could be something or someone on another planet beyond the stars, intrigues us. Imagine, actually utilizing every possible resource available to you in order to find and inspect possible employees. It's truly frightening to realize that no one's life is really *personal*. Friends, relatives, former/current classmates, and associates of the possible employee could easily be found a social networking site. As implicated by Vidal, "Further complicating matters is that, according to CareerBuilder.com, more job candidates are using Facebook, Twitter, LinkedIn, and other social networks to check out companies before they apply for jobs. They are forming brand impressions before they ever speak to a recruiter."

Vidal concludes his paper with a seven step How To: guide on creating and including a virtual environment in the workplace. Those seven steps are:

1. Start by defining the strategy and the goals for your virtual environment. Do you want to create more interaction between top management and the rank and file? Are you trying to get more employees to self-serve when it comes to benefits questions rather than calling when they have a question?
2. Plan and build the experience. Know what you want it to be—and what you want it to say about your organization. Virtual environments by nature are very visual, so what people see defines who you are. Think about the navigation and how you can make it easy for visitors to find what they need. Lay out a schedule of activities – what needs to be done by whom and by when—and then stick to it.
3. Promote often and well in advance of the completion of your virtual environment.
4. Do a NASA-like check before launch. Review it thoroughly, and have a few people who have never used it before check it out for ease of use and functionality as well. Only launch when you are sure everything is as it should be.
5. Launch—and monitor. Prepare documentation so everyone working the virtual environment knows their roles and responsibilities—as well as what to do in the event of something unforeseen. For limited-time events, have someone on staff overseeing all aspects and be available. For ongoing environments, have one or more people assigned to provide continuous monitoring of performance and to make sure questions are being answered in a timely manner.

6. Evaluate and analyze. Whether you're building a one-day job fair or an ongoing entity, one of the best features of virtual environments is the ability to gather data and make constant improvements. If you find certain documents or areas are never visited, get rid of them. If some content is very popular, create more like it or promote it to increase traffic (if that is a goal). If you're doing a limited-time live event, use the data from that period to make adjustments to the on-demand offering that will follow it. And be sure to gather all the stakeholders to discuss what went right, what didn't go as well as you'd like, and start the cycle all over again.
7. Some components or features inside the virtual environment can be offered separately (e.g., InterCall products like webcasts, audio conferencing, and online meetings, as well as outside social media solutions like Twitter and LinkedIn, of course).[9]

Computing as a Whole

This report has covered several aspects of computing and computer science in various positions. Finally, several of the most frequently asked questions: what is computer science exactly? How does it relate to K–12 education? What can we do to encourage computational thinking before college?

Table 1

Core Computational Thinking Concepts and Capabilities [11]

CT Concept, Capability	CS	Math	Science	Social Studies	Language Arts
Data collection	Find a data source for a problem area	Find a data source for a problem area, for example, flipping coins or throwing dice	Collect data from an experiment	Study battle statistics or population data	Do linguistic analysis of sentences
Data analysis	Write a program to do basic statistical calculations on a set of data	Count occurrences of flips, dice throws and analyzing results	Analyze data from an experiment	Identify trends in data from statistics	Identify patterns for different sentence types
Data representation	Use data structures such as array, linked list, stack, queue, graph, hash table, etc.	Use histogram, pie chart, bar chart to represent data; use sets, lists, graphs, etc. To contain data	Summarize data from an experiment	Summarize and represent trends	Represent patterns of different sentence types
Problem Decomposition	Define objects and methods; define main and functions	Apply order of operations in an expression	Do a species classification		Write an outline
Abstraction	Use procedures to encapsulate a set of often repeated commands that perform a function; use conditionals, loops, recursion, etc.	Use variables in algebra; identify essential facts in a word problem; study functions in algebra compared to functions in programming; Use iteration to solve word problems	Build a model of a physical entity	Summarize facts; deduce conclusions from facts	Use of simile and metaphor; write a story with branches
Algorithms & procedures	Study classic algorithms; implement an algorithm for a problem area	Do long division, factoring; do carries in addition or subtraction	Do an experimental procedure		Write instructions
Automation		Use tools such as: geometer sketch pad; star logo; python code snippets	Use probeware	Use excel	Use a spell checker
Parallelization	Threading, pipelining, dividing up data or task in such a way to be processed in parallel	Solve linear systems; do matrix multiplication	Simultaneously run experiments with different parameters		
Simulation	Algorithm animation, parameter sweeping	Graph a function in a Cartesian plane and modify values of the variables	Simulate movement of the solar system	Play age of empires; Oregon trail	Do a re-enactment from a story

Barr and Stephenson created a basis for change in K–12 education including a table of Core Computational Thinking Concepts and Capabilities for Science, Math, Language Arts, Computer Science and Social Studies [Table 1]. Their article consists of but is not limited to: multiple definitions of computer science and computational thinking, how computer science can relate to K–12 students and their core classes, and what can we do to encourage an interest in computing. (Please note: Table 1 is included in the Conclusions and Summarization section. It was also found in reference 11.) In short, Barr and Stephenson summarize that, “The process of increasing student exposure to computational thinking in K–12 is complex, requiring systemic change, teacher engagement, and development of significant resources. Collaboration with the computer science education community is vital to this effort."

Many people have argued as to the true definition of computer science. According to Barr and Stephenson, theories have run rampant about computer science since 1985. "Questions of the nature and educational value of computer science are as old as the discipline itself. In 1985, Abelson and Sussman argued that computer science is "a discipline of constructing appropriate descriptive languages." However our question is this: what is the definition for computer science in regards to K–12 educators? Barr and Stephenson state that "The ACM Model Curriculum for K–12 Computer Science [11] provides a definition of computer science specifically for K–12 educators. Computer science argues that it is neither programming nor computer literacy. Rather, computer science is "the study of computers and algorithmic processes including their principles, their hardware and software design, their applications, and their impact on society" (pg. 1). Computer science therefore includes: programming, hardware design, networks, graphics, databases and information retrieval, computer security, software design, programming languages and paradigms, logic, translation between levels of abstraction, artificial intelligence, the limits of computations (what computers cannot do), applications in information technology and information systems, and social issues (Internet security, privacy, intellectual property, etc.).

As an interested reader, it is important to note to not assume that everything will be easily fixed if there is no set plan or precedent. Barr stated that, "The successful embedding of computational thinking concepts into the K–12 curriculum requires efforts in two directions. Educational policy must be changed, overcoming significant infrastructure hurdles, and K–12 teachers need resources, starting with a cogent definition and relevant age appropriate examples. In this paper we report on the first part of a multiphase project aimed at developing an operational definition of computational thinking for K–12 along with suitable resources for policy and curricular change. In addition to explaining the issues involved in the K–12 arena, this paper, following Gal-Ezer and Stephenson [4], is intended to help bridge the gap between the K–12 and CS education communities."

The final part of their plan includes the CSEC. Stephenson and Barr concur that, "The computer science education community can play an important role in highlighting algorithmic problem solving practices and applications of computing across disciplines, and help integrate the application of computational methods and tools across diverse areas of learning. At the same time, CS educators must understand the complexities of the K–12 educational setting, incorporating that knowledge into outreach activities and support for K–12 changes.

Developing a definition of, or approach to, computational thinking that is suitable for K–12 is especially challenging in light of the fact that there is, yet, no widely agreed upon definition of computational thinking…. Computer scientists can promote understanding of how to bring computational processes to bear on problems in other fields and on problems that lie at the intersection of disciplines. For example, bioinformatics and computational biology are different, but both benefit from the combination of biology and computer science. The former involves collecting and analyzing biological information. The latter involves simulating biological systems and processes. Presenting both bioinformatics and computational biology in algorithmic form helps scientists exchange information [5], [11].

In conclusion, each source has revealed several aspects of computer science and computing. From computing in K–12 education to computing in numerous careers, social experiments regarding the effects of virtual environments on the human psyche, and the use of virtual environments for acts of rehabilitation. Needless to say, we have been affected by computing too much to distance ourselves and although not all of the results are positive, the benefits are too great for us to ignore.

Virtual Environments in Mathematics Education

Mathematics achievement in the African American community is a huge concern in mathematics education. According to the National Assessment of Education Progress (NAEP), Caucasian students scored higher in all grade levels than African American students. The NAEP also reported that Hispanic and African American students scored below Caucasian students. Only 8% of Hispanic students and only 5% of African American students are at or above the achievement level than their Caucasian counterparts. Having access to algebra instruction in middle school will facilitate achievement in more advanced mathematics courses in secondary education according to Nasir, et al. Low achievement in mathematics has adverse and negative implications in a student's adult life such as limited opportunities in higher education, earning potential, employment, etc. (Lee, 2002).

Much progress has been made in closing the gap in mathematics achievement between majority and minority students. However, there is still much work to be done to increase mathematics achievement and to close the gap. Mathematics educators need places for their students to supplement their classroom instruction. All students deserve the opportunity to receive a quality education in mathematics.

> "We live in a time of extraordinary and accelerating change. New knowledge, tools, and ways of doing and communicating mathematics continue to emerge and evolve. Calculators, too expensive for common use in the early eighties, now are not only

commonplace and inexpensive but vastly more powerful. Quantitative information available to limited numbers of people a few years ago is now widely disseminated through popular media outlets. The need to understand and be able to use mathematics in everyday life and in the workplace has never been greater and will continue to increase" [48].

Here are a few examples from the National Council for Teachers of Mathematics (NCTM) *Principles and Standards for School Mathematics* [49]:

1. ***Mathematics for life***. Knowing mathematics can be personally satisfying and empowering. The underpinnings of everyday life are increasingly mathematical and technological. For in- stance, making purchasing decisions, choosing insurance or health plans, and voting knowledgeably all call for quantitative sophistication.
2. ***Mathematics as a part of cultural heritage***. Mathematics is one of the greatest cultural and intellectual achievements of human- kind, and citizens should develop an appreciation and under- standing of that achievement, including its aesthetic and even recreational aspects.
3. ***Mathematics for the workplace***. Just as the level of mathematics needed for intelligent citizenship has increased dramatically, so too has the level of mathematical thinking and problem solving needed in the workplace, in professional areas ranging from health care to graphic design.
4. ***Mathematics for the scientific and technical community***. Although all careers require a foundation of mathematical knowledge, some are mathematics intensive. More students must pursue an educational path that will prepare them for lifelong

work as mathematicians, statisticians, engineers, and scientists. [49]

Through innovative pedagogies that use culture in the mathematics curriculum to enhance and facilitate learning, the gap in mathematics achievement between Caucasian students and African American students should decrease.

Parks, Simmons and Gilbert (2003) developed the African American Distributed Multiple Learning Styles System (AADMLSS) as a collaborative research project to advance the African American community through the use of innovative information technologies. The goal is to improve learning and mathematics achievement. This project is funded by the National Science Foundation which involves several educational institutions: Auburn University, Clemson University, Boston University, Portland State University, and Texas A&M University. AADMLSS is an online technology that incorporates culture and instructional tools into the learning environment.

AADMLSS

AADMLSS is a three dimensional multimedia system with rap lyrics and animated characters of African American decent. These characters are conversational tutors. The use of African Americans as tutors creates an environment of familiarity for the learner while learning mathematical concepts. AADMLSS also creates a culture which resembles an urban setting.

The AADMLSS educational system is a hierarchical structure. This hierarchical structure contains three layers: Courses, Module, and Concept. The Course level is the highest layer followed by the middle layer, the Module, which contains the instructors for the course. At this level, the instructor uses his or her own teaching style. The bottom layer is the Concepts that consist of the lessons for the course. Each lesson focuses on a specific learning objective. This is a many-to-one relationship between the course and the concepts. The benefit of this adaptive model is to ensure that the student's learning style is appropriately matched to the instructional style, thus facilitating learning.

The course that is presently used in AADMLSS is Algebra. The Algebra course contains three components: Instruction, Assessment, and Practice. The core of AADMLSS is the AADMLSS Practice. The Instructional component presents the objectives of each lesson to the student in a culturally relevant manner. For example, the objective of the first lesson is to solve linear equations. The student is asked to enter his or her name. An avatar is created so that the student can interact within its three dimensional (3D) environment. Once the avatar enters the candy store to purchase candy and a selection is made, the total purchase price is given. The student avatar will calculate the price of a single candy bar by presenting a solution to a linear equation. The student can interact with its environment by pausing and repeating the animation as needed. This process continues until the student has interacted with each of the worlds within the environment.

The Practice component provides opportunities for the student to practice and supplement the learning goals. Once the Instruction component is completed, the student goes to the Practice component to reinforce the concepts and to practice problems. Next, an assessment is given to the student. The assessment component evaluates the student on the concepts taught in the Instruction and Practice components, respectively. The student interacts with the system via the keyboard and mouse. The student must achieve at least 80% on the assessment to have mastered the learning objectives. If the student scores 80% or better, the system automatically moves the student to the next lesson with the same instructional methods and styles. However, if the student scores below 80%, the same algebra lesson will be reassigned with a different instructional approach using the many-to-one adaptive instructional model. Each lesson can repeated as necessary whether from the Instruction component to the Assessment component.

The Instruction component utilizes animation to train the student as well as the Assessment component. Within the Instruction component, the environment is three dimensional and has a gaming look and feel. The Practice component allows the student to interact in the environment with a tutor through typing. Paper and pencil or computer-based testing is used in the Assessment component with no advanced technologies.

Culturally Relevant Instruction

Hanley (2010) indicates that culturally relevant instruction can be used as a method for enhancing learning for African American students. Also, culturally relevant instruction empowers students intellectually, socially, emotionally, and politically through knowledge, skills, and attitudes. Ethnomathematics is the study of the relationship between mathematics and culture. Ethnomathematics belongs to a broad cluster of ideas ranging from distinct numerical and mathematical systems to multicultural mathematics education. Ethnomathematics facilitates understanding culture as well as mathematics (Wikipedia, 2010). By implementing culture into the curriculum facilitates students in making connections with mathematics and learning mathematical concepts (Abdal-Haqq, Barta, Schelling, & Katz). When culture is integrated into the curriculum, ethnomathematics assists students in developing a deeper mathematical understanding (Masingila & King, 1997). "At the heart of culturally relevant instruction is the culture of the learner. In order to use ethnomathematics to teach African American students, before an instructional program that is relevant to students is designed, their predominant culture must be identified" (Masgingila & King).

“MindRap is another tool that harnesses the power of culture and the students’ creativity to energize the learning process and encourage an interest in math and science by combining interactive teaching applications with hip-hop music and culture (Gilbert et al., 2008). In another example, Lee uses culture modeling to teach literature. Culture modeling in essence provides instructional organization that makes academic concepts, strategies, and habits explicit and provides ways of engaging in the work of the disciplines familiar and that provides supports for instances where the learner is unsure (Lee, 2007). She uses the culture of everyday practices as a lens for understanding the role of perception in influencing actions. Within culture modeling, culture data sets are used, which are familiar examples that new learning can be anchored and used to provide problems whose solutions mirror the demands of the academic task that the learner is to discover (Lee, 2007). Similarly, Eglash investigates fractal geometry as in geometric patterns, calculations and theories, as facets expressed in various African cultures (Eglash, 1999). Making connections across relevant schemata or clusters of schematic networks helps to create connections between the known and the unknown.

Table 2 shows how Lee engages inner city students in conversations about symbolism by discussing well-known rap lyrics and drawing parallels to similar ideas in literature.

Table 2

Lee's Culture Data Set Example

Culture Data Sets	Literature
Rap lyrics "The Mask" by the Fugees 1996 Students analyze the meaning of the Mask and terms in the Mask like "why Golden Child was not symbol but figurative language such as saying 'you star bright is a another way of saying you light-skinned'"	Symbolism
Rap video "I use to Love Her" by Common Sense 1994	Symbolism
Short story "Everyday Use" by Alice Walker 1994	Symbolism
Novel "Beloved" by Toni Morrison 1987	Symbolism

Similarly, Table 3 shows the connection made by Eglash in identifying illustrations of fractal geometry in indigenous African architecture designs, decorative arts, ceremonies and customs. Much like the models created by Eglash and Lee, this research demonstrates a similar model" (Eugene, 2011).

Table 3

Eglash African Fractals Example

Culture	Fractals
Kinship and descent	Recursion
Divination	Binary codes=> numeric systems
African windscreen (the Sahel have strong wind and dust. The shortest rows keep the dust out the best because they are the tightest weaved, but also require more material and effort. They know that wind blows stronger when you go up from the ground, so they make the windscreen to match)	Scaling
African windscreen: Maximum in function (keeping dust out) for a minimum of cost (effort and materials)	Cost benefit analysis

According to Eugene (2011), “There are several examples in research, and other disciplines and domains of various efforts of using culture attributes, practices and experiences to facilitate learning and to connect to the mental model of the target audience. Numerous tools and agents have been developed in response to the understanding of the importance of culturally relevant learning.”

Adaptive Instruction

Every student learns differently just as every instructor teaches differently. When designing tutorials, one must be cognizant of the teaching and learning styles of all stakeholders.

It is imperative to consider instructional techniques so that individual learning styles are being accommodated as shown in several studies (Gilbert, 2000; Gilbert & Han, 2002). Thus, adaptive instruction is used in the form of many-to-one or Multiple Instructor Single Learner (MISL). The many-to-one instructional model refers to the relationship between instructors and learners. With this model, a student can have many instructors. The goal is to ensure that the concepts being taught are being understood and learned by the students. Thus, the learner can have access to pedagogical approaches.

Virtual Learning Environments in Gaming

When most people think of video games designed for children negative thoughts come to mind because of how video games are portrayed; however, video games can enhance learning in numerous ways. Prensky suggests that video games are, "The best opportunity we have to engage our kids in real learning" [11]. Since most people are visual learners, video games have become a very popular mechanism for students to learn. On average kids will spend at least 10,000 hours playing video game by the time they are 21 years old [12]. Kids enjoy playing video games, so this is a perfect opportunity to learning this phenomena to support learning. Video games reach audiences of all demographics, and also becoming increasingly popular amongst females. Prensky implies, "Kids, like and all humans, love to learn when it isn't forced on them" [13]. Kids may be unaware, however, that some form of learning is taking place each second they are playing a video game. According to Shaffer, "Video games create new social and cultural worlds: worlds that help people learn by integrating thinking, social interaction, and technology, all in service of doing things they care about" [14].

The large question at hand that many critics of video games face is if video games are really engaging to kids. Prensky states that there are 12 major elements that help support how video games are engaging to students [15]:

1. Games are a form of **fun.** That gives us ***enjoyment and pleasure.***

2. Games are form of **play**. That gives us ***intense and passionate involvement.***

3. Games have **rules.** That gives us ***structure.***

4. Games have **goals.** That gives us ***motivation.***

5. Games are **interactive.** That gives us ***doing.***

6. Games are **adaptive.** That gives us ***flow.***

7. Games have **outcomes and feedback.** That gives us ***learning.***

8. Games have **win states.** That gives us ***ego gratification.***

9. Games have **conflict/competition/challenge/opposition.** That gives us ***adrenaline.***

10. Games have **problem solving.** That sparks our ***creativity.***

11. Games have **interaction.** That gives us ***social groups.***

12. Games have **representation and story.** That gives us ***emotion.***

There is no other learning tool that can fully incorporate all of these features. Books and lectures share some characteristics, but they are traditionally not very interactive. These elements are not present in every single video game, but when they are present they can be used as a powerful learning tool. Gaming designed for learning is still a fairly new topic on the rise and Prensky states "An emerging coalition of academics, writers, foundations, game designers, companies like Microsoft and, increasingly, the U.S. Military is working to make parents and educators aware of the enormous potential for learning contained in the gaming medium" [16].

Video Games in Mathematics

Mathematics is a subject that many students across the United States struggle with, and this is mainly because they find the subject boring and irrelevant to their lives. According to Sedighian, there are two closely inter-related issues regarding learning mathematics in the context of computer-based mathematical game (CBMG) environments [17]:

1. Some of the needs of children when learning mathematics
2. Elements that motivate children to learn the embedded mathematical content.

Motivation plays a central role in any learning activity [18]. If a child is not motivated to learn chances are they will not pick up the essential skills needed to fully understand the material. Electronic games to enhance children's motivation towards school subjects [19]. Sedighian suggest, "When playing well-designed CBMGs (i.e., ones in which the mathematics is used as a continual and natural part of the game rather than as incidental diversions from the main activity), children gradually develop the need to learn the embedded mathematical content in order to satisfy their need to play the game" [20]. It is important to understand the needs of the student in order for the video game to be effective. Based on Sedighian's observations there are eight factors affect children's learning of mathematics [21]:

1. ***Meaningful learning****:* Computer games are an integral part of children's popular culture [22].
2. *Goal:* Oftentimes CBMGs provide children with a goal or a set of goals to achieve.
3. ***Success:*** Accomplishing the goals of CBMGs can provide children with a sense of success.
4. **C*hallenge*:** Being challenged motivates kids to do better.

5. ***Cognitive artifact****:* This interactive learning process helps children develop a sense of the mathematics they are learning.
6. ***Association through pleasure***: Children need to associate mathematics with some pleasant memory.
7. ***Attraction****:* In order to stimulate children to intensely think about mathematics, they need to be put in learning environments which attract them to mathematics and allow them to experience the joy of learning it.
8. ***Sensory stimuli****:* Children such sensory stimuli add to the fun of playing the game and make the learning of mathematics more enjoyable and memorable.

Three-Dimensional Digital Environments

The use of three-dimensional (3-D) representations tends to be very motivational and engaging to students [23]. Three-dimensional graphics, along with virtual environments enhance education for K–12 students. Jorge Ferreira Franco and Roseli de Deus Lopes explains that three-dimensional digital environments improve learning, is effective, and leaves life learning experience for students [24]. They have conducted data showing that there is great potential for stimulating individual motivation and development from places that are at sometimes at a social and economic disadvantage.

Another study conducted by Khe Foon Hew and Wing Sum Cheung examines the use of 3-D virtual worlds in educational settings and how they assist students [25]. The authors reviewed multiple studies about virtual worlds and formed conclusion. The research conducted explores how teachers use virtual worlds to teach, and how students use virtual worlds to teach and learn. With their analysis they observed that virtual worlds may be utilized for communication spaces, simulation of space, and experiential spaces. Most of the research was conducted at universities, and the virtual worlds were implemented in the areas of concentrations such as health, environment, media, and the arts. Studies show that students like 3D worlds because they are able to explore the spaces; however they dislike the fact that they are unable to accesses virtual worlds on older computers [26].

Benefits of Virtual Learning Environments

Many people feel that virtual learning environments will eventually dominate or replace traditional classrooms in the future. There are thousands of schools across the US using VLEs because how convenient they are and their effectiveness. There are many different types of virtual learning environments and they can cater to individuals' specific needs. With the advancements in technology elements that are presented in a traditional classroom setting can be duplicated digitally. Wayne Galloway express, "More flexible, comprehensive and dynamic communication is now possible through the available technologies of videoconferencing, live broadcasting, and faster connection speeds" [27]. Virtual learning environments can provide rewarding experiences, and they may very well be the means of learning in the future.

Disadvantages of Virtual Learning Environments

While many people favor with virtual learning environments, there are still some concerns whether they are truly effective or not. Many people feel that virtual learning environments are becoming popular because they are convenient to students and professors; however, they fail to engage the learner. The lack of social interaction may harm students in the long run. M. J Stiles suggest that learning is a social process and VLEs eliminates this, "VLE's lead to a genuine sense of isolation, and in ignoring the social aspects of learning lead to less effective learning" [28]. He also feels that there are certain conditions that are required for effective learning, and until these conditions are met most virtual learning environments are inadequate for the learning process.

Video Games

Video games are a huge entity in today's society. As we continue to strive in technology and in education separately, it is beneficial for the two disciplines to cross paths. By finding new and interactive styles of teaching youth causes students to become more involved in their learning instead of passively receiving the information. Educational video games or "edutainment" can be an extremely effective form of teaching for both students and teachers.

Who Really Plays Them?

The demographics research has shown that over half of all Americans are active gamers [24]. A gamer is a term used to describe an individual who plays video games on a regular basis. An estimated 68% of American households play computer or video games.

The entertainment software association (ESA) is an organization that has been conducting market research on the video game industry and its products for years [7]. The ESA is the U.S. association dedicated to serving the business and public affairs needs of companies publishing interactive games for video game consoles, handheld devices, personal computers, and the Internet [7]. The ESA offers services to interactive entertainment software publishers including a global antipiracy program, owning the E3 EXPO, business and consumer research, federal and state government relations, First Amendment and intellectual property protection efforts [8]. The leaders in the video game industry like, Atari, EA (Electronic Arts), Sony, Microsoft, and Ubisoft are current and ongoing members. Their research and the research of other organizations like theirs has shown that the majority of gamers are between the ages of 18–

49 and that of that majority 40% are female. A study has found that more than half of adults play video games, about one-fifth play daily or almost every day [8].

Controlling Content/Parental Controls

Among elementary and middle school populations, girls play for an average of about 5.5 hours/week and boys an average 13 hours/week [27]. Playing games is not limited to adolescent boys. Recently, the Wall Street Journal reported that several companies are now designing video game consoles for preschoolers. Preschoolers aged two to five plays an average of 28 minutes/day. The amount of time spent playing video games is increasing, but not at the expense of television viewing which has remained stable at about 24 hours/week [27].

Of course there is a mass market for youth who play video games. Because those who are not of working age and even many who are do not have the buying capacity to purchase their own games and consoles there is some in the household who is supporting this habit. Parents are the ones who purchase many games, or other relatives in the form of a gift of some sort. The experts have many rules, regulations, and tip as to how handle and over see gaming in the household. Parental controls are tools available to parents to use so a way of controlling from a distance the use of gaming, and electronics in general around the home. The "power of the purse" is what some call it, when a parent exercises the authority of simply declining to purchase a game that they see as inappropriate for their child. Parents can, and do, establish media budgets to better control what their kids see, hear, or play [27]. Those whom feel strongly about the issue of negative behavior as a result of violence and graphic material in video games and interactive entertainment see parental controls not as an option but a non-negotiable necessity in every household that has a child [27].

An important tool in the fight for control of content is the Entertainment Software Rating Board (ESRB) [10]. The ESRB is a non-profit, self-regulatory body established in 1994 by the Entertainment Software Association (ESA) [7]. ESRB independently assigns computer and video game content ratings, enforces advertising guidelines, and helps ensure responsible online privacy practices for the interactive entertainment software industry [13]. Their mission is "To empower consumers, especially parents, with the ability to make informed decisions about the computer and video games they choose for their families through the assignment of age and content ratings, and to hold the computer and video game industry accountable for responsible marketing practices." Their philosophy is to listen to all from expert to parent and they have come up with a ratings system for video games on the market, it is supported by retailers and is considered the best entertainment rating system in the US [10].

The ESRB's system is twofold; there is the rating symbol on the front and the content descriptors on the back [10]. The ESRB has seven rating symbols that give the appropriate age for someone playing the game [10]. It is on the front of almost every game box whether for retail or rental. There is also a content descriptor, which can be found on the back next to the rating symbol. This will describe the content and element in a game that may have triggered a particular rating, or anything that may be interesting and especially anything that may be a concern to a parent. The rating symbols are:

> EARLY CHILDHOOD
> Titles rated EC (Early Childhood) have content that may be suitable for ages 3 and older. Contains no material that parents would find inappropriate.
>
> EVERYONE
> Titles rated E (Everyone) have content that may be suitable for ages 6 and older. Titles in this category may contain minimal cartoon, fantasy or mild violence and/or infrequent use of mild language.

EVERYONE 10+
Titles rated E10+ (Everyone 10 and older) have content that may be suitable for ages 10 and older. Titles in this category may contain more cartoon, fantasy or mild violence, mild language and/or minimal suggestive themes.

TEEN
Titles rated T (Teen) have content that may be suitable for ages 13 and older. Titles in this category may contain violence, suggestive themes, crude humor, minimal blood, simulated gambling, and/or infrequent use of strong language.

MATURE
Titles rated M (Mature) have content that may be suitable for persons ages 17 and older. Titles in this category may contain intense violence, blood and gore, sexual content and/or strong language.

ADULTS ONLY
Titles rated AO (Adults Only) have content that should only be played by persons 18 years and older. Titles in this category may include prolonged scenes of intense violence and/or graphic sexual content and nudity.

RATING PENDING
Titles listed as RP (Rating Pending) have been submitted to the ESRB and are awaiting final rating. (This symbol appears only in advertising prior to a game's release [10].)

Economic Influences

As can be expected from the stats on the frequency in households' video games have made a major impact on the economy as well. The entertainment software industry represented 3.8 billion dollars in added value for the GDP (U.S. Gross Domestic Product) in 2006 [16]. It has continued to see an incline in every year since [22].

The industry is also a mass employer, they have directly or indirectly employed more than 80,000 people and the industry is growing at an annual rate of 4.4 percent, which in today's market in exceptional. California is currently the largest employer of computer and video game personnel in the nation, representing 40 percent of the industry and 1.8 million in compensation. So, this industry does not only represent the people that play it on a very regular basis, it also represent real financial value for our country and jobs in many households.

The industry that was once looked upon as a little industry, has now become a serious cash cow for the US and abroad. The sales growth from 2007–2008 alone was 2.2 billion dollars [22]. In 2009, the video game revenues reach a staggering $41.9 billion dollars in sales [7]. In 2008, over 37 million consoles sold in the US alone. Although the industry continues to thrive it has not proven to be recession proof. It showed a 7% fall in Global sales in 2009. The largest and strongest markets are the US, Japan, and the United Kingdom. The industry stood strong in the US but did not fare well in the United Kingdom, which showed a 14 percent decrease [26]. Much of this is due to the lack of interest in the Playstation 2 gaming, for one, because the console itself is nearly 10 years old and represents a 57 percent plummet in sales in 2009 [26].

One game though, was able to stand tall amongst others. Clearly, 2009 was the year of Call of Duty: Modern Warfare 2 [3]. But while its sales were significantly ahead of any other titles, it was not the only game that sold well last year. But one title that can't be blamed for the difficult year is Activision's Call of Duty: Modern Warfare 2 [3]. The fastest-selling video game of all time turned in sales of 11.86 million copies in the three markets, despite only being released in November 2009 [3]. The game includes multiplayer functions, as well as single-player combat.

Positive Influences of Video Games

There are some positive things about gaming that is often over shadowed by groups that bring a lot of attention to the violence and language that is used in some of the games on the market today. Video games are natural teachers. Children find them highly motivating: by virtue of their interactive nature. Children are actively engaged with them: they provide repeated practice: and they include rewards for skillful play [9]. These facts make it likely that video games could have large effects, game designers intend some of which, and some of which may not be intended [13]. Video games have shown improvement in their hand-eye coordination and their reflexes. They will also naturally improve a player computer literacy and comfort level with technology in general [13].

As technology grows, the gaming industry will grow also and thus a gamers' knowledge of and appreciation for this growing technology will do the same [21]. It has been shown that action video game players have better visual-motor skills, such as their resistance to distraction, their sensitivity to information in the peripheral vision and their ability to count briefly presented objects, than non-players [17].

Learning principles found in video games have been identified as possible techniques with which to reform the U.S. education system [14]. It has been noticed that gamers adopt an attitude while playing that is of such high concentration, they do not realize they are learning, and that if the same attitude could be adopted at school, education would enjoy significant benefits [12]. The games are also shown to improve one's analytical skills and adaptation to boundaries, rules, and guidelines. Students are found to be "learning by doing" while playing video games while fostering creative thinking [15]. Some say that the video games can be used to help students focus on their goals as well as encourage patience and acceptance of delayed gratification.

Current Use in Education and Careers

Some educational institutions use gaming as a way of training students. At Atlanta Intercontinental University (AIU) [1] there is a virtual reality game that they use in the training of those who are looking to go into law enforcement. Even the FBI is embracing this form of training to overcome the limitations of classrooms and drills. The virtual reality can provide real world training that allows you to learn from your mistakes and live to tell about it. A luxury that was not available prior to this technology. In the virtual reality you are armed with a gun that, although harmless, has the same weight and "kick-back" of the real weapon you would have as an officer of the law. The Department of Defense (DOD) leads public and private industry in developing virtual reality training. Since the early 1980s, DOD has actively researched, developed, and implemented virtual reality to train members of the armed forces to fight effectively in combat [18]. In the armed forces virtual reality can create battlefield and "what-if" scenarios that can train soldiers to be more equip when faced with the real life scenarios. Some of the other areas of law enforcement that have used virtual reality in training are pursuit driving and firearms training.

Hospital training is another market where virtual reality has found a home in the educating of future nurses and surgeons. Pulse!! is an educational game that is a training tool for nurses and physicians. It's a $7.5 million project that immerses students in the hectic environment of a hospital's intensive care unit and places them in a first-person role as a health-care professional [19]. Funded by the U.S. Office of Naval Research, Pulse!! is being developed by Texas A&M-Corpus Christi, which in turn hired Hunt Valley (Md.)-based BreakAway to produce and design the platform. BreakAway makes simulations for the U.S. military, as well as popular strategy titles like *Tropico*, a leader in the so-called "serious games" market [19]. In Pulse!! there are details from an everyday medical facility, from large equipment to cotton balls. Again this is a use for virtual gaming that allows the gamer to make the mistakes that are not allowed in the real world [19].

Video Games in School

Video games have been found to be a valuable resource in schools as well. There are games that teach classroom lesson and educational principles that are backed by teaching. Some games teach through more indirect methods. A study conducted in the United Kingdom shows that children who played Sim City and RollerCoaster Tycoon showed improvement in reading, mathematics and even spelling [30]. A group called TEEM (Teachers Evaluating Educational Multimedia) is conducting studies for the Department of Education. This group has looked into developing games that have scenarios that are challenging and engaging for children, rather than just simply putting text on a screen [2]. The director of TEEM, Professor Angela McFarlane, said, "Adventure, quest and simulation type games have a lot of benefit – they're quite complex and create a context in which children can develop important skills [30]." In the past there has been some debate about how effective the use of simulation and/or adventure computer games can be, but the some say that simulations of historic events, for example, could be used to test pupils' knowledge of key facts and games that have city building and running of companies exercise valid economic principles.

There are many other groups that are focused on providing solutions to merging video games and schooling. A coalition including Harvard and George Mason is developing MUVEES, Multi-User Virtual Environment Experiential Simulators, which uses museum multimedia to create a virtual world where students can learn cooperatively online [21]. Gravel is another college-educational video-game research and development group, part of the New Media Institute at the University of Minnesota [4]. Their proposal gives some estimates of how much it costs to produce a video game, even with deep educational discounts. Some of the biggest challenges in designing a video game involve the graphical environment, but tools for this part of a game are already partly developed in the form of virtual field trips and visualization software.

In 2006 the industry had a surprising turn of events when an educational video game named the Brain Age held the number 2 position in the rankings on Amazon.com [23]. The game was released a year prior in Japan where more than 3 million copies were sold and later released in the United States and experienced mass success. The Brain Age game was made for the Nintendo DS, a portable gaming device that allows that player to travel from place to place while playing the game. The game included some puzzle favorites, for example Sudoku and also simple math and speed-reading. Some attribute the success of this particular game because of the marketing strategy that the game would "keep the brain young". One medical clinic in Toronto is even using Brain Age as therapy for Alzheimer's patients. Players' scores are given as "ages," with 20 as the ideal—and as players improve, they get "younger." Maybe that's why the game is so popular [3].

Successful Educational Video Games

There are some extremely successful video games over the years that are centered on education. Seven in particular have been considered the best and most successful of all time. Mavis Beacon is a PC-based game that teaches typing skills; the company has currently released its 20^{th} version [1][20]. The newest addition has customizable lesson and has games. Another feature that this program has is "import you own MP3 files", it is made by the Encore Software Company and has experienced success and growing popularity over the years. Other educational games that have had success are Number Munchers, Jeopardy, Where in the World is Carmen Sandiego?, Math Blasters, Sim City and Oregon Trail [29].

Oregon Trail is considered the most successful educational game to date. I even remember playing in my younger school days. The Oregon Trail is a crash course in resource management. The Oregon Trail is one of the most iconic early computer games of all time. As you move across the nation in your iconic covered wagon, you are given a historical and geographical snapshot of the manifest destiny 1800s. In the end, if you make it all the way to the Pacific Ocean you are most likely rewarded with some fabulous prize. The Leapster Company is one of the leaders in handheld games, with their first system designed to help kids learn to read. The books let the kids read along and touch the screen to hear words spoken. They now make similar systems to teach kids other subjects such as math and science. There are even video games meant for consoles like the Nintendo Wii and XBOX 360.

Scratch

Scratch is a "new [emerging] programming language that makes it easy to create interactive stories, games, animations, [music, and art]" (MIT Media Lab, 2007, p. 1). The software does not require prior knowledge in programming. While observing this programming language, Scratch appeared to be user friendly and encourages computational thinking and creativity when developing learning games.

"Scratch is written in Squeak, an open-source implementation of the Smalltalk language" (OLPC, p. 1). Squeak is a "media authoring tool" developed by a community of people from Massachusetts Institute of Technology (MIT). It can be use to create your own media or share and play with others" (Kay, 2007, p. 1). It allows novice programmers to create tools for learning or play in an environment that is non-threatening and fairly intuitive. Kay believes that "education is a primary focus for many Squeakers who are doing cutting edge research on how computers can be used to enhance and amplify learning" (p.1).

Scratch consists of a programming language made up of different blocks and an easy to learn graphical development environment that includes a paint application for creating graphics and built-in sound editing capabilities. Scratch blocks are snapped together to create well-structured programs compose of color-coded tags describing motion, looks, sound, pen, control, sensing, operators, and variables. Scratch blocks resemble puzzle pieces in the way that they snap together as shown in Figure 10. Thus, Scratch enforces proper programming syntax and ensures that novice programmers learn the proper way to assemble and formulate programming logic. Scratch projects consist of sprites, costumes, blocks, and scripts. Even though Scratch is a gentle approach to programming, it does not have the advanced functionality of some programming environments like Squeak and Alice 3D. This was observed when trying to develop a math tutorial for an Algebra I class. Despite the lack of advanced functionality, Ford (2008) reports "Scratch provides robust support for performing mathematical calculations" (p.159). Some of the basic functionality of the tool Scratch include: 1) adding, subtracting, multiplying, and dividing; 2) generating random numbers in any range; 3) performing various types of numeric comparisons; and 4) performing a number of built-in operations. As such, a simple math tutorial was implemented in Scratch to assist students in learning basic math facts.

The Scratch environment is separated into several task panes as shown in Figure 11. The middle section contains the scripts, i.e. the instructions controlling the actions. The first section consists of blocks to create the scripts. The Scratch blocks are organized as the following: Motion, Looks, Sound, Pen, Control, Sensing, Operators, and Variables. The last pane contains the area where the results are populated as well as the objects, sprites, costumes, and stages. Each sprite consists of three distinct components: 1) scripts, 2) costumes, and 3) sounds.

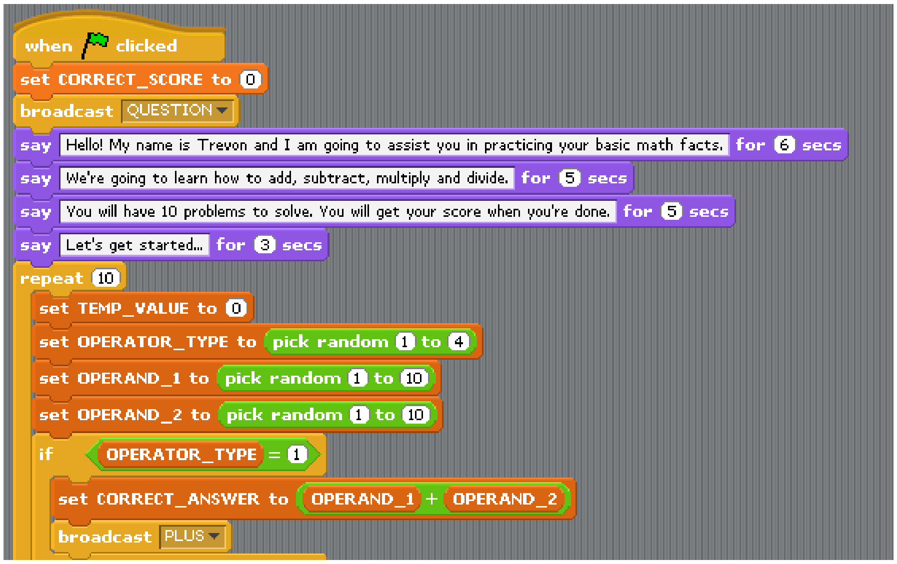


Figure 10: Scratch blocks

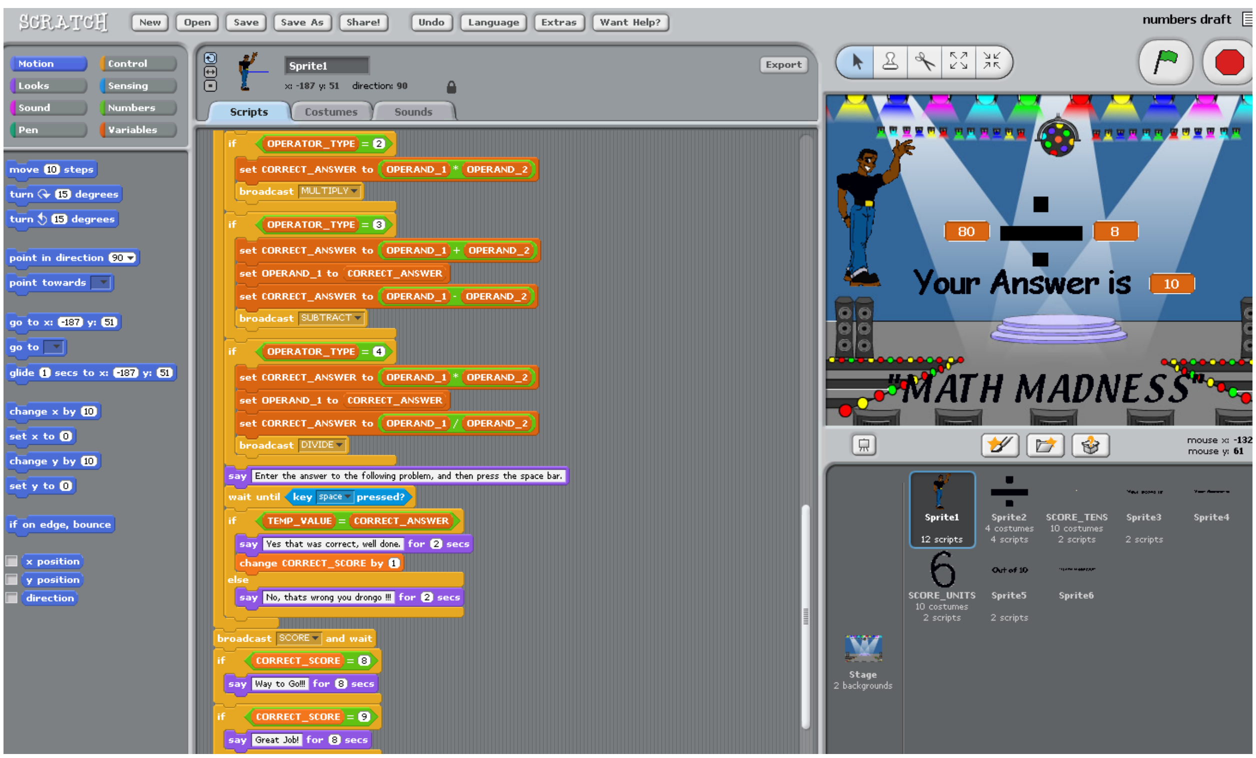


Figure 11: Scratch Environment

Basic Math Facts Tutorial

Creating tools that facilitate student achievement in math is critical. It is imperative that we find ways to generate interest in mathematics and make it more interesting. One way to do that is to develop software that is culturally relevant such that the participants are enthusiastic about learning, and engaged in the learning; thus learning can be achieved.

Scratch implementation assists individual in learning their basic math facts such as multiplication, division, addition, and subtraction as shown in Figure 12. Participants are given ten randomly chosen basic math facts problems. The tutorial is culturally relevant as the tutor is represented according to participants' preferences in terms of race, gender, and clothing. For the purpose of this study, we use Trevon, an African-American male as the agent that guides the participant through the tutorial. This feature enables participants to relate with their tutor and therefore allows a safe learning environment. The system immediately informs the participant whether the answer is correct. If not, the system generates a message indicating the answer is incorrect. Furthermore, another math problem is generated when participants press the spacebar. Upon completion of the short tutorial, the score is generated and a message indicating the performance level and instructions for resetting the tutorial are displayed on the screen.

The layout of the basic math facts tutorial consists of objects called sprites, costumes, a stage, and several scripts shown in Figure 13. There are eight sprites and one stage. Sprite1 as illustrated in Figure 13 depicts the agent Trevon. To start a game, the green flag must be clicked and to end a game, the red stop sign must be clicked (see Figure 11).

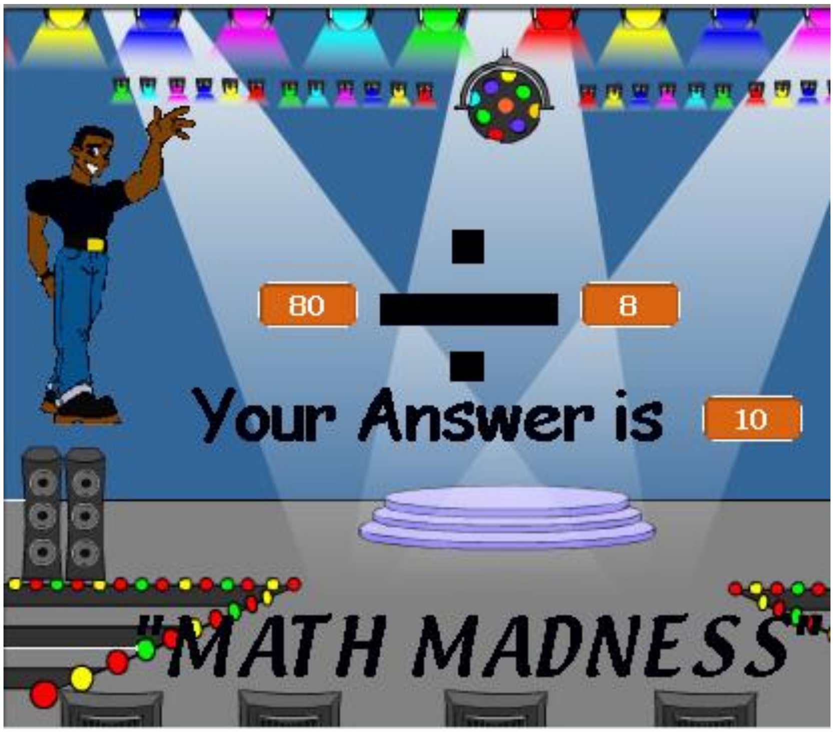


Figure 12: Basic Math Facts Tutorial

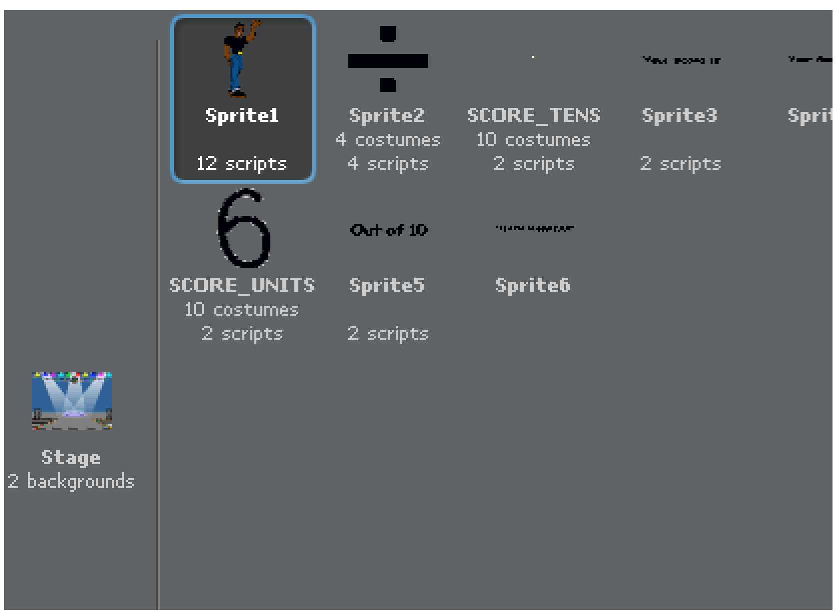


Figure 13: Objects, Sprites, Costumes, Stages, and Scripts

Conclusion

According to Klopfer, et al. (2008),

> As technologies become more and more advanced, we have empowered students to magically create things themselves on computers. They can manipulate media, explore virtual worlds, and communicate across the globe almost effortlessly. The day when students need to program computers to do interesting things is far behind us. So what is the role of computer programming for students at this point in time? What are the advantages to kids in understanding and controlling the science behind the magic? (p. 1)

As such, it is imperative that government, educational institutions, and industry convene to provide a solution to this nationwide problem regarding mathematics achievement. This community of stakeholders can involve the students in their learning and teach them to program in an environment that is less threatening while promoting achievement in mathematics. This basic math tutorial illustrated in this paper does not involved any advanced mathematical problem solving; however, it demonstrates that visual programming can be used as a fun and easy tool to possibly increase mathematics achievement.

In terms of future work, more research is required to implement advanced topics in mathematic. Visual programming via Scratch can "provide a rich context for learning programming, how to collaborate with others, becoming a member of an affinity group,

In conclusion, the importance of technology plays an important role in learning and development. The trend of virtual words is increasing, and they are beneficial to students and teachers. Virtual learning environments are beneficial because they are convenient and effective. Virtual learning environments are still a fairly new topic in computer science, and there are still many issues that need to be addressed. One problem with virtual learning environments is the social aspect of learning is sometimes lost. Students and professors can benefit from virtual learning environments in many different aspects. The technology involved with VLEs challenge students to be independent and productive individuals. Virtual environment is a new and engaging way that students of the 21st century can learn effectively. Virtual learning environments can provide rewarding experiences, and they may very well be the means of learning in the future. Students have many different learning styles, and visual learners are the most common. Due to this video games are ideal ways that students can effectively learn.

Virtual learning environments are on a rise so they should be implemented in higher education because in the next couple of years they will be prominent, and implementing them now makes the transition much smoother for the future.

Educational video games have great potential to hone critical-thinking skills, help teach academic curricula, and evaluate what students learn. Using games in school will likely require shifting curricula and the order in which materials are presented as well as shifting the role of teachers. Games might not be an integral part of schools for another decade. Despite this, video games are critical in both the work place and the university because they require players to master skills that employers want, such as strategic and analytical thinking, problem solving, and adaptation to rapid change. And further research is needed to determine which features of games are important for learning and why, and how best to design the systems to ensure students are learning appropriately. But all the research done and millions spent on building educational video games will be pointless if educators are not convinced of the effectiveness of video games in improving learning.

Chapter 3

METHODOLOGY

Research Outline and Statement of the Problem

This chapter introduces the purpose, research problem, and the research questions of the study. It gives a brief overview of the visual programming language Scratch and describes a prototype of an implementation of basic math tutorial using Scratch. The prototype demonstrates a visual programming language as a tool to create mathematical tutorials. Additionally, this chapter provides a modicum of information as it relates to the educational value of visual programming to mathematical achievement. Peppler and Kafai (2007) indicate "game players program their own games and learn about software and interface design. Some efforts have integrated the learning of subject matter, such as mathematics and science" (Jenkins, 2006, p. 1). Jenkins articulates "three issues that policymakers and educators face as they attempt to bridge the gap between those that contribute and those that do not: the participation gap, the transparency problem, and the ethics challenge. These three issues encompass the need to ensure that every young person has access to the skills and experience needed to become a full participant, can articulate their understanding of how media shapes perception, and is knowledgeable of emerging ethical standards that shape their practices as media makers and participants in online communities" (p. 1). The work presented in this research belongs to a broader spectrum of end user programming and learning that could possibly facilitate achievement in mathematics.

Purpose

The objective of this research is to explore virtual environments and how virtual environments can enhance learning for students and to develop a system to increase mathematics achievement in K–12 education. One particular way that virtual environments can enhance learning is through interactive video games.

Statement of the Problem

Across the nation, math scores lag (Lewin, 2006). Students are performing lower than ever. Lewin reports, for "the second time in a generation, education officials are rethinking the teaching of math in American schools" (p. 1). It is imperative that higher education, industry, and K–12 collaborate to ascertain a viable solution to the problem of low achievement in mathematics education. One way to get students interested in math is to teach them how to creatively solve mathematical problems using a visual programming language. Using a visual programming language would allow the students to learn mathematics in an environment that is conducive to learning and would facilitate mathematics achievement. With the students' involvement, they are able to not only use games and other forms of media; they are also learning mathematical concepts. Not only will the usage of these applications benefit the designers of the software, but also those students that will follow in their footsteps.

Kay (2007) states, "globally networked, easy-to-use computers can enhance learning, but only within an educational environment that encourages students to question facts and seek challenges," (p. 3). "A visual programming language (VPL) is any programming language that lets users specify programs by manipulating program elements graphically rather than by specifying them textually. A VPL allows programming with visual expressions, spatial arrangements of text and graphic symbols. Most VPLs are based on the idea of "boxes and arrows," that is, boxes or circles or bubbles, treated as screen objects, connected by arrows, lines or arcs". According to the Microsoft Robotics Studio (2008), although visual programming was initially developed for novice programmers who had some knowledge about variables and logic, VPL is also for the more experienced programmers. For the purpose of this research, Scratch, an open-source visual programming language, was chosen for our study as its environment supports user creativity and software development.

Research Approach

The research approach includes creating an environment where students in K–12 education can use mathematical simulations in a virtual environment while learning mathematical concepts at the same time. This allows the study of visual programming tools to be used as a means to increase student achievement in mathematics. Thus, the main goals of the study are:

1. Develop an appropriate tool for increasing mathematics achievement
2. Configure the tool to accommodate the user group
3. Suggest a model of computer supported collaborative work for informal educational experiences through lessons and educational simulations
4. Develop a minimalist tutorial for the tool
5. Conduct a usability and acceptance test with the test group
6. Introduce new technical skills to novice computers users and enhance technical skills of novice users
7. Encourage users to adopt VMS technology for collaboration instead of traditional methods

The main goal is to encourage and promote informal learning through a new environment for collaboration among groups in K–12. This study will focus on the usability of the tool as the main part of the research because the feedback will provide the data to show the effectiveness of the tool as well as the usability. To determine the usability of the tool, a broad array of questions to be answered by the experimental participants has been created to gather data for the research through a survey. The survey requires a user to identify themselves as a novice or having advanced computer skills for the purpose of assessing the usability level of the tool and its impact on subjects.

To gather more data on the usability and effectiveness of the collaborative environment, experimental participants performed a series of tasks to include completing a detailed survey to provide feedback on their experiences with the system. The immediate contributions of this research will increase mathematics achievement in K–12 education. In addition, the results of this research may capture and generate interests within the computer-supported collaborative learning community.

Research Questions

In order to understand how virtual environments can be used to increase mathematics achievement through a computer-based system (http://spider.eng.auburn.edu/bjc/edutainment/index.php), the following research questions will guide this research.

1. Are students better engaged with VMS and traditional instruction versus traditional instruction alone?
2. Are students more engaged when using educational math games?
3. Will students have a positive reaction to the VMS?
4. Will students recommend the tool to others?
5. Do students retain knowledge acquired from VMS?
6. Are students satisfied using VMS?

This research proposes a system that will be effective, efficient, and provide user satisfaction. Breaking down this hypothesis, the study will first show effectiveness in that the participants will be able to successfully use the system to create an environment where students in K–12 education can develop mathematical simulations while learning a visual programming language. Second, the study will determine if the participants are able to learn mathematical concepts at the same time. Lastly, the participants will complete a survey to measure how satisfied they feel using the system. In order to accurately assess these criteria, the study will compare the proposed system with a culturally relevant system.

This study will examine the usability and the user interface by test group participants. The data collected during the experiment and surveys will be presented in tables and descriptive statistical methods.

Research Plan

In order to determine the feasibility of the proposed VMS, an initial design was implemented. This chapter reports on a preliminary experiment performed using this initial design, and proposes a plan for experimentation on the final design. The initial implementation was tested using a limited demographic to show proof of concept. The results from this preliminary work serve as a basis for future design decisions, and a direction for the next implementation steps. Further experimentation is necessary to fully gain the impact of that the proposed work will have on the intended user population. This experiment will allow the usability of the final implementation to be thoroughly evaluated.

The remainder of this chapter is organized as follows. A brief description of the proposed hypothesis is provided. Next, preliminary research findings and conclusions are presented, followed by the work plan for the proposed approach for impending research with the intended user population. Finally, the chapter closes with the expected outcomes from this work.

This study will first show the effectiveness in that the participants will be able to successfully use the system in an environment where students in K–12 education can increase student engagement with a virtual learning environment. Second, the study will determine if the participants are able to learn mathematical concepts at the same time. Lastly, the participants will complete a survey to measure how satisfied they feel using the system. In order to accurately assess these criteria, the study will compare the proposed system with traditional methods.

Preliminary Experiment

The primary objective of the preliminary study is to observe and analyze how students interact with the Virtual Mathematical System. The goal of the study was to determine the effectiveness of VMS with respect to increasing mathematical achievement in the VMS system. The data from this study will be analyzed to determine the effectiveness of VMS. It is expected that VMS would significantly increase mathematics achievement when involving students in learning math in a virtual environment. Additionally, it is expected that the participants in the study would be able to use the system effectively, meaning they will be able to use visually programming tools to increase mathematics achievement.

Participants

The participants in this study will be middle school girls who are members of Girls, Inc. Girls, Inc. is a non-profit organization that spans both the United States and Canada that has an initiative to increase the participation of girls in information technology. Girls Inc. are constantly encouraging the girls to be strong, smart, and bold [47]. All students are accepted to participate in the study, given they have permission from their parents and or guardian. A total number of 50 participants are expected to participate in this study. “Girls Inc. programs focus on science, math, and technology, health and sexuality, economic and financial literacy, sports skills, leadership and advocacy, and media literacy for girls ages 6 to 18 throughout the United States and in Canada. While our goal is to reach all girls, we recognize that girls in at-risk communities have an even greater need for our programs. Of those we serve, 76 percent are girls of color and 70 percent come from families earning $25,000 or less. More than half are from single-parent households, most of which are headed by women" [46].

Materials

A desktop computer and the SCRATCH software are needed for this study. "Scratch is written in Squeak, an open-source implementation of the Smalltalk language" (OLPC, p. 1). Squeak is a "media authoring tool" developed by a community of people from Massachusetts Institute of Technology (MIT). It can be use to create your own media or share and play with others" (Kay, 2007, p. 1). The desktop computer will be used to run the VMS system software. The experiment results will be analyzed using Microsoft Excel.

Procedures

The setting for the experiment was conducted at two different locations of Girls, Inc., the Baker Center and the Kobb Center, in Columbus, Georgia. The participants were asked to read the information letter, which was used to inform the participant of his or her rights in participating in this study. The participants were given a parental consent letter to be completed by the parent or guardian. All participants were informed not to discuss the experiment with friends and classmates to ensure that all participants had an equal knowledge of the study. All participants were given a list containing all the tasks to complete during the study.

The participants were directed to fill out a pre-questionnaire to obtain their demographic information and prior usage with computing. Once the pre-questionnaire was completed, a scenario was given to the participants explaining the study. The scenario was to inform the participants about the VMS.

Data Collection

The first method of data collection for the study was done through the pre-questionnaire. Each participant was required to complete the pre-questionnaire so that demographic information about the participants could be collected. Demographic information is needed to determine the type of participants in the study. The demographic information tells us the ethnicity and gender of the participants. It also indicates their level of education, and other information. In addition, several math problems were included to determine the participants' level of knowledge regarding mathematical concepts.

The second method of data collection for the study was done through the post-questionnaire. Each participant was required to complete the post-questionnaire so that information about the use and effectiveness of the VMS could be collected. In addition, the participants were given the same math questions from the pre-questionnaire to solve. During the study, information will be gathered to analyze the participants' use of the system. A data collection sheet was used to record all information during the study. This sheet contained a space for observations made throughout the study. The results of both the pre-questionnaire and the post-questionnaire will be presented in this study.

Chapter 4

SYSTEM IMPLEMENTATION AND PROCEDURE

This chapter outlines in detail the refined requirements for the development of the system based on the initial requirements analysis and system implementation. It also includes the details of the scenario system. The implementation has been outlined with Use Case Diagram design standard to capture requirements and a sequence diagram. This chapter also provide details of the Edu$^{\text{tain}}$ment project as well as implementation and testing of the components.

Concept

Video games are a huge entity in today's society. As we continue to strive in technology and in education separately, it is beneficial for the two disciplines to cross paths. Finding new and interactive styles of teaching youth causes students to become more involved in their learning instead of passively receiving information. Educational video games, or "edutainment," can be an extremely effective form of teaching for both students and teachers. The Edu$^{\text{tain}}$ment website's purpose is to facilitate mathematics achievement among students learning mathematics, particularly students in grades sixth through eighth. The objective of the website is to enhance learning for students in mathematics and to increase mathematics achievement in K–12 education. One particular way that virtual environments can enhance learning on the Edu$^{\text{tain}}$ment website is through interactive video games. The Edu$^{\text{tain}}$ment website contains the standards for teaching mathematics, lesson plans, assessments, and video games as shown in Figure 14.

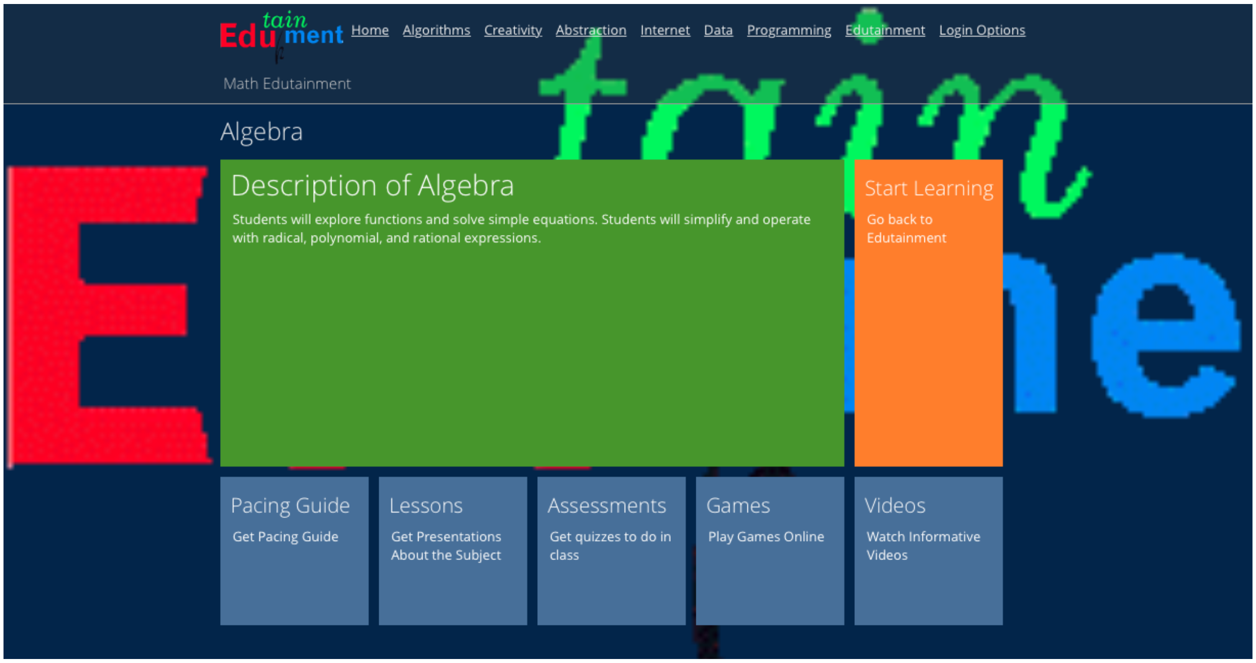


Figure 14: Edu^{tain}ment Algebra

According to the *New York Times*, nearly 90% of American high school graduates are not interested in perusing a degree or a career in the fields of science, technology, engineering, or mathematics (STEM). One of the main reasons why students have a strong disinterest in the field of STEM is due to a lack of confidence in their ability to do math. In addition to their uncertainty in their math skills, they believe that math is just out right boring. Mathematics is essentially the foundation for all aspects of STEM. According to the *United States Department of Commerce*, there were 7.6 million STEM related jobs in the United States in 2010 alone. By 2018, they expect a 17% increase in jobs related to STEM. That's 1,292,000 new jobs!

Many students today believe math is boring. However, they are missing the impact of mathematics on their future and the genre of possibilities in STEM. Mathematics is more than just the manipulation of numbers. Math is more than just following formulas and solving for variables. By learning and practicing solving math problems, one is effectively challenging and developing their problem solving skills. After being exposed to the same type of problem repeatedly, it becomes easier to identify the problem and solution. Problem solving, or critical thinking, is essentially what drives the field of STEM. However, we can develop math skills as well as increase the number of students pursuing STEM via Edu^{tain}ment!

Project Requirements

One of the goals of Edu^{tain}ment is to help students with their ability to do math successfully. Since the aim of the project was to increase mathematics achievement for middle school students while not overwhelming them with difficult material in the beginning of their studies, we chose to design an interactive web development game style tutorial. The activities teach mathematics via the interface. There are pages that explain the standards and allow students to assess the objectives and to also interactively facilitate their learning through gaming as well as provide a pacing guide that directs the instructor through each lesson. Table 4 outlines the project requirements for the Edu^{tain}ment website.

Table 4

Project Requirements

Project Requirements	
Use as a resource for users to find information about mathematics	Provide lessons, assessments, videos and games to enhance a user's knowledge of a particular aspect of mathematics
Provide a safe reliable medium for simulated learning of mathematics	Make the materials on mathematics easily accessible for the students
Interface Requirements	
Make the information easily visible for the user to choose their selection	Display information in a rotational manner that provides brief descriptions of the lesson/ game
Data Requirements	
Games and videos should be related to the topic on that page.	
Security Requirements	
In order to access the full web site users will need to create an account.	A user is defined as a Teacher, Parent, or student.
The homepage can be viewed without becoming a registered user.	
Homepage Interface Requirements	
The home page should contain the tabs to the other parts of the site in a Tiled-App format	Each tile should contain links to different information throughout the site.
Professional users after logging into the website should have certain options: upload a new game or lecture, post or comment inside of the community blog about a specific teaching topic.	
Mathematics Content Pages Requirements	
After selecting which area the unregistered user would like to explore, the user may then choose to play a game or do a lesson.	After that game or lesson has finished, the user will be prompted to either create an account or log into an existing account if they wish to continue to use the site
Student users have full access to all games and lessons with no time limitations.	Have access to user registration in pages
A user should indicate if their status: professional or student.	System administrators will verify each professional user.
A user will be prompted to enter certain information to determine the demographic using the website.	

Implementation

The Edu^{tain}ment website provides a description of the project as well as an overview of the rationale for the project, which is located on the homepage. The website has been designed to resemble the Windows 8 tiled grid display. Located on the website (as shown in Figure 15) are links to seven pages that have been set up to focus on various areas of mathematics: 1) Algebra; 2) Functions; 3) Geometry; 4) Modeling; 5) Standards; 6) Numbers; and 7) Probabilities.

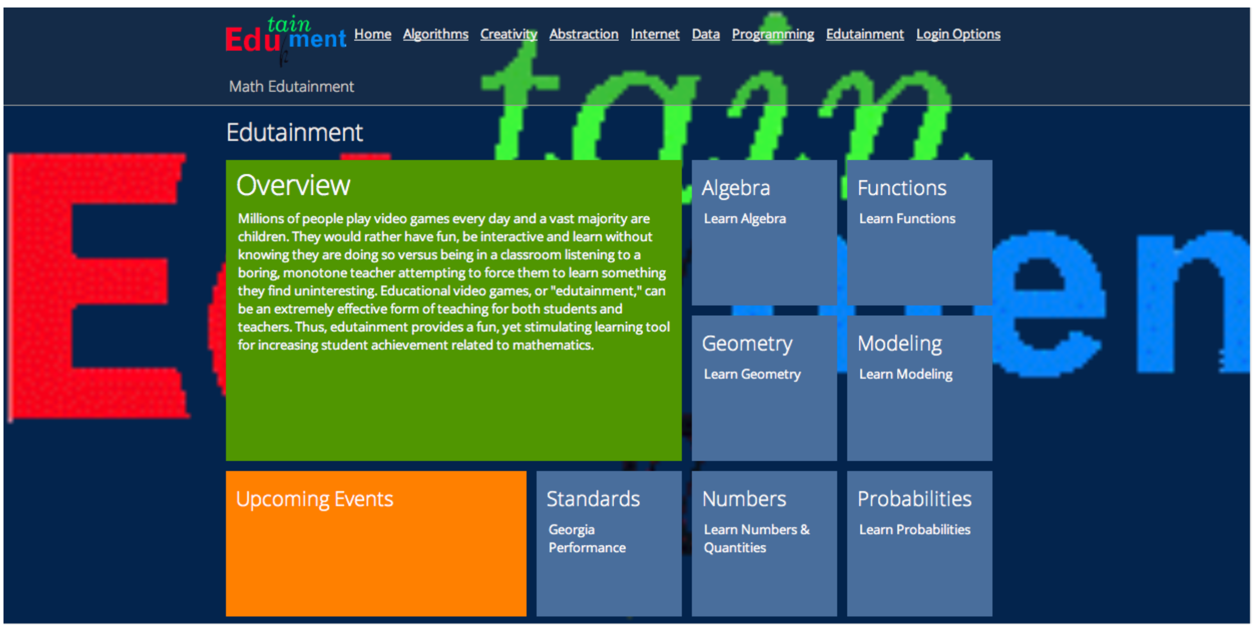


Figure 15: Edu^{tain}ment Website Homepage

The links to the core areas within mathematics carry the user to similar pages that are designed to focus on the topic that the user has chosen. When the user selects a topic link of choice, the page that populates has a tile that gives further information. There is also a link to return to the homepage. Once the user chooses to enter the full curriculum for the specific topic, a new page opens containing links to the pacing guide, lessons, assessments, games, and videos pertaining to that specific concept in mathematics. The lessons, videos, and assessments attempt to explain the mathematical concepts and get the user thinking about that concept and how it can be used. The games are designed to give the user some hands-on experience with the mathematical concept in a fun and interactive environment.

Mathematics as Games	
Algebra	Linear Equations games
Functions	Functions games
Geometry	Geometry games
Modeling	Content to be added later
Standards	Link to Standards website
Numbers	Numbers games
Probabilities	Probabilities games

Figure 16: Mathematics as Games

The use case diagram in Figure 17 depicts a typical user interaction with the application. The user logins to the Edu^{tain}ment website and select a topic to view its contents. The application then opens the corresponding page for the topic the user selected. The content page would contain additional links to items pertaining to that topic. The user selects one or more of the items to view such as pacing guide, assessments, lessons, videos and games. Once the user finished viewing content for that topic, the user returns to the main content page for that topic. From the topic homepage the user can select to return to the Edu^{tain}ment homepage. The user may choose to logout of the application from the Edu^{tain}ment homepage.

Figure 17: Use Case Diagram

Typical Use Case Scenarios

Use Case 1. Kalei is a sixth grade student taking a mathematics course. The teacher informs the class that they will be studying linear equations over the next several weeks. The teacher then directs them to study the materials on Algebra on the Edu^{tain}ment website for the remainder of the class. Kalei goes to the website enters her user login information. She then selects the topic link for linear equations. She then looks at the lessons content, plays the solving one-step linear equations game and watches the video that is available. At the end of class she returns to the Algebra content page. From there Kalei returns to the Edu^{tain}ment homepage and logs out of the website.

Use Case 2. Joshua is an eighth grade middle school student taking his first class in Algebra. The teacher has been talking about solving absolute value linear equations for the last few days. The teacher decides to let them get some hands-on experience and sends them to the Edu^{tain}ment website. Once Joshua has the website up he logs in and clicks on the Algebra link. From there he selects the absolute value video. Nathan works on learning about how to solve absolute value linear equations. After taking the quiz to see how well he could do on it Joshua returned to the Algebra page and play the absolute value game. From there he could then return to the Edu^{tain}ment homepage and logout.

Sequence Diagram

Once the application functionality was defined, the next aspect of the application that needed to be examined was how the application responds to a task initiated by a student user. To illustrate the interaction between the system and the user, a system sequence diagram was created. The sequence diagram shows the typical interaction and response for a student user. The sequence diagram addresses the typical action of accessing content for one of the math topics.

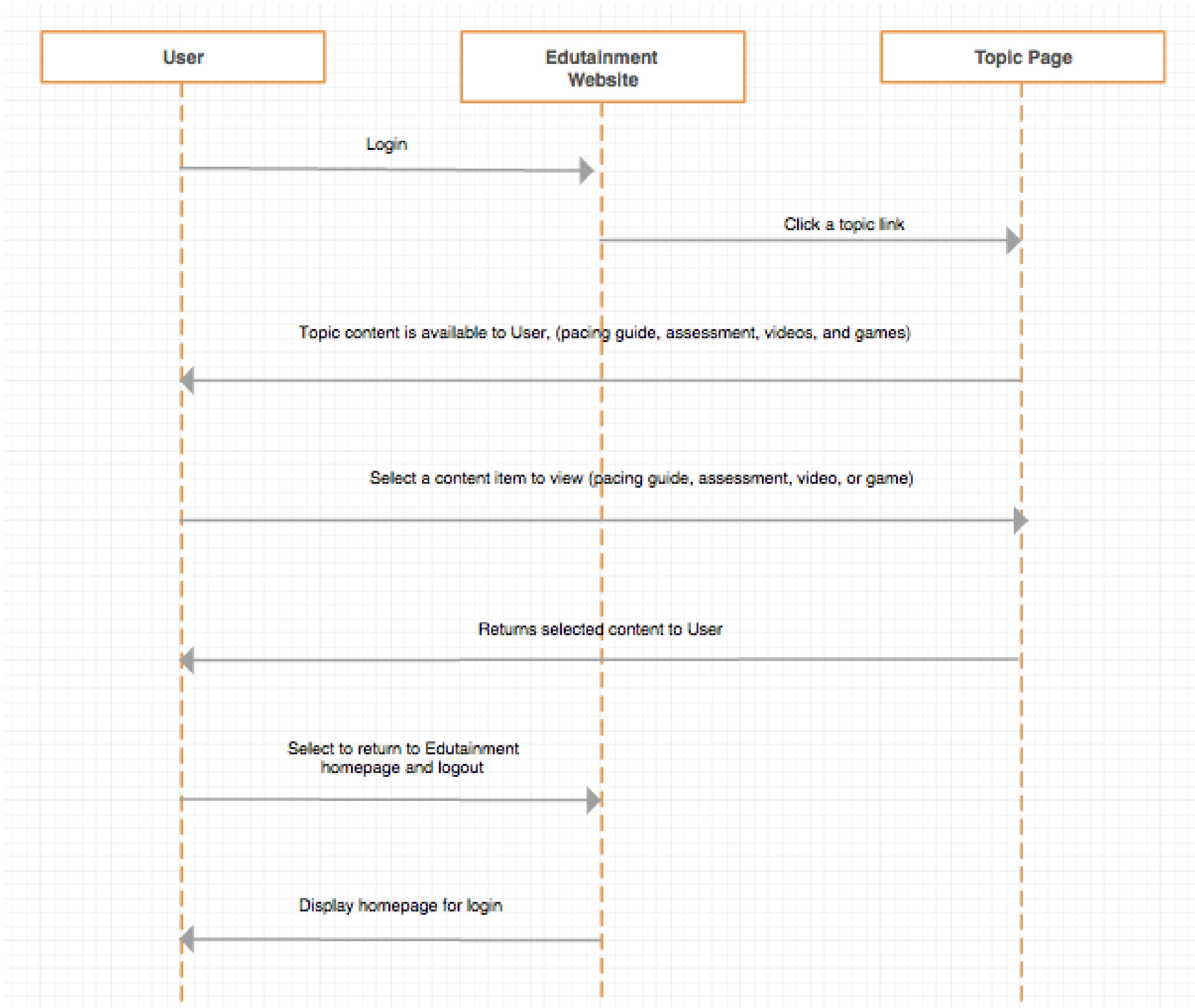


Figure 18: Sequence Diagram

Testing of Edu^{tain}ment Website

The development team conducted usability testing of the main Edu^{tain}ment website. The testing group consisted of 10 impartial computer science majors. Approximately 90% of the test group ranked the site as being easy to navigate and find the items they were looking for. All of the test group ranked the lessons, assessments, games and videos as important site content. And 40% gave the site an excellent overall rating and all test users agreed that they would return to the site and use it again.

Functional Requirements

The project has the following requirements to be fulfilled in order to achieve the objectives:

1) The application must be web-based.
2) The application must be interactive, meaning that the user is able to interact with the software.
3) The application must present the activity as a game or in a game-like fashion.
4) The application must support lessons taught in traditional classroom sessions in the area of mathematics, meaning the application should function as a web-based learning environment that enables students to learn basic information concerning the mathematics.

The first requirement was for the project to be web-based. To meet this requirement, the activities were implemented using HTML and JavaScript programming. The determination was made to utilize mathematical concepts that were a part of the lesson and integrate these concepts into the learning application.

The second requirement was the creation of an interactive software application. The application meets this requirement. First, the application meets the interactivity requirement with the assessment. The assessments were designed to see how well the user retains information about various topics in mathematics while they are playing within the site. The assessments have been designed to give the user instant feedback upon each answer submission as to whether the answer chosen is correct or not. If the answer is incorrect they are also provided with the correct answer. At the end of the quiz, users are provided their overall quiz results as well.

The third requirement is that the application must present the activity as a game or in a game-like fashion. The application meets this requirement by allowing the user to interactively solve linear equations in a virtual environment. While it is not a 3-D interfaced video game, it is a game that allows students to demonstrate what they have learned through interaction with a web coding application.

The final requirement states that the application must support lessons taught in traditional classroom sessions in the area of mathematics, meaning the application should function as a tool in a web-based learning environment that enables students to learn mathematics whether it is algebra or geometry. This requirement was met through the assessments, games, and videos provided on various pages of the website. The application also met this requirement through the standards and pacing guide homepage that allows the user to edit view existing standards and pacing guides that were already structured.

Conceptual Model and Design

The main goals of the Edutainment website is to increase mathematics achievement among middle school students. The website is coded using HTML and JavaScript. Since the main goal of the website is to enhance student learning in mathematics, the homepage provides links to standards for teaching mathematics and also links to various topics in mathematics such as Algebra, Functions, Geometry, Numbers, Modeling, and Probabilities. Any of these links can be selected. Once a topic has been selected, the new page provides a description of the topic and tile-like links that include a pacing guide, lessons, assessments, games, and videos.

This activity fosters creativity by letting the user edit the code anyway they wish to see the effects it would have on an actual web page. At any time the user can go back to the original default code by clicking the reload page button.

I wanted to keep the application relatively simple while still promoting interest and allowing the user to learn HTML coding. So from the home page the user can access other pages via the links along the right side of the page. The links takes the user to pages explaining HTML tags, video sources, image sources which all provide HTML tutorial type information for using the various tags. The video and image pages also provide available video and image sources that the user has to choose from within the application for use in their web coding activities.

The create link takes the user to a page that will allow them to create their own ‘web page’ from scratch in the empty source pane provided. Just like on the home page the results pane will dynamically update to reflect the code the user has implemented. This exercise allows the user to be in control the entire time and create a ‘web page’ within the application completely from code they have learned while working through the web builder application tutorials.

The quiz link takes the user to a short 10 question quiz that merely allows the user to gauge for them-selves what they have learned while working in the application. As each answer is submitted the user is given automatic feedback on whether they answered correctly or not. If they answered incorrectly the correct answer is revealed to them. At the end of the quiz they are given an overall score.

Chapter 5

EXPERIMENTAL ANALYSIS AND EVALUATION

The primary purpose of this study was to explore virtual environments and how virtual environments can enhance learning for students and to develop a system that increases mathematics achievement in K–12 education. One particular way that virtual environments can enhance learning is through interactive video games. This study has identified Girls, Inc. members as the initial subgroups that will benefit from the results of this research. The main criterion for choosing members to participate in the study is a voluntary acceptance of middle school girls of Girls, Inc. to willingly subscribe to use the Edutainment website that we have developed to potentially increase mathematics achievement by using virtual environments. Participants will provide feedback on its usability and how easy it is to use by novice users for increasing mathematics achievement in K–12 education. This Edutainment tool is assumed to be a framework model of collecting quantitative data on using virtual environments to increase mathematics achievement. To extend this study, the research will focus on middle school students sharing and reusing the Edutainment software amongst other groups.

This chapter presents a comprehensive evaluation of the Edu^{tain}ment website that will be used by members of communities or groups to share best practices and its supporting principles. As outlined in the subsequent sections, the comprehensive evaluation will rely on analytic and empirical evaluations conducted by experts on potential users. This chapter also outlines the general methodological concerns for the empirical study conducted, the comparative evaluation, which includes the research target population group, sample descriptions, and the experimental design. Recommendations for further research are also included.

The experts and experimental evaluations will explain the Experimental Design, Data Collection, and Experimental Results. The data collection section will present methods for the work, materials used, experimental data (i.e. demographics, user satisfaction questionnaires), procedures and experimental observations. The chapter concludes with a discussion of the experimental hypothesis and the implications of the study. The usability results and implications support the adoption of Edu^{tain}ment website as a suitable tool for a community of practice to share and reuse best practices.

Experimental Design

The experimental procedure included a pre-questionnaire, a task list, and post-questionnaire to collect data from the experts during this phase of the study. Fifty-eight participants were surveyed during the pre-questionnaire phase. However, due to absences on the day of the post-questionnaire, forty-seven participants were surveyed. The goal of the study was to gain useful insight on the effectiveness of the Edu^{tain}ment website. The research approach includes creating an environment where students in K–12 education can use mathematical simulations in a virtual environment while learning mathematical concepts at the same time. This allows the study of visual programming tools to be used as a means to increase student achievement in mathematics. Thus, the main goals of the study were:

1. Develop an appropriate tool for increasing mathematics achievement
2. Configure the tool to accommodate the user group
3. Develop a minimalist tutorial for the tool
4. Conduct a usability and acceptance test with the test group
5. Introduce new technical skills to novice computers users and enhance technical skills of novice users

6. Increase mathematics achievement
7. Encourage users to adopt the use of the technology for collaboration instead of traditional methods
8. Suggest an algorithm-based model to improve usability and management within a collaborative tool and write a simulation of it

To gather more data on the usability and effectiveness of the collaborative environment, experimental participants performed a series of tasks to include completing a detailed survey to provide feedback on their experiences with the system. The immediate contributions of this research will increase mathematics achievement in K–12 education. In addition, the results of this research may capture and generate interests within the computer-supported collaborative learning community.

This work supports our hypothesis among potential user groups. Our goal was to answer the following questions:

1. Can students learn better using Virtual Mathematics System (VMS) when compared to culturally relevant tutorial system?
2. Can VMS alleviate the mathematical concerns students may have when learning mathematics?
3. Do students retain knowledge acquired from VMS?
4. How satisfied are the students using VMS?

In answering these questions, we provide data on the feasibility of the Edu^{tain}ment website as a collaborative tool supporting communities of practice in advancing informal education; provide insights on the problems, and the limitations in adopting the Edu^{tain}ment website by end users. These results can serve as a general guideline for choosing and developing online collaborative tools to support groups.

Overview

The following characteristics were identified for the middle school girls in the Southeast United States.

Participants

The participants in this study were middle school students located in the southeast United States. Fifty-eight (58) pre-surveys were administered to middle school girls at Girls, Inc. in Columbus, Georgia. Seventeen (17) of the girls reported that they were sixth graders. Ten (10) of the girls reported that they were seventh graders. Twenty-seven (27) of the girls reported that they were eighth graders. The remaining four (4) girls did not report their grade in school. Forty-seven (47) post-surveys were administered to middle school girls at Girls, Inc. in Columbus, Georgia. The participants were in grades sixth, seventh, and eighth. All of the participants were girls who were from low socio-economic backgrounds.

Materials

The materials for this experiment included the informed consent for users to sign before undertaking the experiment and the tutorials that were prepared to guide users through their learning and re-use sessions.

Informed consent. The Auburn University Institutional Review Board requires researchers to have an informed consent approval of research designs when conducting any type of research involving surveys, interviews or human factors. The informed consent stated to the participant the purpose of the study, justification, procedures, benefits, and risks of the project and guarantees the participants that all responses will be held confidential and will be used only anonymously.

Pre-survey questionnaire. Using the pre-questionnaire survey form found in Appendix C, we were able to document various types of user characteristics. The instrument used in this study consisted of two parts and twenty-one (21) questions. Part one contained twelve (12) questions of background and general data information such as gender, grade in school, and race. Part two consisted of eight (9) linear equations and expressions. In addition, the pre-survey questionnaire was used to assess whether the participants met the criteria established for classification as both novice and content area experts. The remaining questions in Part 2 required the participants to solve linear equations.

Post-survey questionnaire. The post questionnaire found in Appendix C was used to gather detailed information about how participants assessed their performance and the system used as well as to ascertain the usability of the system. Part one consisted of 7 Likert-type scale items and Part two consisted of nine (9) linear equations. The Likert-type scale items were assigned a value to each response. The responses were (1) strongly agree, (2) agree, (3) neutral, (4) disagree, and (5) strongly disagree. The remaining questions in Part 2 required the participants to solve linear equations.

Workshop task list. The task list was used to guide the participant through the workshop. The task list contained the specifics tasks that each participant was to complete on each day of the workshop by the week. In addition, the participant provided responses to three questions on the task list: (1) What was the most interesting thing about the website? (2) What do you think you learned? (3) Do you like doing math through games? A copy of the workshop task can be found in Appendix B.

Experiment Setup and Requirements

The study was conducted at the Girls Inc. Baker and Cobb centers in Columbus, Georgia. Each of the focus groups together was comprised of a total of 58 users at computer workstations with meeting facilitators at the head of the group to guide the process.

Procedures

An email was sent to the directors of the Girls Inc. centers in Columbus, Georgia explaining the purpose of the study and the instrument, along with the proposed dates of evaluation. The email also contained Auburn University Institutional Review Board's approval for the experiment and affirms the informed consent. This was to familiarize them with the experiment and allow them the opportunity to have the parents of the participants both to sign the informed consent and become a participant in the experiment or decline to participate.

Following the consent, participants completed a printed or an online user background questionnaire used as a baseline comfort level with computers and to determine whether the participants met the minimum qualifications or set standards as a user regarded as suitable for the experiment. Each participant was given a workshop task list that outlined the tasks to be completed.

Procedures for protection of human subjects. All potential participants were informed that the data from the survey were being used for a dissertation. An assurance of anonymity was given to all participants. The researcher had a list of all potential participants. These procedures for the protection of human subjects were reviewed by Auburn University Institutional Review Board and approved for use in this study. A copy can be found n Appendix A.

Data Collection and Analysis

Table 5 is a summary of the overview of the experimental instruments and measures that were used to collect data in this study.

Table 5

Summary of Experimental Overview

Instrument	**Description**
Pre-Survey Questionnaire	User background, demographics, and knowledge
Performance Data	Errors in problem solving
User observations	Qualitative observation
Post-Survey Questionnaire	User satisfaction and system ratings

Performance data. The performance data was collected during the guided exploration with the aid of minimalist tutorials on the Edu^{tain}ment website.

User observations. This was collected in the form of user observations as well as more formal observations in the form of critical incidents as self reported data from participants.

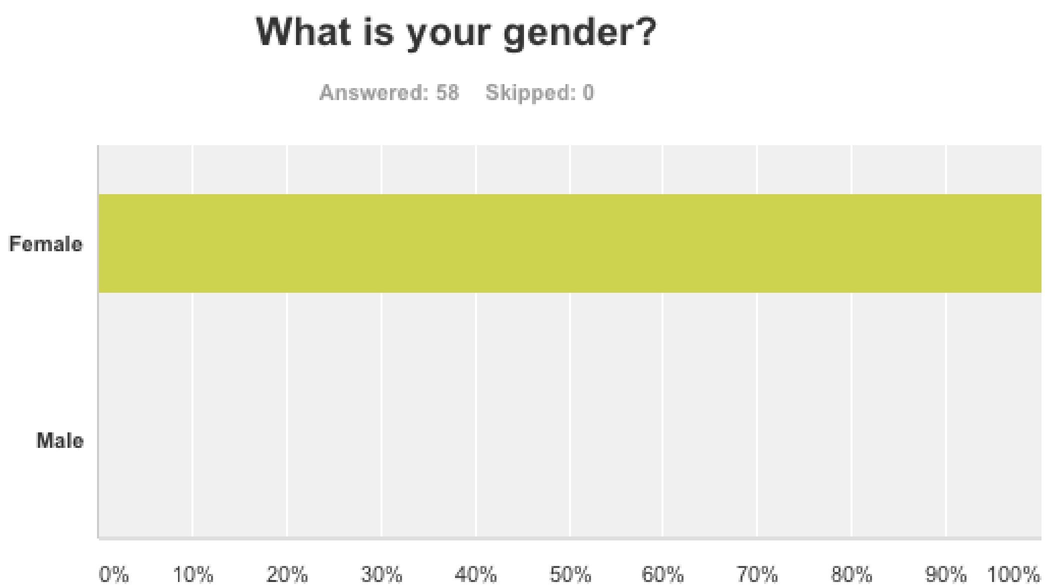
Statistics. The data collected is reported and analyzed to ascertain the usability of the Edu^{tain}ment tool as easy to use and supporting novice users and promoting of online informal education. These results confirm and validate usability criteria that guided us in adopting the Edu^{tain}ment system for a community of practice.

Experimental Results

The goal of the empirical study was to discover whether the Edu^{tain}ment system meets the planned usability specifications, and to develop suggestions for improving the design. To fulfill this goal as evaluators, we have to understand not just what the participants did during the test tasks, but why they behaved and reacted as they did. Characterizing the test participants, and probing the details of the responses to the tasks (e.g. time, and errors), and subjective reactions (e.g. comments while using the system and ratings or opinions) provided after tests [34] accomplished this.

Pre-Survey Results

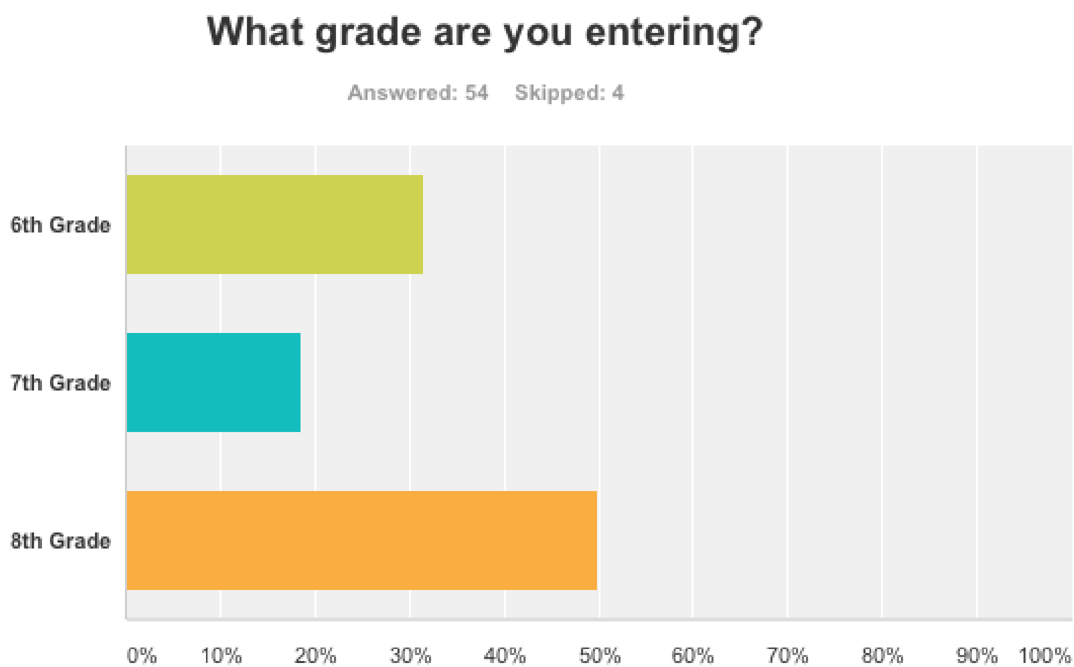
Figure 19 represents the gender of participants with a group distribution. The numbers in percentages (e.g. 8%) represent the percentages of test subjects respectively. All (100%) of the participants were girls. There were no male participants in this experimental study.



Answer Choices	Responses	
Female	100.00%	58
Male	0.00%	0
Total		58

Figure 19: Gender

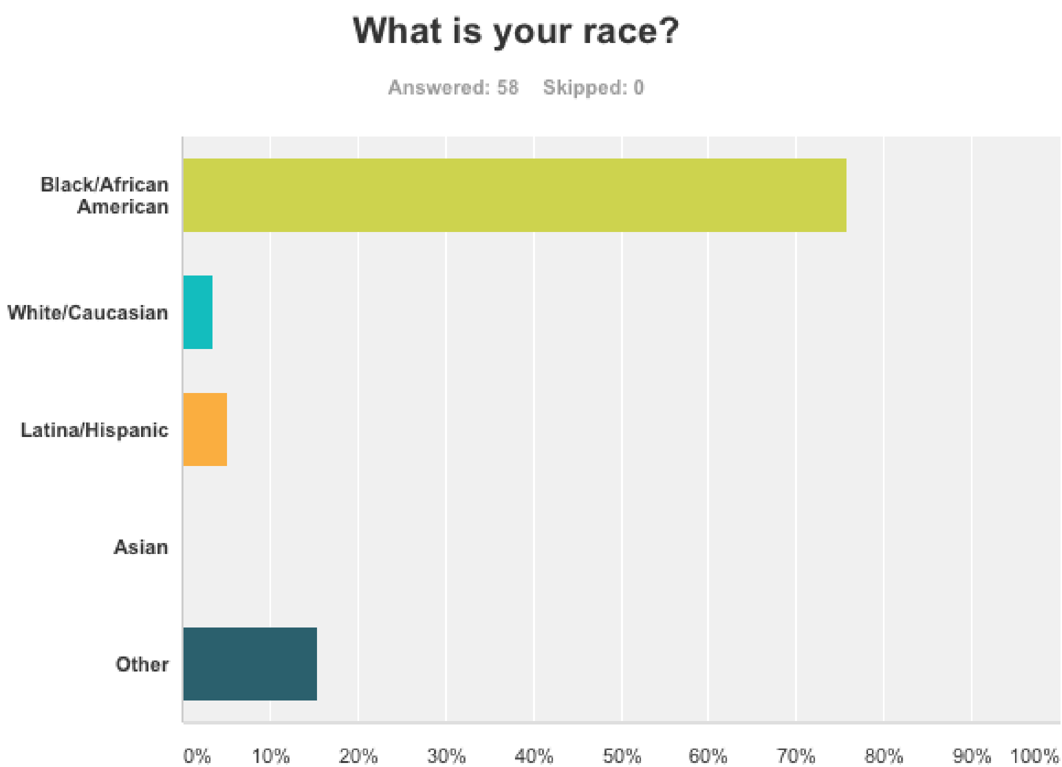
All of the participants were middle school girls. Figure 20 shows the percentages of girls in the sixth, seventh, and eighth grades who participated in this study. Fifty-percent (50%) of the participants were entering the eighth grade; eighteen point fifty-two percent (18.52%) of the participants were entering the seventh grade; and thirty-two point forty-eight percent (32.48%) were entering the sixth grade. Only fifty-four participants responded to this question, while four participants skipped this question.



Answer Choices	Responses	
6th Grade	31.48%	17
7th Grade	18.52%	10
8th Grade	50.00%	27
Total		54

Figure 20: Grade in School

The participants in this study were from various backgrounds and ethnicities. Figure 21 shows the participants by race. A majority (75.86%) of the participants were Black/African American. Only 3.4% of the participants reported as White/Caucasian while 5.17% were of Latina/Hispanic descent. The remaining participants (15.52%) reported as Other. Four (4) of the participants skipped this question.



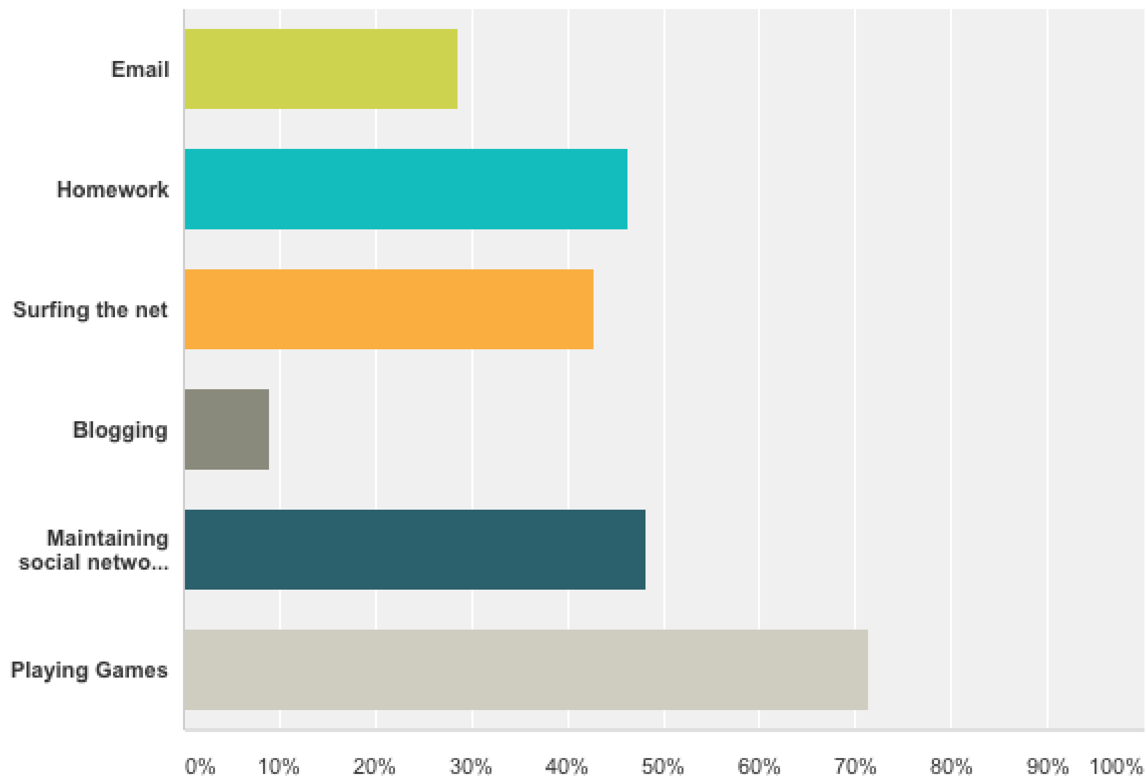
Answer Choices		Responses	
Black/African American		75.86%	44
White/Caucasian		3.45%	2
Latina/Hispanic		5.17%	3
Asian		0.00%	0
Other	Responses	15.52%	9
Total			58

Figure 21: Race

A majority (71/43%) of the participants indicated that they used a computer to play games while 48.21% used the computer for social media (e.g. Facebook and Twitter) followed by 46.43% who used the computer for homework as shown in Figure 22. In addition, 42.86% used the computer to surf the Internet. Other uses of the computer were for email (28.5%) and blogging (8.93%).

What do you normally use a computer for? (Select all that apply)

Answered: 56 Skipped: 2

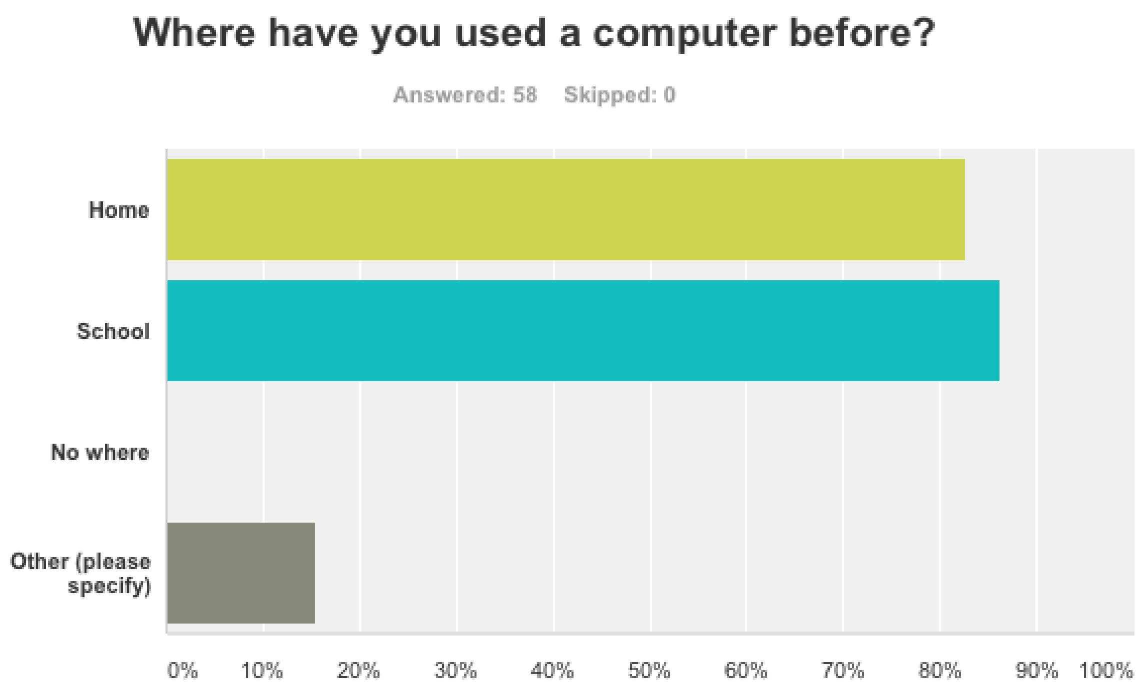


Answer Choices	Responses	
Email	28.57%	16
Homework	46.43%	26
Surfing the net	42.86%	24
Blogging	8.93%	5
Maintaining social network like Facebook, twitter etc	48.21%	27
Playing Games	71.43%	40
Total Respondents: 56		

Comments (3)

Figure 22: Computer Use

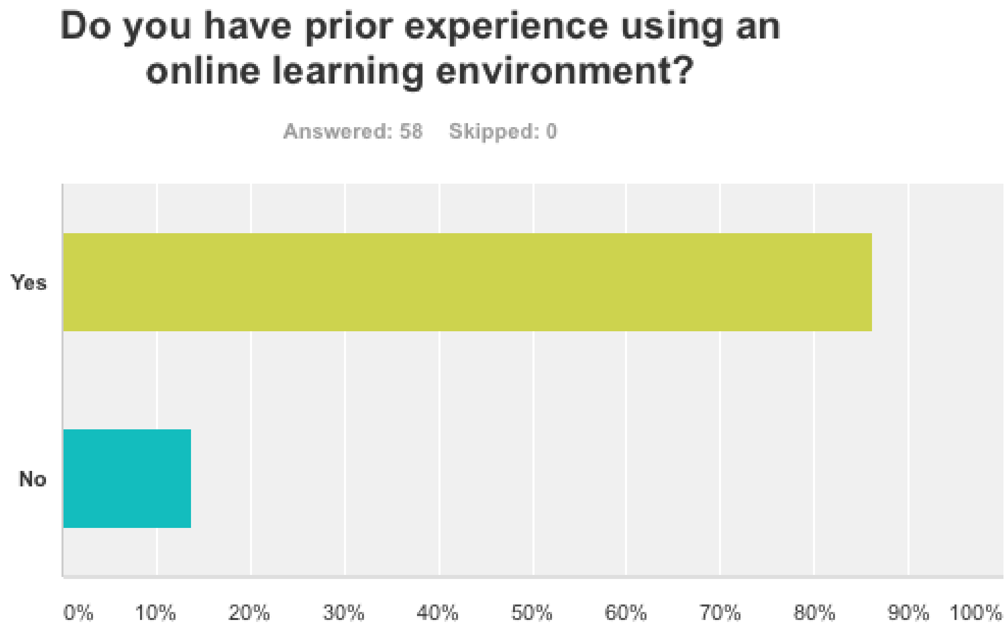
Most (86.21%) of the participants in Figure 23 used the computer at school while 82.76% use the computer at home. The remaining participants indicated “Other” (15.52%) and “No where” (0.00%).



Answer Choices	Responses	
Home	82.76%	48
School	86.21%	50
No where	0.00%	0
Other (please specify) Responses	15.52%	9
Total Respondents: 58		

Figure 23: Location of Computer Use

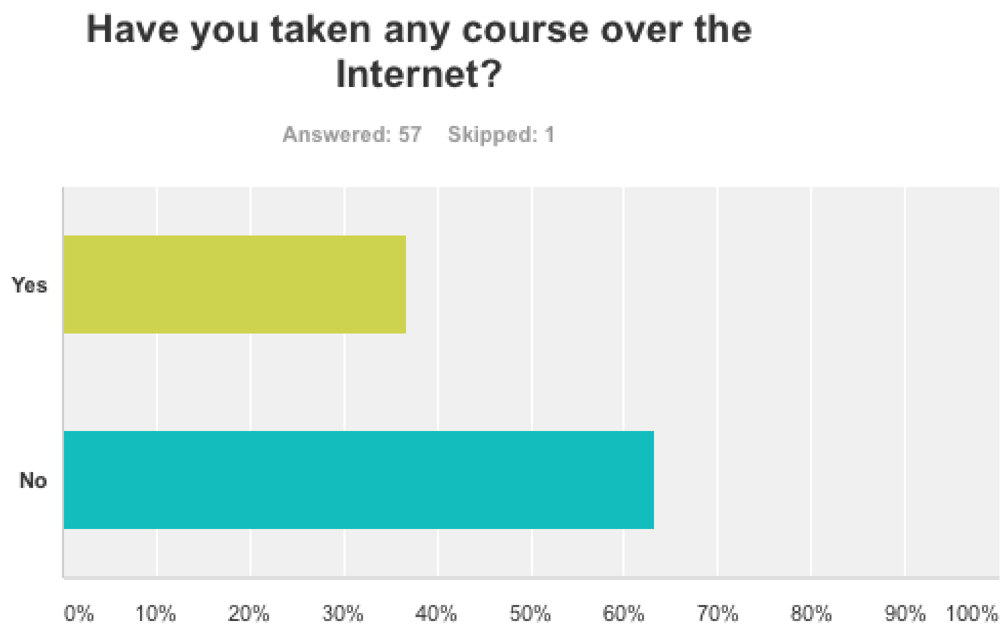
In Figure 24, 86.21% of the participants have prior experience using an online learning environment, while 13.79% reported no prior experience using an online learning environment.



Answer Choices	Responses	
Yes	86.21%	50
No	13.79%	8
Total		58

Figure 24: Online Learning Environment

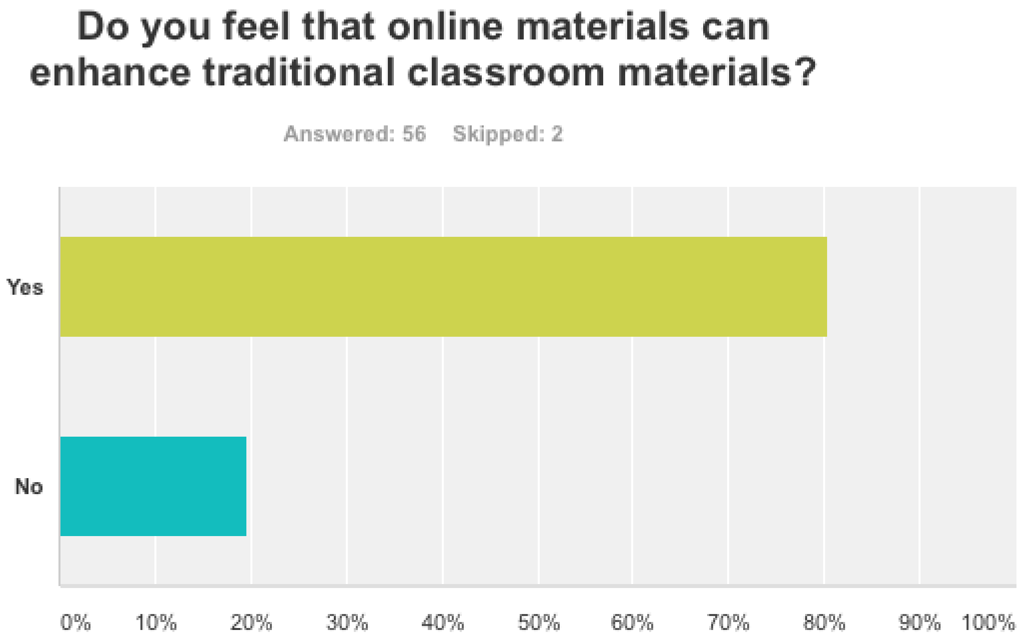
A majority (63.16%) of the participants reported that they never took a course over the Internet. Only a small percentage (36.84%) reported that they took a course over the Internet.



Answer Choices	Responses	
Yes	36.84%	21
No	63.16%	36
Total		57
Comments (10)		

Figure 25: Internet Courses

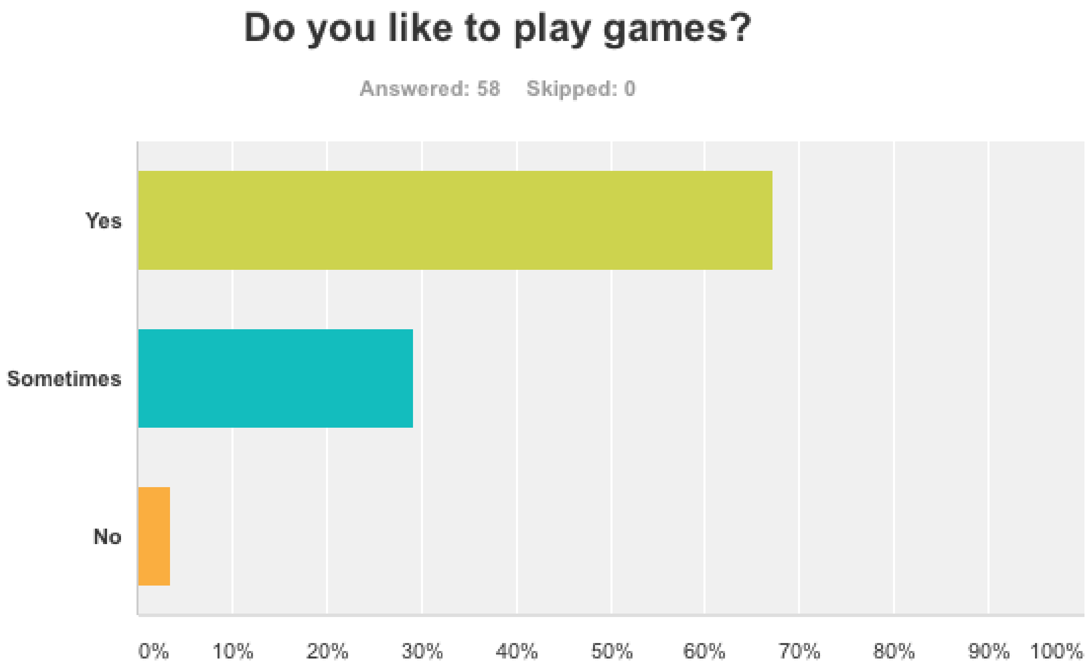
In Figure 26, most (80.36%) of the participants believed that online materials can enhance traditional classroom materials. A modicum (19.64%) of participants did not believe that online materials would enhance traditional classroom materials. One participant skipped this question.



Answer Choices	Responses	
Yes	80.36%	45
No	19.64%	11
Total		56

Figure 26: Online Materials

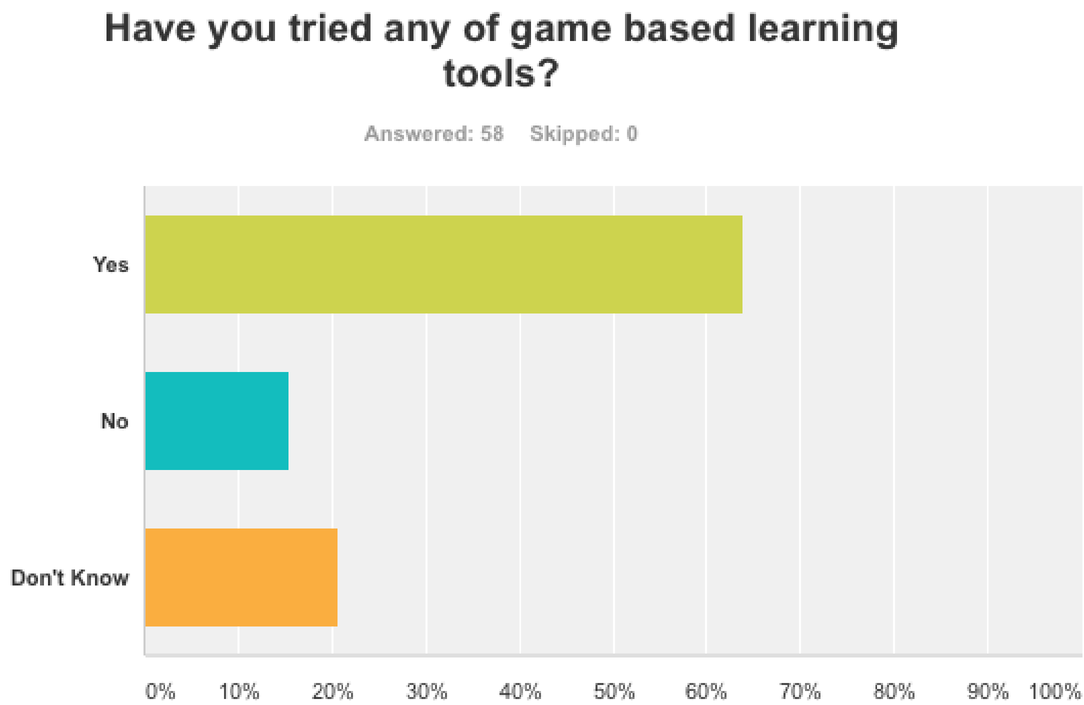
In Figure 27, a majority (67.24%) of the participants like to play games while only 29.31% like to play games sometimes. A few participants (3.45%) like to play games sometimes. Two of the participants skipped this question.



Answer Choices	Responses	
Yes	67.24%	39
Sometimes	29.31%	17
No	3.45%	2
Total		58

Figure 27: Games

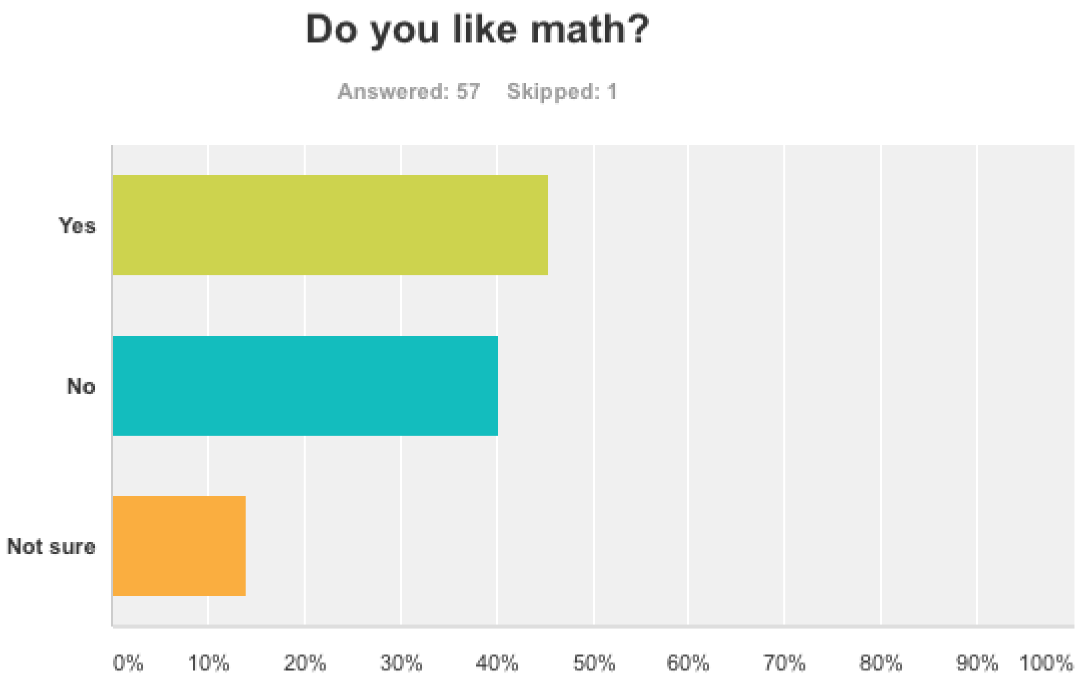
Most (63.79%) of the participants in Figure 28 indicated that they have tried game based learning tools while 15.52% reported they never tried game based learning tools. Some of the participants (20.69%) did not know whether they tried game based learning tools.



Answer Choices	Responses	
Yes	63.79%	37
No	15.52%	9
Don't Know	20.69%	12
Total		58

Figure 28: Game Based Learning Tools

The results in Figure 29 indicated that a majority (45.61%) of the participants like math while 40.35% did not like math. The remaining participants (14.04%) reported that they were not sure if they liked math. One participant skipped this question.

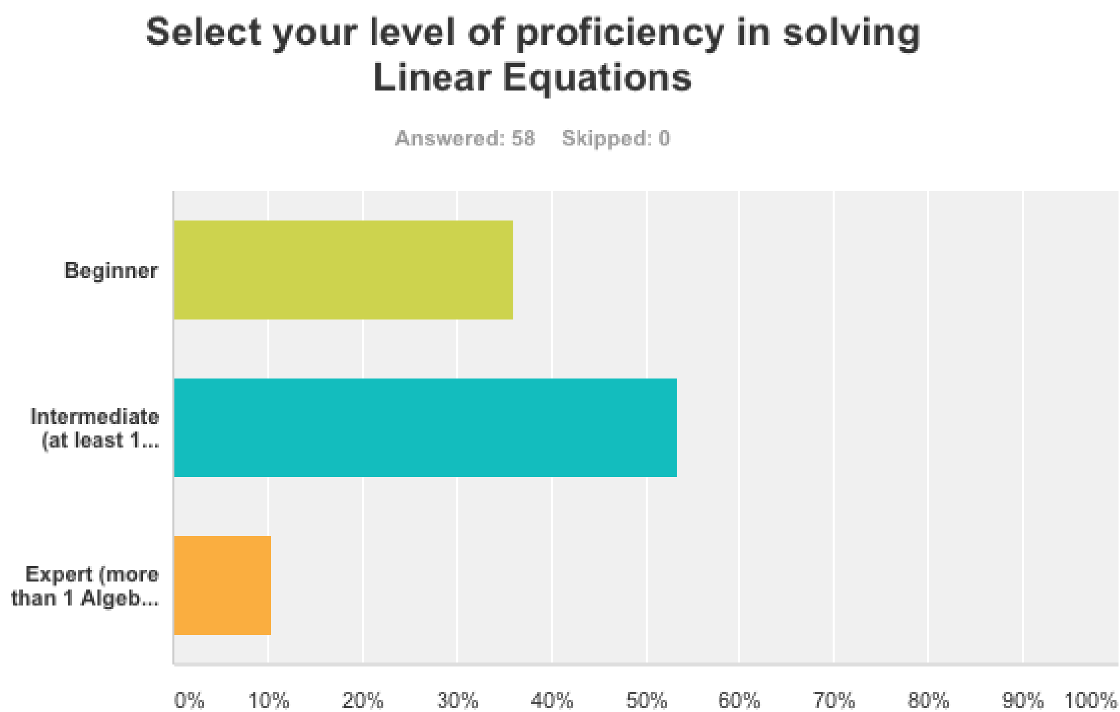


Answer Choices	Responses	
Yes	45.61%	26
No	40.35%	23
Not sure	14.04%	8
Total		57

Comments (40)

Figure 29: Attitudes Towards Math

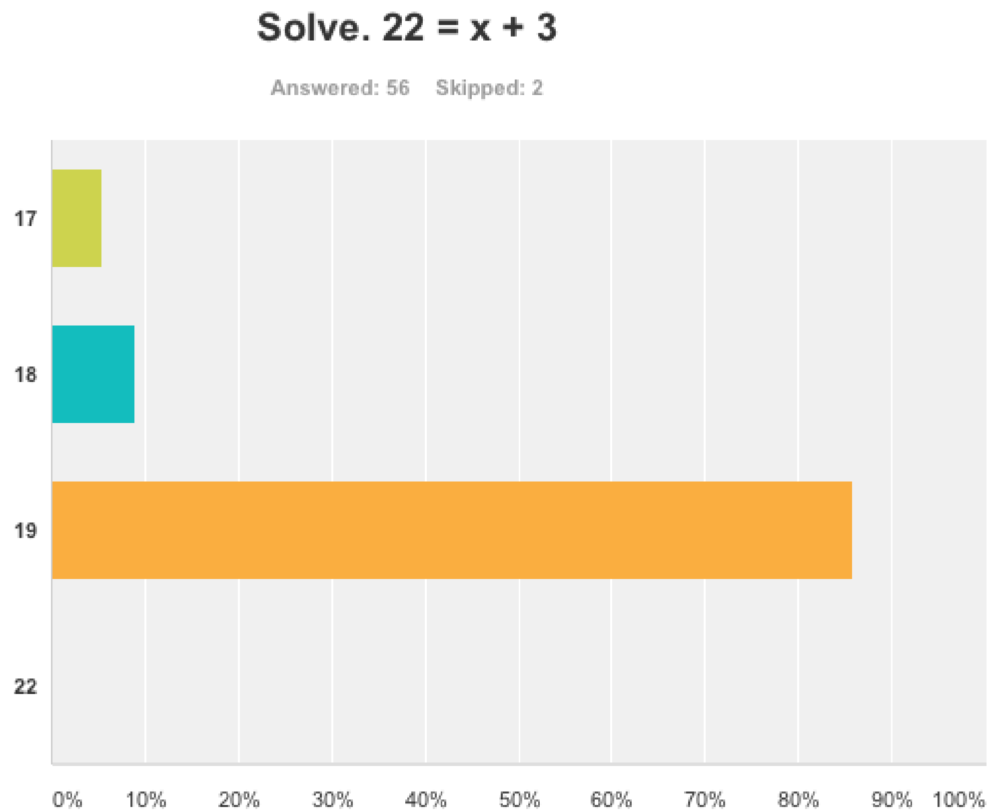
More than half of the participants (53.45%) had taken at least one Algebra course as reported in Figure 30. Some participants (36.21%) reported that they were beginners, meaning that they were new to Algebra. The remaining participants (10.34%) considered themselves experts in Algebra, meaning they had taken more than one course or related Algebra experience. One participant skipped this question.



Answer Choices	Responses	
Beginner	36.21%	21
Intermediate (at least 1 course in Algebra)	53.45%	31
Expert (more than 1 Algebra course or related Algebra experience)	10.34%	6
Total		58

Figure 30: Proficiency in Solving Linear Equations

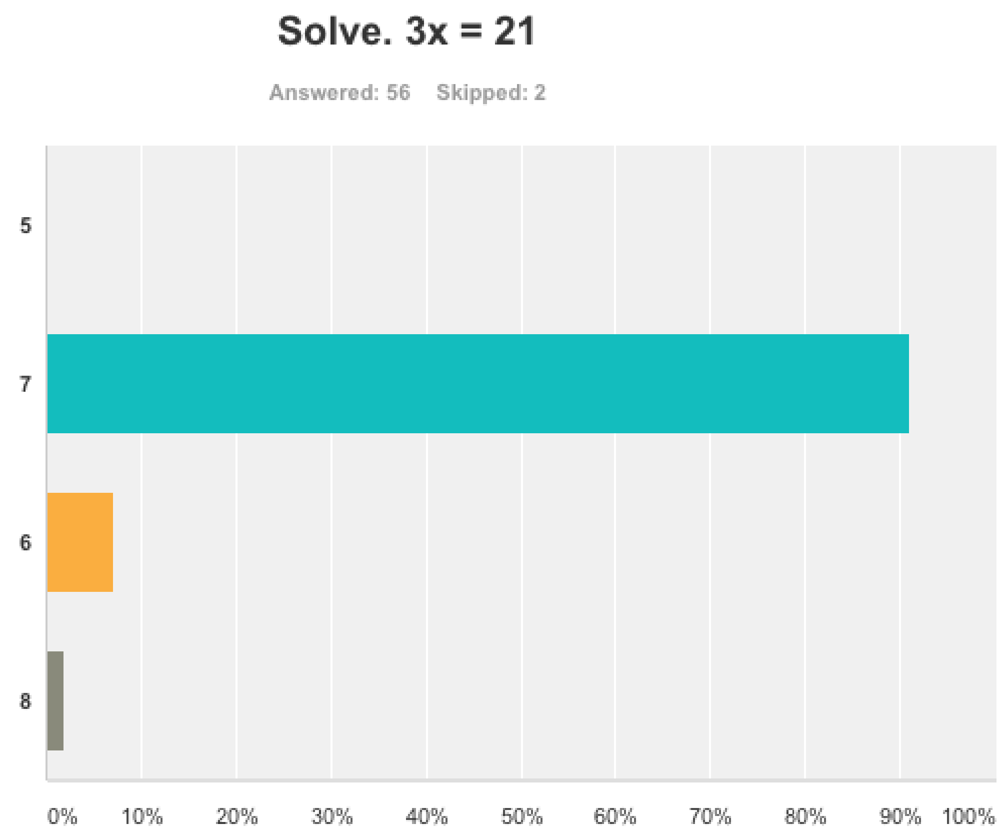
The remaining eight (8) pre-survey questions assessed the participant's knowledge of Algebra. Each participant was given eight linear equations to solve. Figure 31 shows a linear equation involving addition. A majority (85.71%) of the participants solve the equation correctly while 14.29% solved the equation incorrectly. Two participants skipped this question.



Answer Choices	Responses	
17	5.36%	3
18	8.93%	5
19	85.71%	48
22	0.00%	0
Total		56

Figure 31: Linear Equation with Subtraction

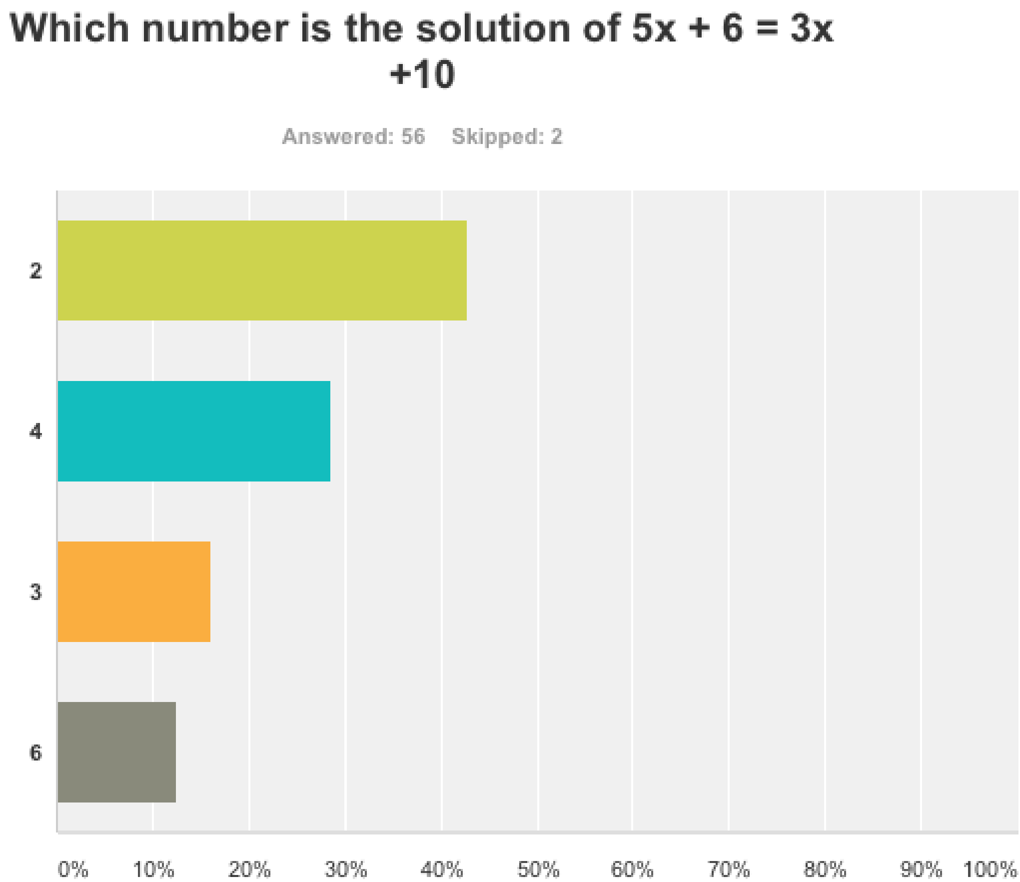
A vast majority (91.07%) of the participants in Figure 32 answered the linear equation with division correctly. Only 8.93% responded to the problem incorrectly. Two of the participants skipped this question.



Answer Choices	Responses	
5	0.00%	0
7	91.07%	51
6	7.14%	4
8	1.79%	1
Total		56

Figure 32: Linear Equation with Division

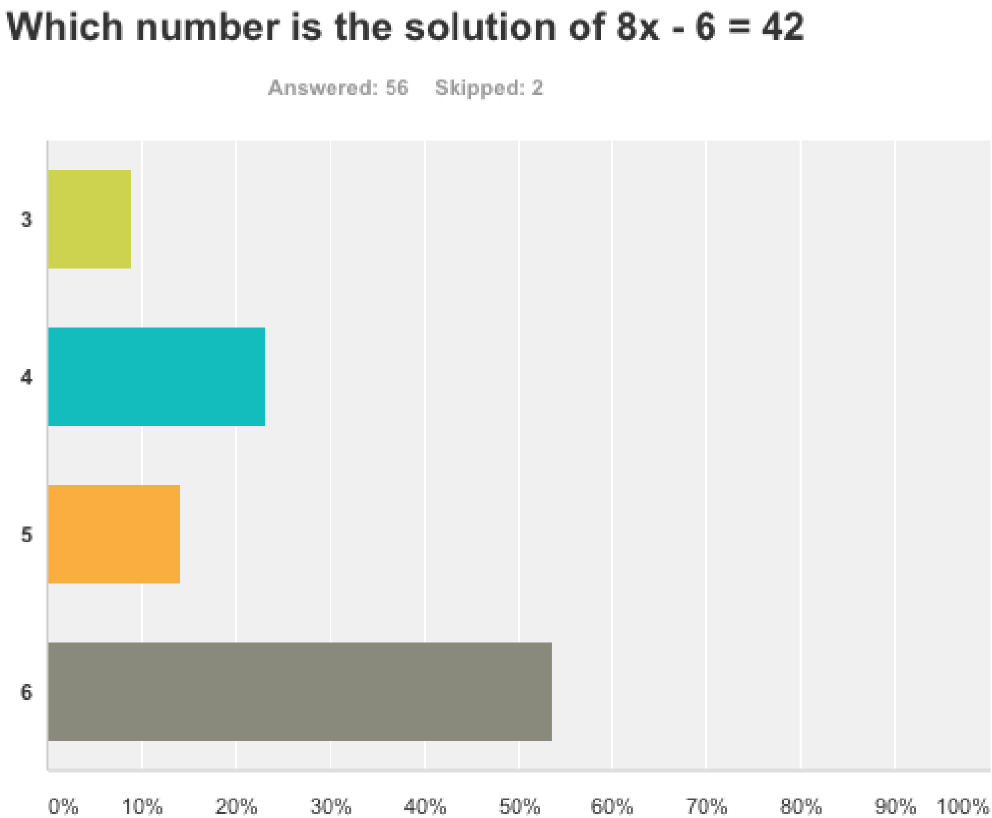
In Figure 33, 42.86% of the participants correctly answered the problem with variables on both sides of the equation. Approximately 57.14% of the participants did not answer the problem correctly. Two of the participants skipped the problem.



Answer Choices	Responses	
2	42.86%	24
4	28.57%	16
3	16.07%	9
6	12.50%	7
Total		56

Figure 33: Variables on Both Sides of the Equation

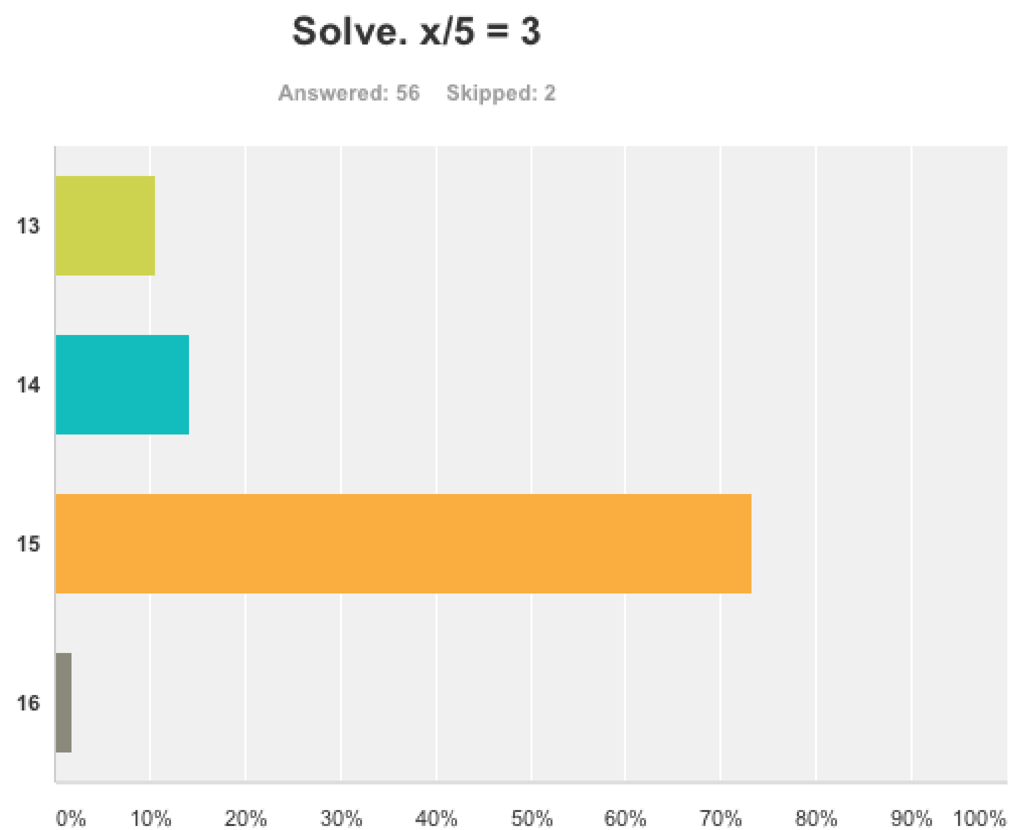
In Figure 34, most (53.57%) of the participants solved the two-step equation involving both addition and division correctly. The remaining participants (46.43%) did not answer the question favorably. Two of the participants skipped the problem.



Answer Choices	Responses	
3	8.93%	5
4	23.21%	13
5	14.29%	8
6	53.57%	30
Total		56

Figure 34: Two Step Equation Addition and Division

Most (73.21%) of the respondents solved the linear equation with multiplication correctly in Figure 35. Approximately, 26.79% answered incorrectly. Two participants skipped this problem.

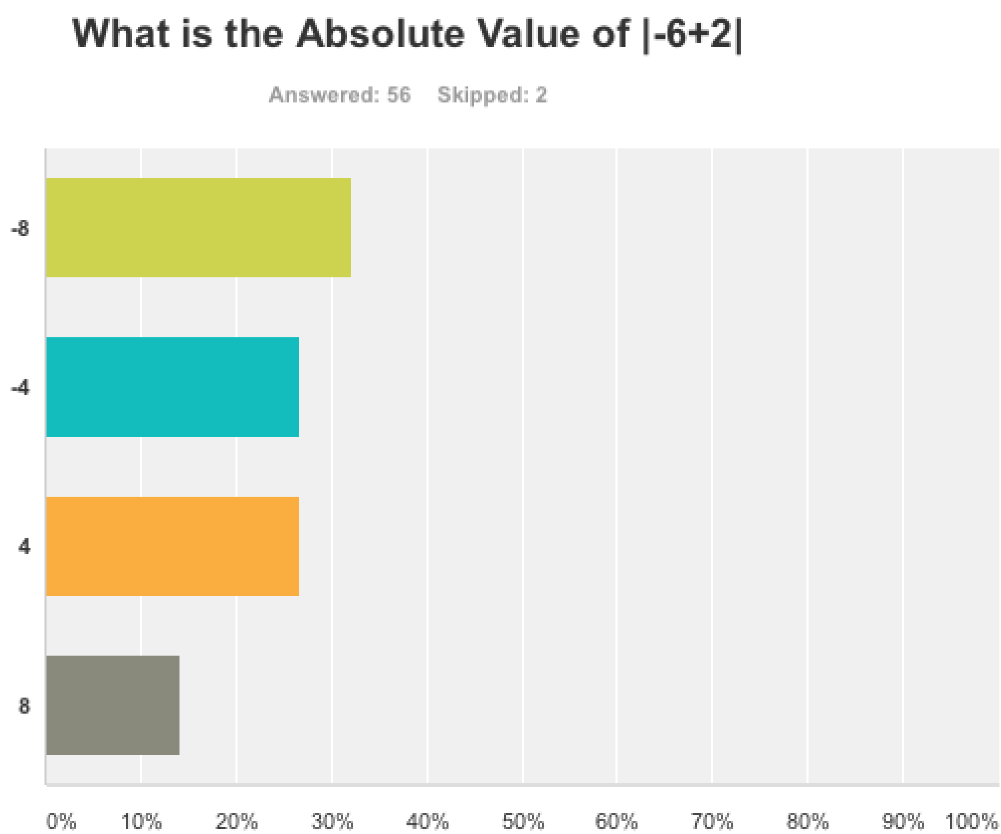


Answer Choices	Responses	
13	10.71%	6
14	14.29%	8
15	73.21%	41
16	1.79%	1
Total		56

Figure 35: Linear Equation with Multiplication

In Figure 36, only 26.79% of the participants answered this question correctly. In addition, 26.79% indicated that the correct response was a negative four (-4). The correct answer was a positive four (+4). A total of 73.21% solved this problem incorrectly. A majority

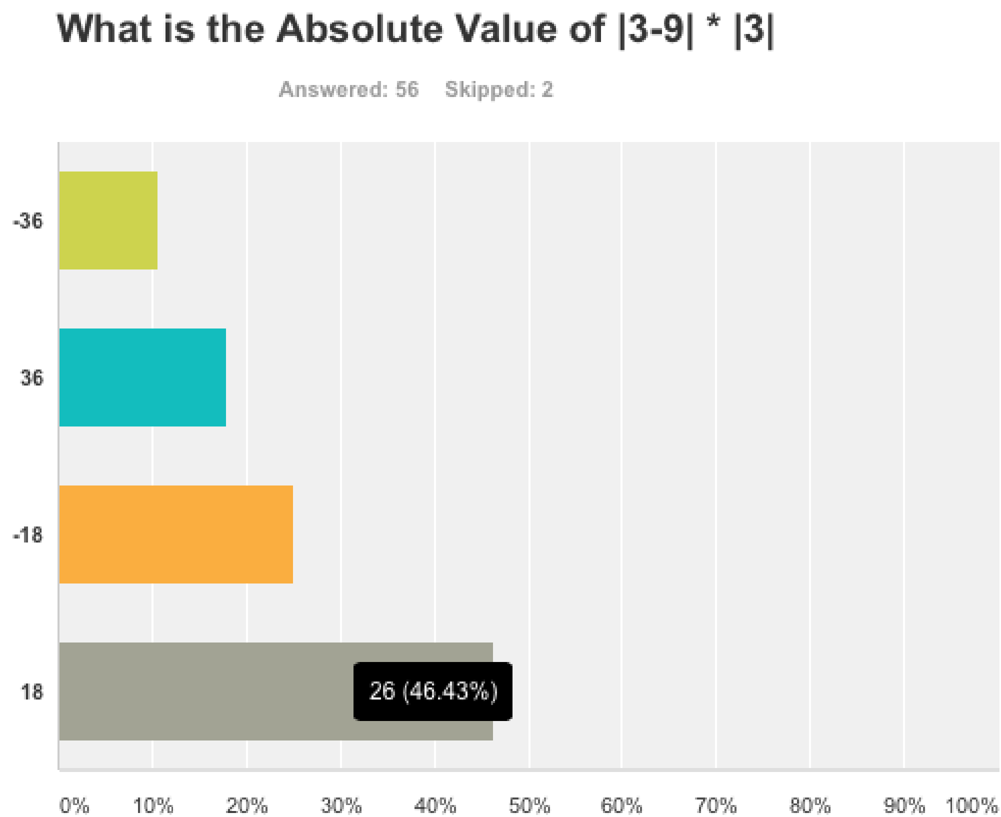
(32.14%) of the participants reported that the correct answer was negative eight (-8). Two of the participants skipped this question.



Answer Choices	Responses	
-8	32.14%	18
-4	26.79%	15
4	26.79%	15
8	14.29%	8
Total		56

Figure 36: Absolute Value Expression

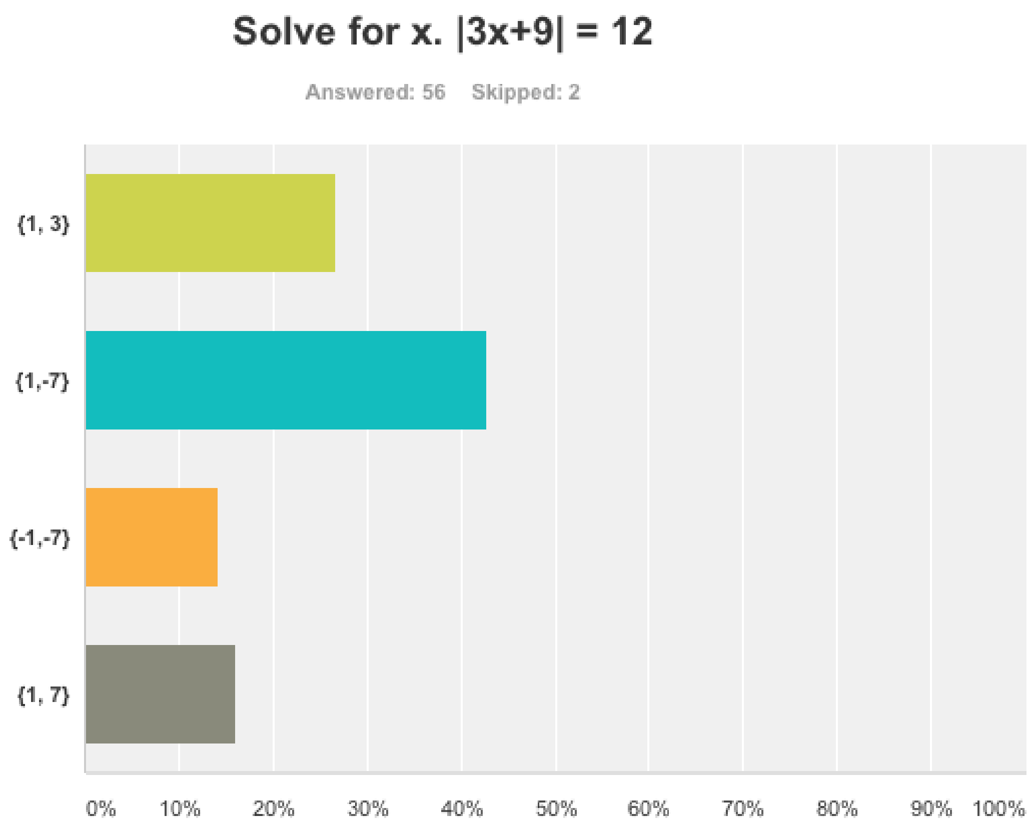
In Figure 37, 46.43% of the participants reported the correct response (18) for solving this absolute value expression involving multiplication. A majority (53.57%) of the participants answered incorrectly. Twenty-five percent (25%) thought that a negative eighteen (-18) was the correct answer. Two participants skipped this question.



Answer Choices	Responses	
-36	10.71%	6
36	17.86%	10
-18	25.00%	14
18	46.43%	26
Total		56

Figure 37: Absolute Value Expression with Multiplication

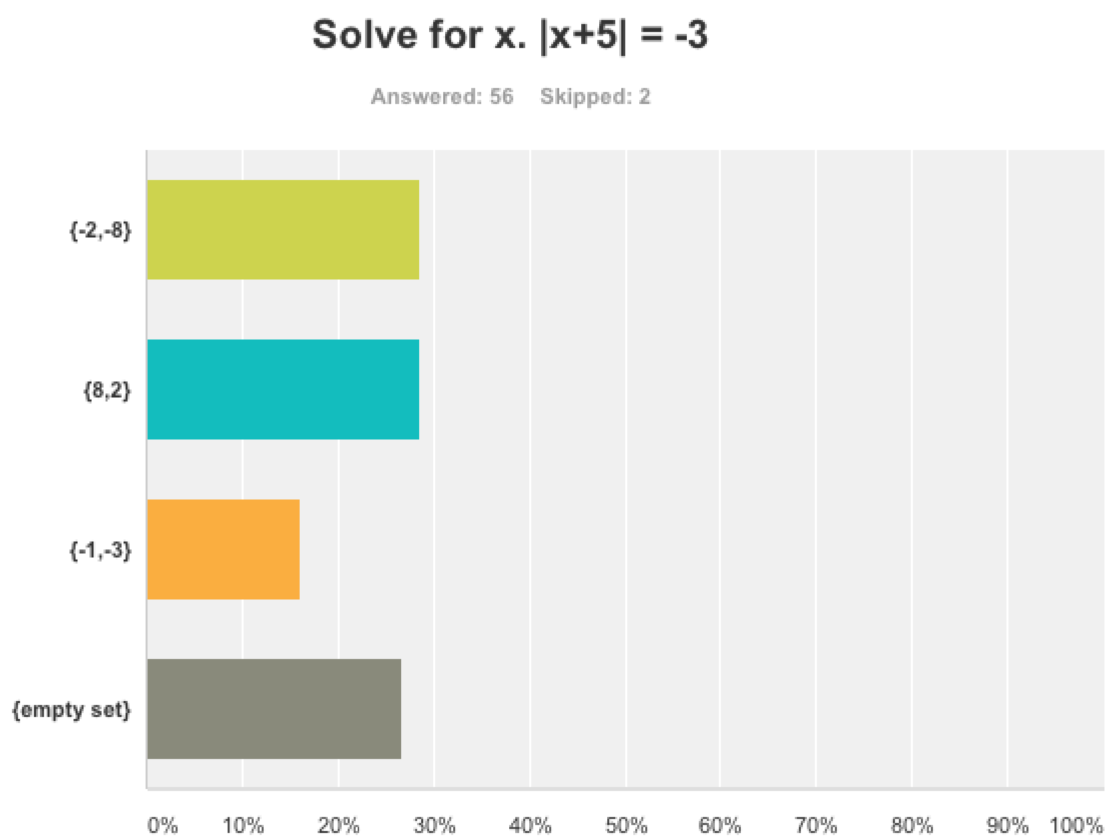
In Figure 38, some (42.86%) of the participants solved the absolute value equation correctly. However, 57.14% of the participants solved the absolute value equation incorrectly. Two of the participants skipped this question.



Answer Choices	Responses	
{1, 3}	26.79%	15
{1,-7}	42.86%	24
{-1,-7}	14.29%	8
{1, 7}	16.07%	9
Total		56

Figure 38: Absolute Value Equation

In Figure 39, a few of the participants (26.79%) chose the empty set as their response. The empty set was the correct answer. A majority (73.21%) of the participants did not solve this absolute value equation with a negative number correctly. If an absolute value equation has a negative number on the right hand side of the equation, the solution set is automatically the empty set. Two of the participants skipped this problem.



Answer Choices	Responses	
{-2,-8}	28.57%	16
{8,2}	28.57%	16
{-1,-3}	16.07%	9
{empty set}	26.79%	15
Total		56

Figure 39: Absolute Value Equation with a Negative Number

Post-Survey Results

Using the post-questionnaire survey form, we were able to document various types of user characteristics. Figure 40 and Figure 41 represents the overall reaction to the game. The numbers in percentages (e.g. 8%) represent the percentages of test subjects respectively. Only 81% of the girls from the pre-questionnaire participated in the post-questionnaire due to absences.

In Figure 40 and Figure 41, a majority (63.04%) of the students believed the game was attractive. Most of the participants (75.56%) believed the Edu^{tain}ment game was easy to use. Over half of the participants (65.11%) indicated that the game was easy to learn. Half (50%) of the participants reported that the game was fun. In addition, 55.55% of the participants believed that the game was interesting. At least 57.78% of the participants believed the game was flexible. Based on their experience with the Edu^{tain}ment game, 45.24% of the students reported that they would pay the game again; however, 35.72% indicated they would not play the game again.

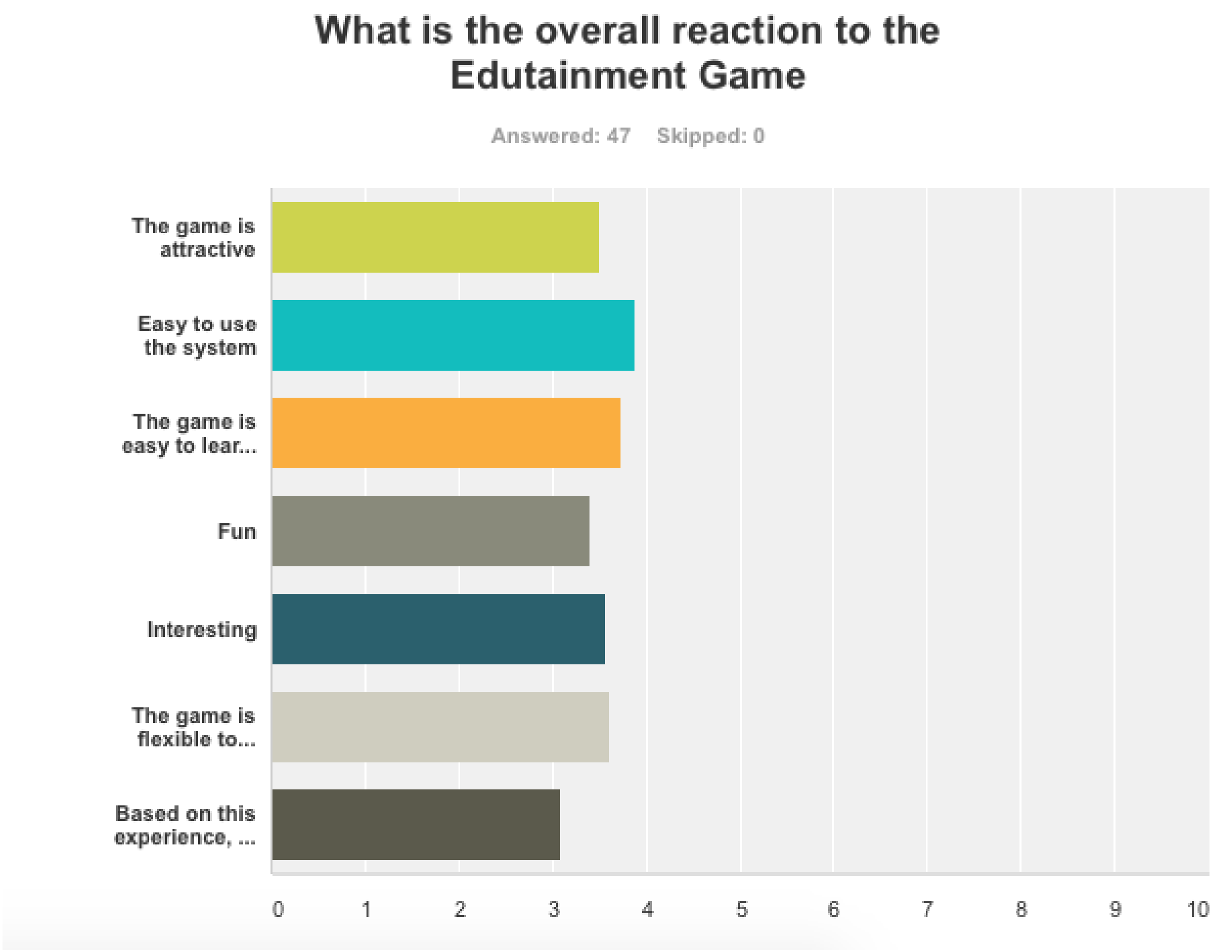


Figure 40: Edu^{tain}ment website Overall Reaction

	Strongly Agree	Agree	Neutral	Disagree	Strongly disagree	Total	Weighted Average
The game is attractive	21.74% 10	41.30% 19	17.39% 8	4.35% 2	15.22% 7	46	3.50
Easy to use the system	35.56% 16	40.00% 18	11.11% 5	4.44% 2	8.89% 4	45	3.89
The game is easy to learn to use	30.23% 13	34.88% 15	18.60% 8	11.63% 5	4.65% 2	43	3.74
Fun	25.00% 11	25.00% 11	27.27% 12	11.36% 5	11.36% 5	44	3.41
Interesting	31.11% 14	24.44% 11	26.67% 12	6.67% 3	11.11% 5	45	3.58
The game is flexible to play	26.67% 12	31.11% 14	26.67% 12	8.89% 4	6.67% 3	45	3.62
Based on this experience, I will play this game again	21.43% 9	23.81% 10	19.05% 8	14.29% 6	21.43% 9	42	3.10

Figure 41: Edutainment website Overall Reaction Percentages

In Figure 42 and Figure 43, 58.69% of the participants believed that the Edutainment game had flexibility and 54.34% reported that the user experience was good. More than half (62.23%) of the participants indicated that they could learn with the Edutainment game. A majority (61.36%) of the participants reported that the visual look of the system was high or very high. Half of the participants (50%) believed that that the Edutainment Game had an interactive feel. Over half (56.81%) of the participants reported the system was easy to play.

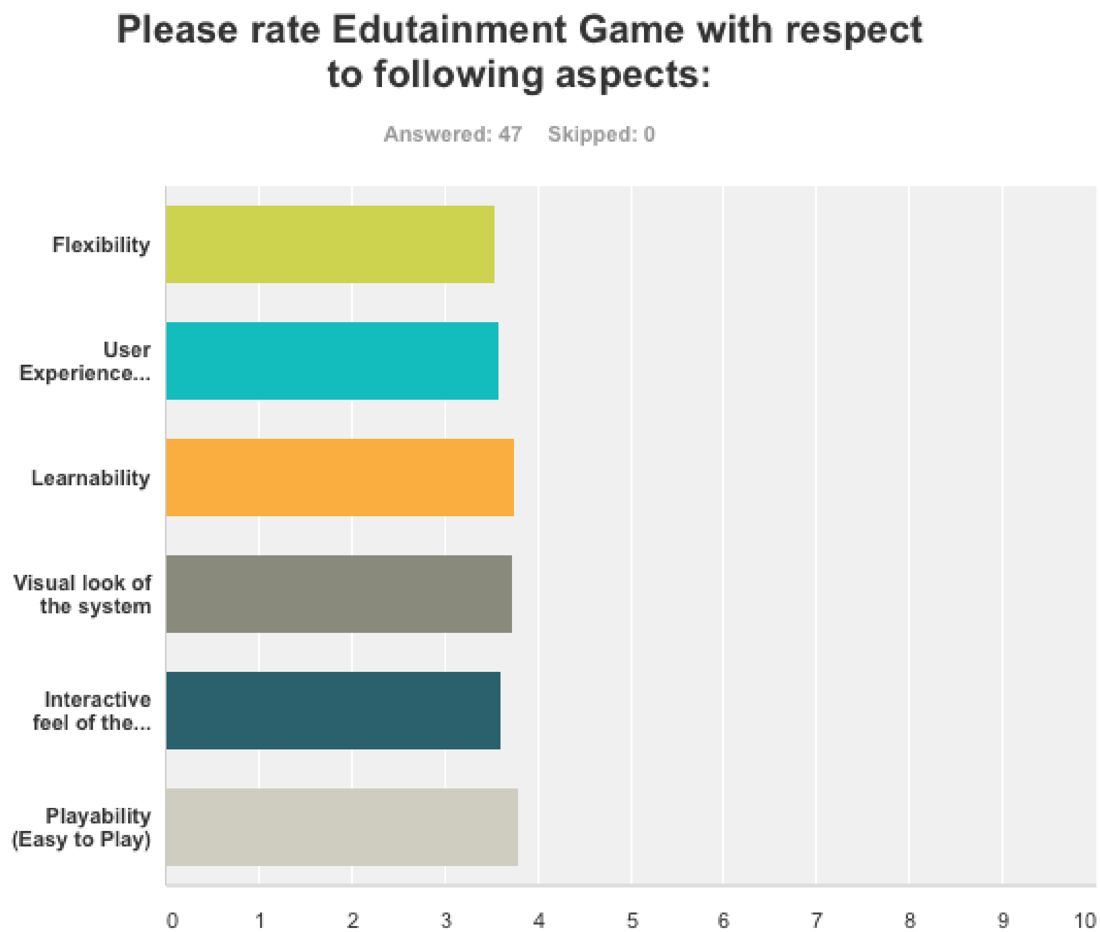
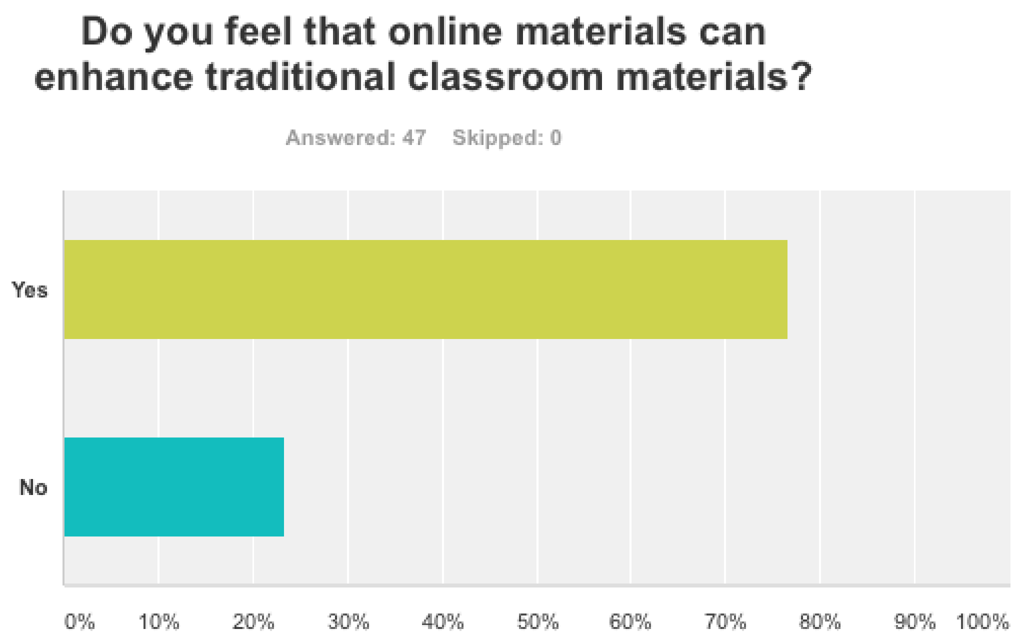


Figure 42: Edu[tain]ment website Ratings

	Very High	High	Moderate	Low	Very Low	Total	Weighted Average
Flexibility	13.04% 6	45.65% 21	30.43% 14	4.35% 2	6.52% 3	46	3.54
User Experience (Good feeling about the system)	23.91% 11	30.43% 14	34.78% 16	2.17% 1	8.70% 4	46	3.59
Learnability	35.56% 16	26.67% 12	24.44% 11	4.44% 2	8.89% 4	45	3.76
Visual look of the system	27.27% 12	34.09% 15	27.27% 12	6.82% 3	4.55% 2	44	3.73
Interactive feel of the system	31.82% 14	18.18% 8	36.36% 16	6.82% 3	6.82% 3	44	3.61
Playability (Easy to Play)	36.36% 16	20.45% 9	34.09% 15	4.55% 2	4.55% 2	44	3.80

Figure 43: Edu^{tain}ment website Ratings in Percentages

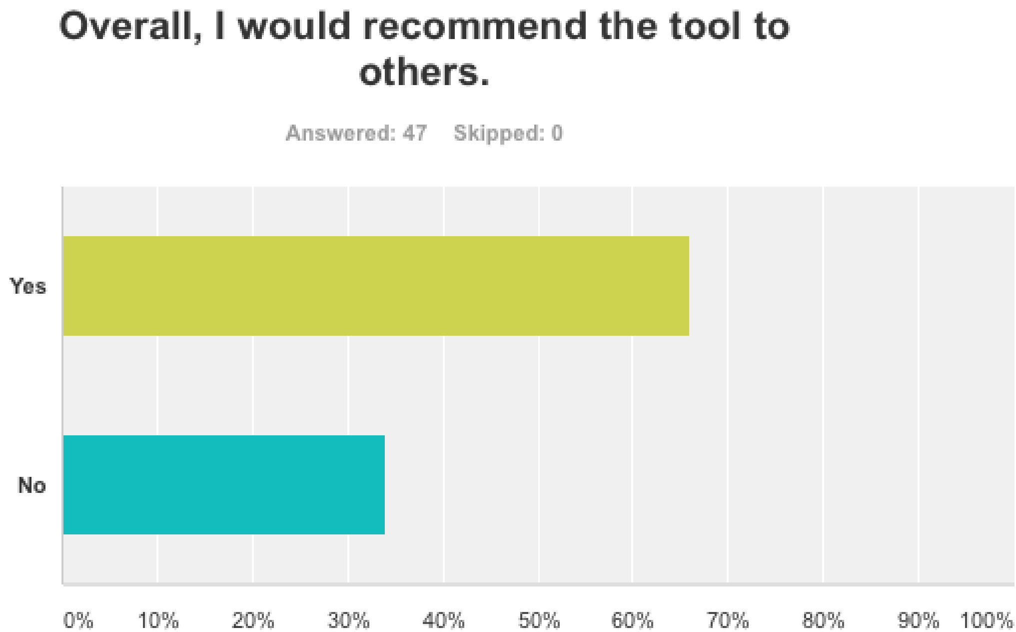
In Figure 44, a majority (76.60%) of the participants believed that online materials could enhance traditional classroom materials. The remaining participants (23.40%) did not believe online materials would enhance traditional classroom materials.



Answer Choices	Responses	
Yes	76.60%	36
No	23.40%	11
Total		47

Figure 43: Online Materials Enhancement

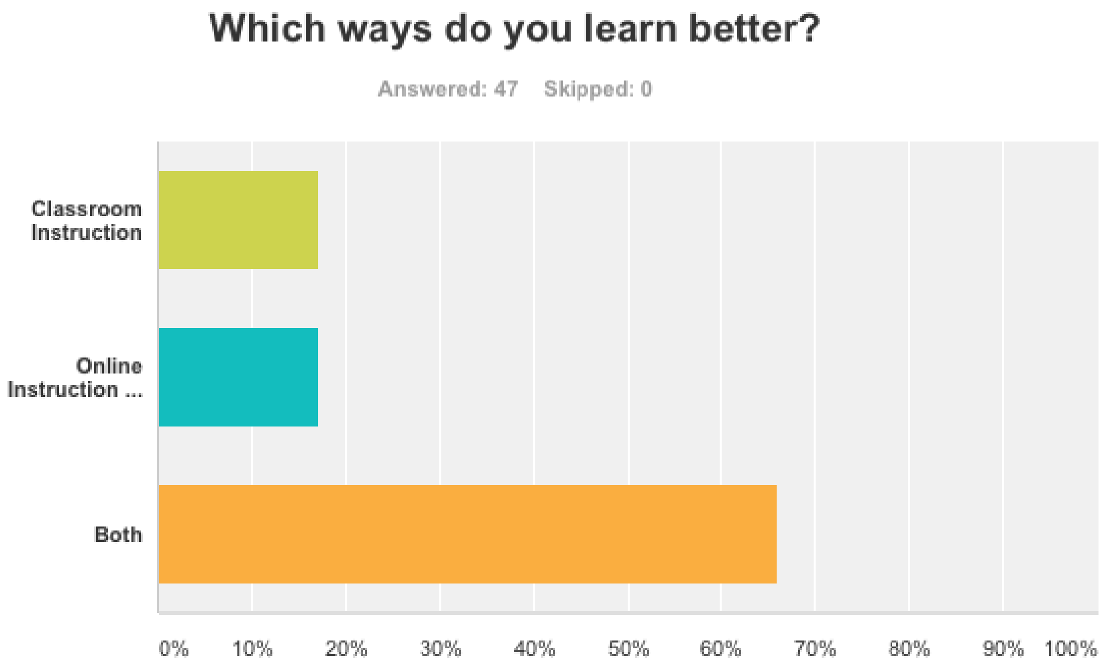
The majority (65.96%) of the participants in Figure 45 reported that overall, they would recommend the tool to others. The remaining participants (34.04%) indicated that they would not recommend the tool to others.



Answer Choices	Responses	
Yes	65.96%	31
No	34.04%	16
Total		47

Figure 45: Edu^{tain}ment website Recommendation

In Figure 46, 65.96% of the participants reported that they would use both classroom instruction and online instruction. Some (17.02%) of the participants preferred only classroom instruction and the remaining participants (17.02%) preferred online instruction.



Answer Choices	Responses	
Classroom Instruction	17.02%	8
Online Instruction and Games	17.02%	8
Both	65.96%	31
Total		47

Figure 46: Ways to Learn Better

Figure 47 reports some of the positive aspects that the participants observed about the website. Some participants believed the Edutainment website was educational. Others thought the website would prepare them for middle school. Some participants thought that the website was fun and easy. One participant indicated that the games helped her to learn more and another participant believed that the Edutainment website gave her ideas on how to teach other people.

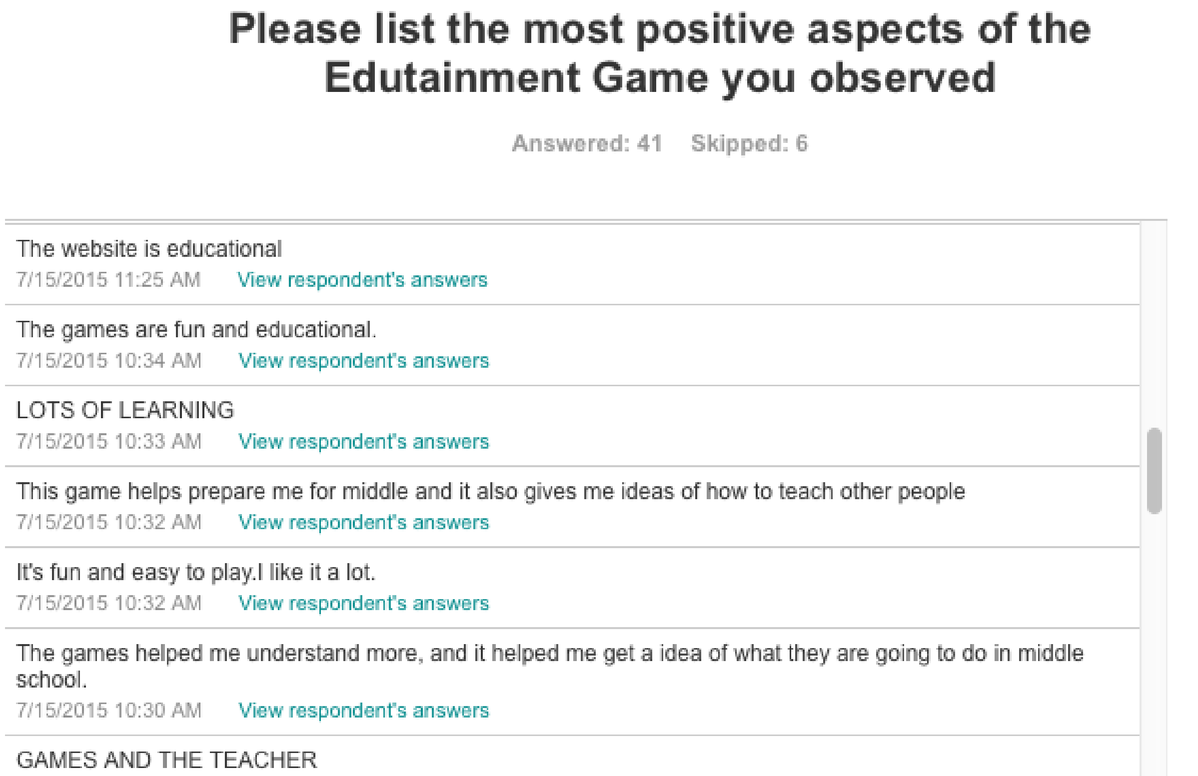
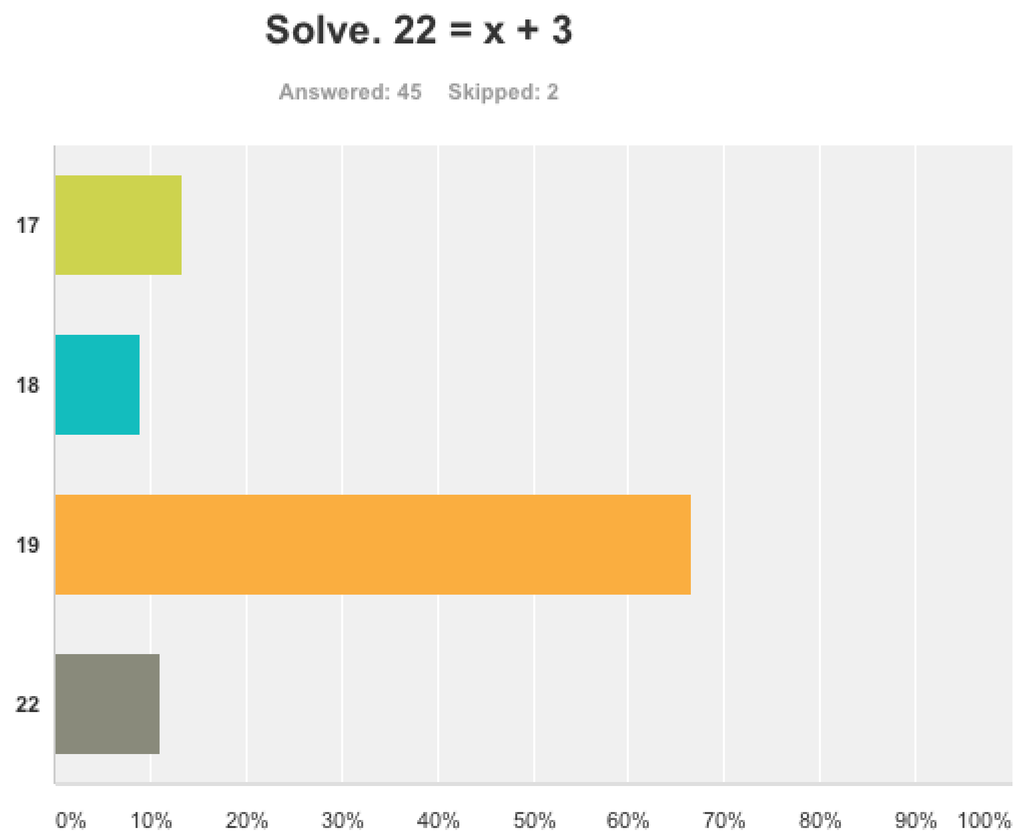


Figure 47: Edutainment website Positive Aspects

In Figure 48, the participants reported the negative aspects of the Edutainment website. Some participants reported that it was hard. Several participants indicated that they did not know any negative aspects. Some participants thought that the website was boring.

Figure 48: Edu^{tain}ment website Negative Aspects

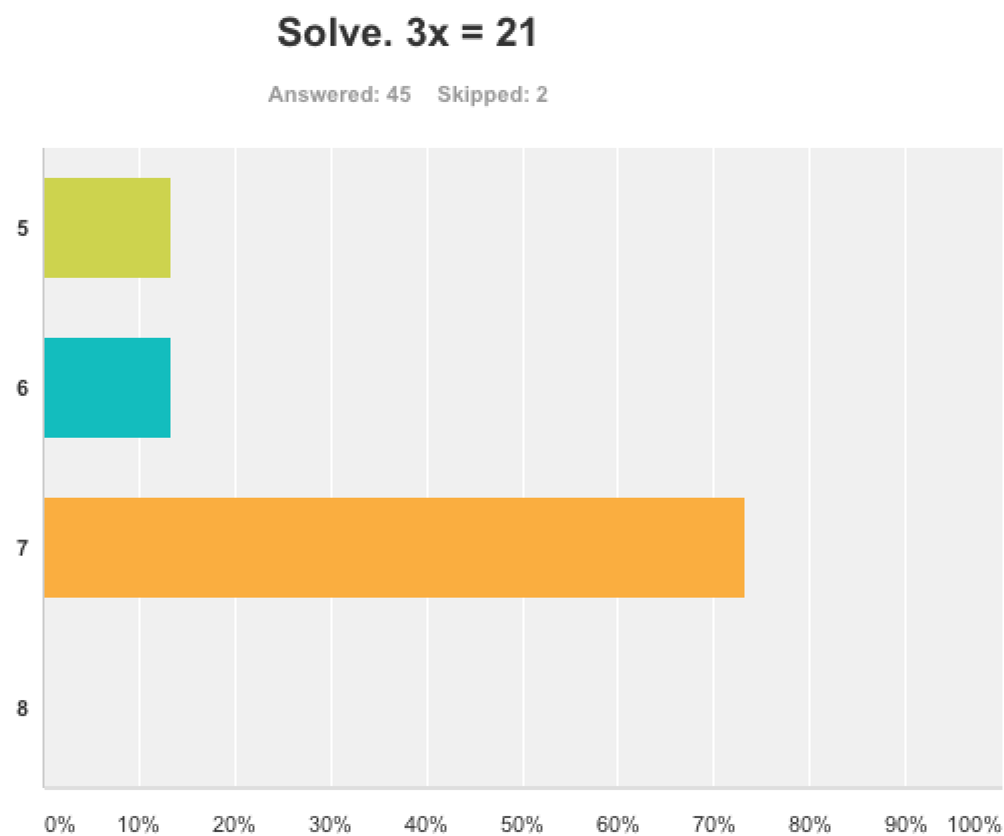
In Figure 49, a majority (66.67%) of the participants correctly solved the linear equation. The remaining participants (33.33%) answered the problem incorrectly. Two of the participants skipped this problem.



Answer Choices	Responses	
17	13.33%	6
18	8.89%	4
19	66.67%	30
22	11.11%	5
Total		45

Figure 49: Post-Survey Linear Equation

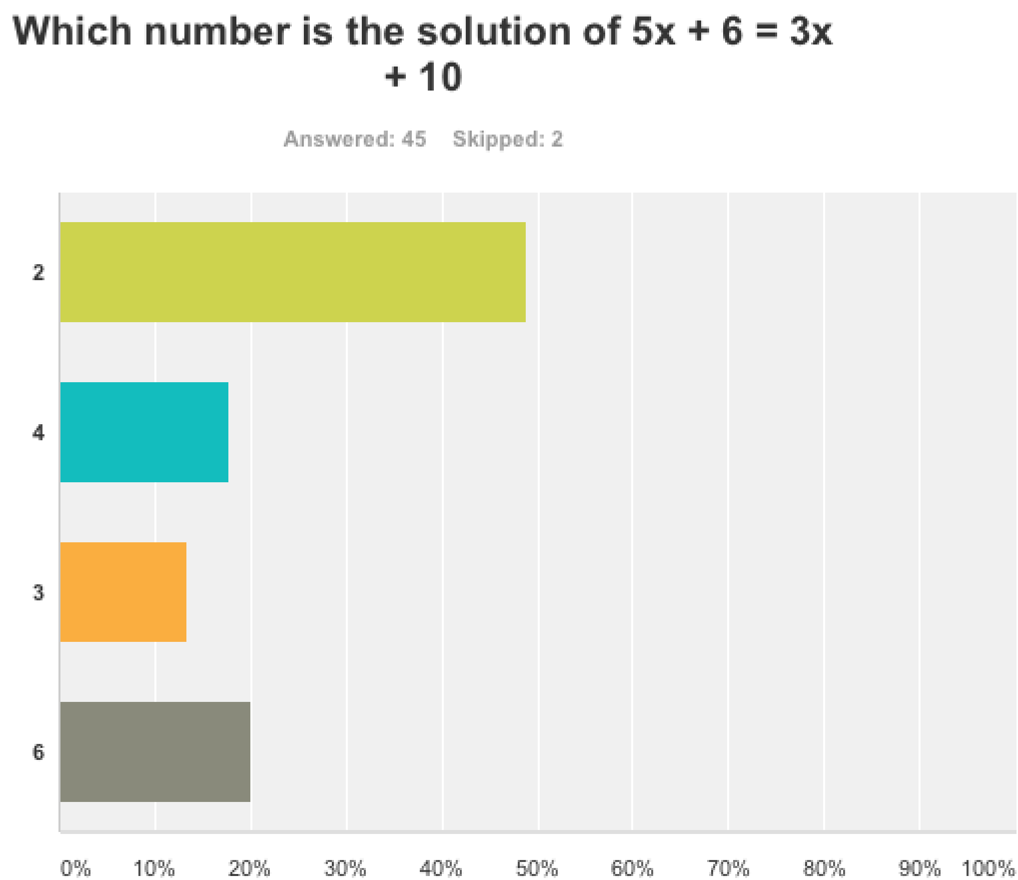
In Figure 50, 73.33% of the participants solved the linear equation with division correctly. The remaining 26.67% of participants did not solve the problem correctly. Two of the participants skipped this problem.



Answer Choices	Responses	
5	13.33%	6
6	13.33%	6
7	73.33%	33
8	0.00%	0
Total		45

Figure 50: Post-Survey Linear Equation with Division

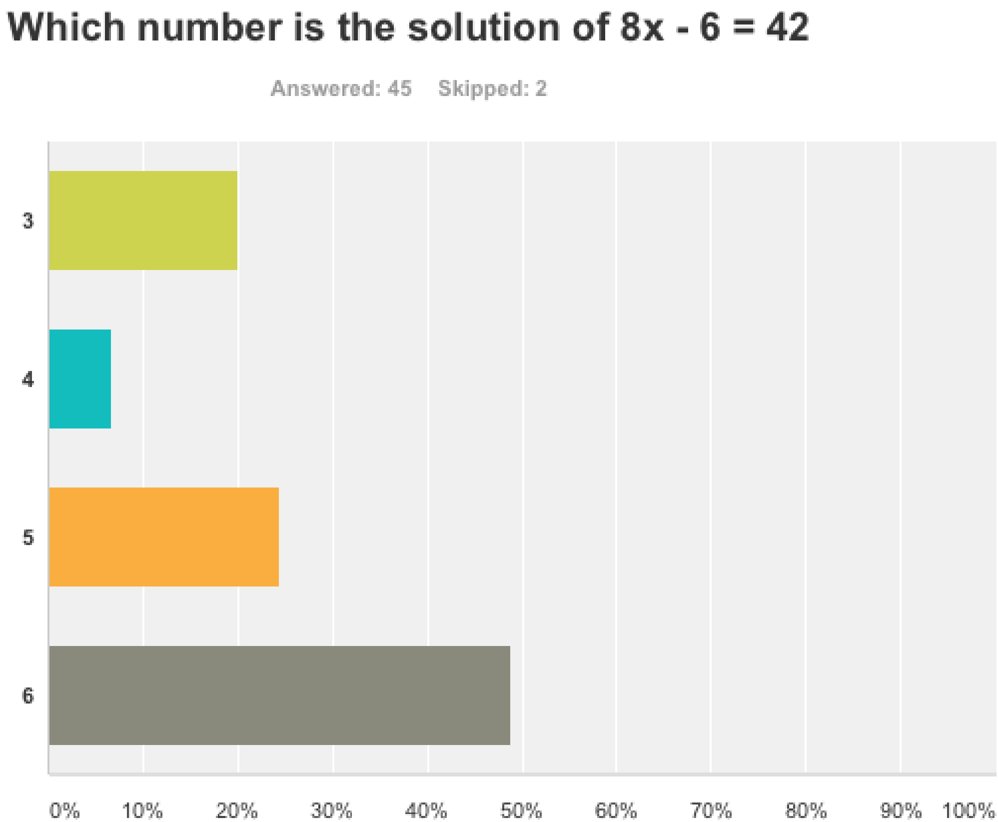
In Figure 51, 48.89% of the participants solved the linear equation with variables on both sides of the equation correctly. Over half of the participants (51.11%) did not solve the equation correctly. Two of the participants skipped this problem.



Answer Choices	Responses	
2	48.89%	22
4	17.78%	8
3	13.33%	6
6	20.00%	9
Total		45

Figure 51: Post-Survey Linear Equation with Variables on Both Sides

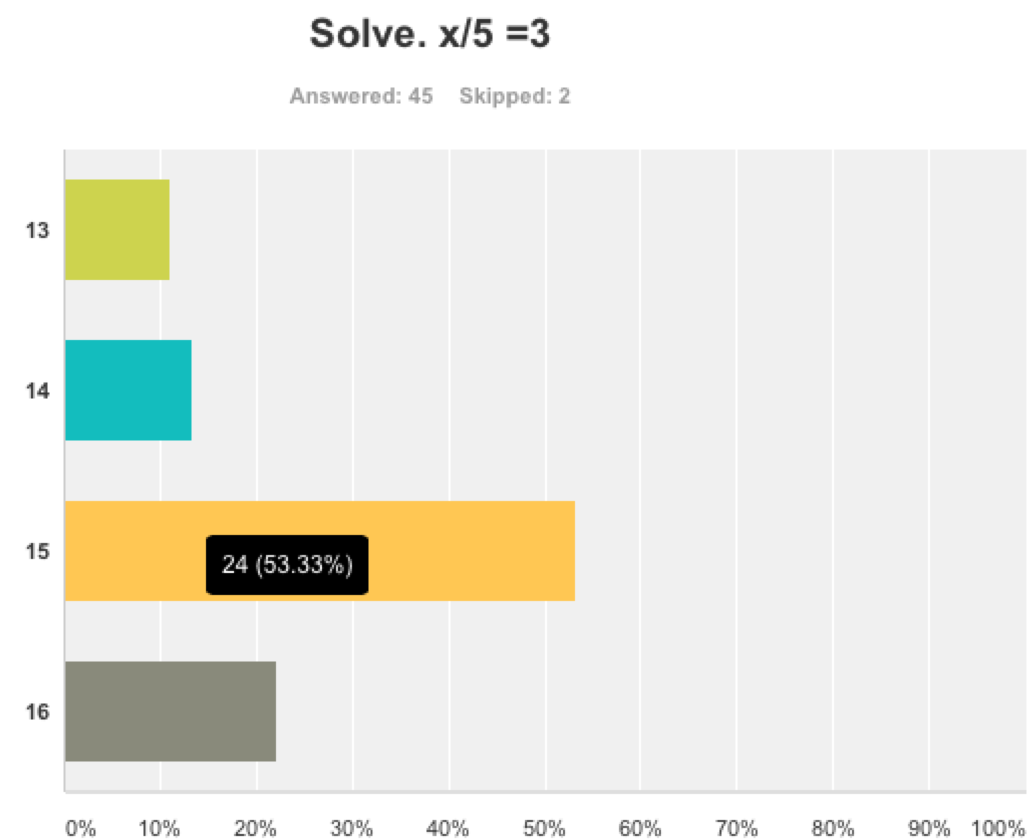
In Figure 52, less than half (48.89%) of the participants answered the problem correctly. Over half (51.11%) of the participants did not answer the problem correctly. Two of the participants skipped this problem.



Answer Choices	Responses	
3	20.00%	9
4	6.67%	3
5	24.44%	11
6	48.89%	22
Total		45

Figure 52: Post-Survey Linear Equation with Two Steps

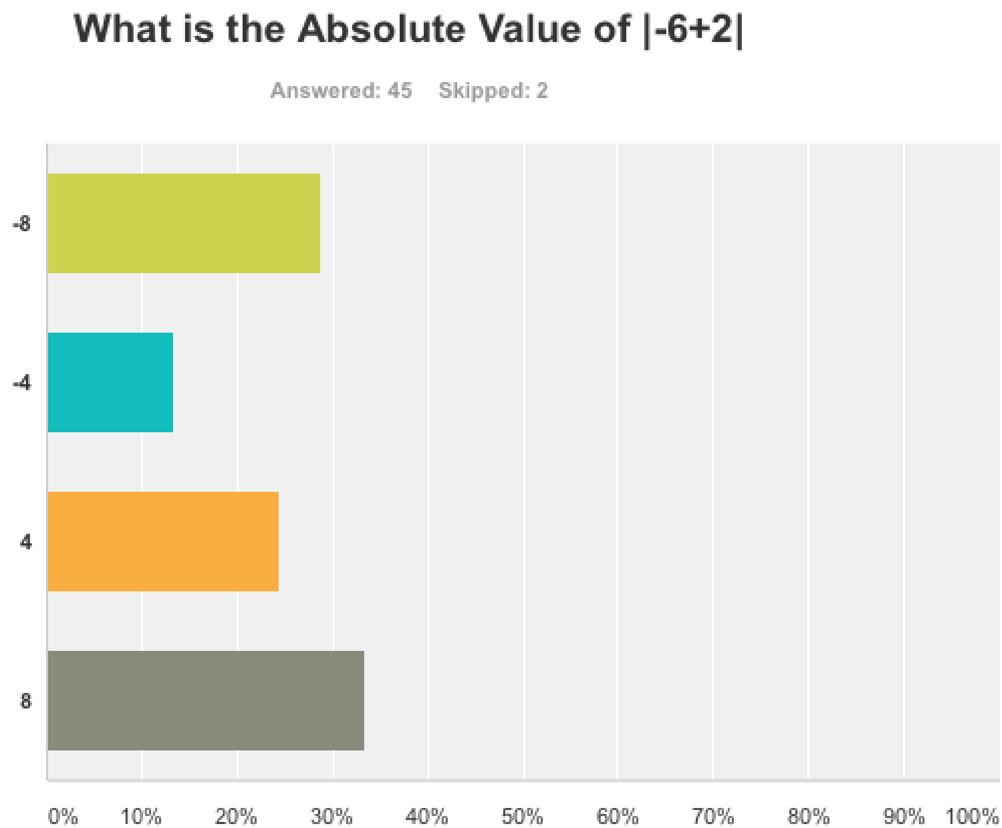
Over half (53.33%) of the participants in Figure 53 solved the linear equation with multiplication correctly. The remaining 46.67% did not solve the problem correctly. Two of the participants skipped the problem.



Answer Choices	Responses	
13	11.11%	5
14	13.33%	6
15	53.33%	24
16	22.22%	10
Total		45

Figure 53: Post-Survey Linear Equation with Multiplication

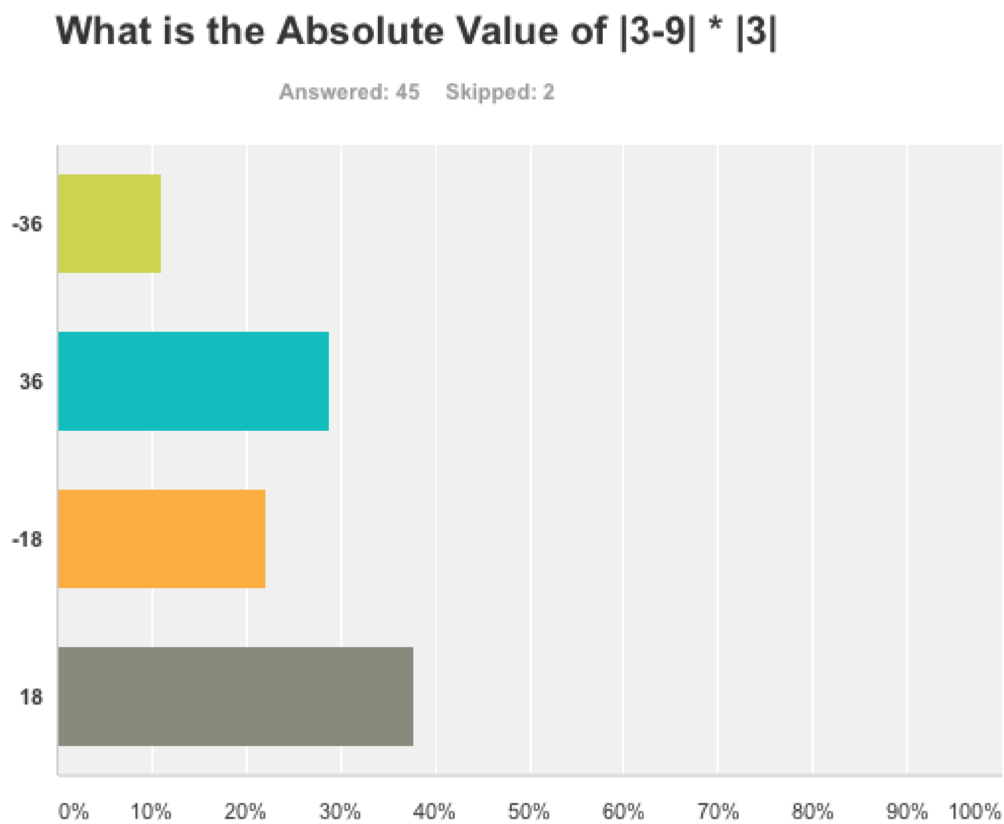
Less than one-fourth (24.44%) of the participants in this survey solved the absolute value expression correctly as indicated in Figure 54. More than half (75.56%) of the participants did not provide the correct response to this problem. Two of the participants skipped the problem.



Answer Choices	Responses	
-8	28.89%	13
-4	13.33%	6
4	24.44%	11
8	33.33%	15
Total		45

Figure 54: Post-Survey Absolute Value

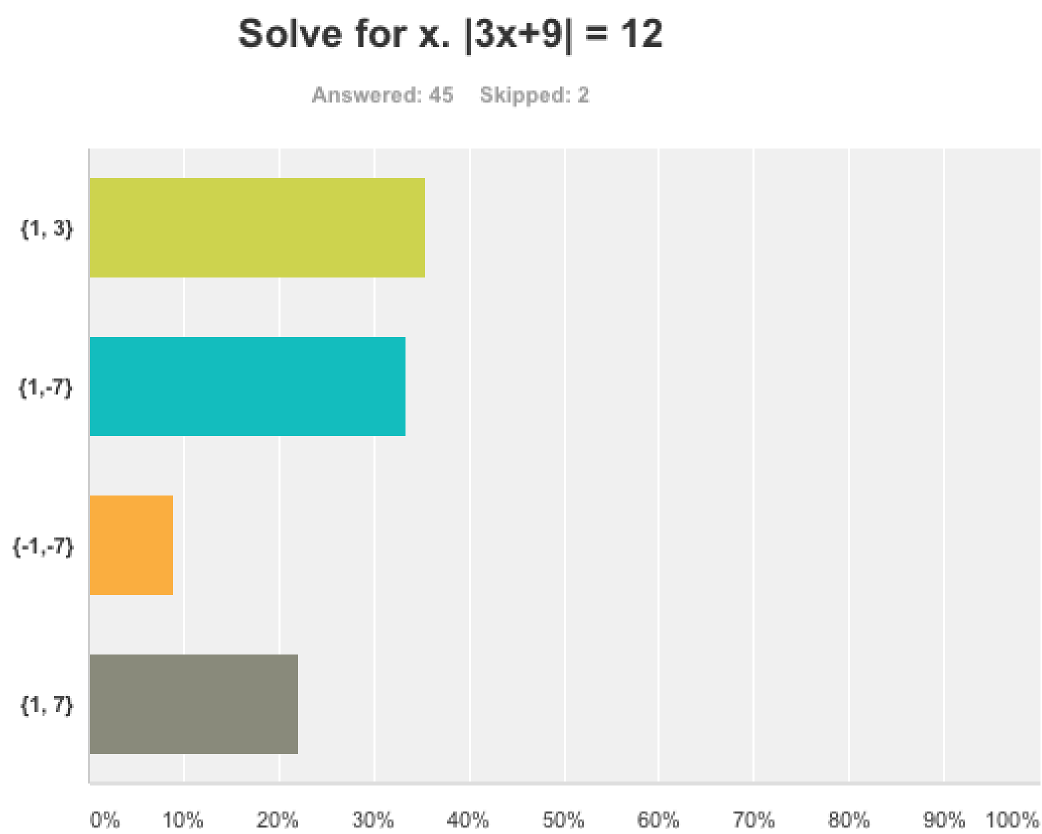
In Figure 55, only 37.78% of the participants responded correctly to the absolute value expression with multiplication. The remaining 62.22% responded incorrectly. Two of the participants skipped the problem.



Answer Choices	Responses	
-36	11.11%	5
36	28.89%	13
-18	22.22%	10
18	37.78%	17
Total		45

Figure 55: Post-Survey Absolute Value Expression with Multiplication

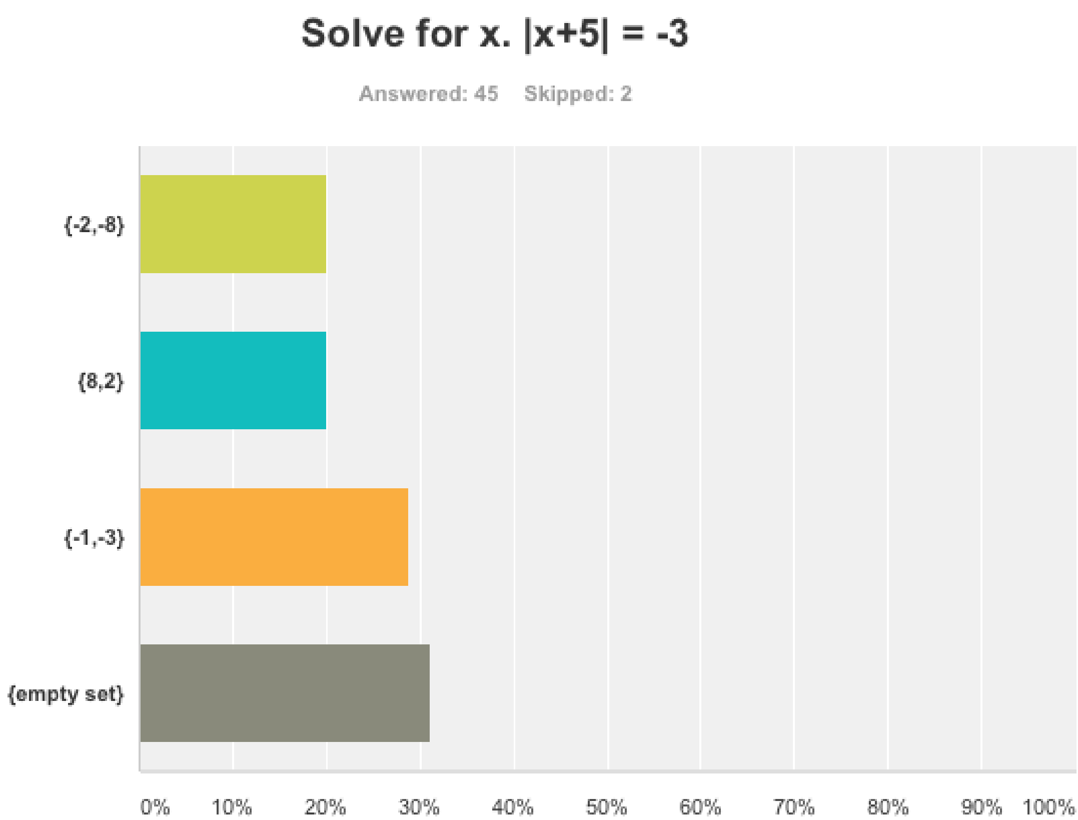
Almost one-third (33.33%) of the participants solved the absolute value equation correctly in Figure 56. A majority (67.67%) of the participants did not solve the absolute value equation correctly. Two of the participants skipped the problem.



Answer Choices	Responses	
{1, 3}	35.56%	16
{1,-7}	33.33%	15
{-1,-7}	8.89%	4
{1, 7}	22.22%	10
Total		45

Figure 56: Post-Survey Absolute Value Equation

Only 31.11% of the participants solved the absolute value equation with a negative number on the right hand side of equation correctly. The remaining participants (68.89%) responded incorrectly. Two of the participants skipped the problem.



Answer Choices	Responses	
{-2,-8}	20.00%	9
{8,2}	20.00%	9
{-1,-3}	28.89%	13
{empty set}	31.11%	14
Total		45

Figure 57: Post-Survey Absolute Value Equation with a Negative Number

Summary of Findings

Fifty-eight middle school girls in the southeast United States were surveyed. There were fifty-eight respondents from Girls, Inc. in Columbus, Georgia. The middle school girls were asked to complete a pre-survey and post-survey that measured their experiences with the Edu^{tain}ment website, mathematics, and the use of the game.

The first research question focused on the VMS system alleviating the mathematical concerns students may have when learning mathematics. The majority (65.96%) of the participants reported that they would use both classroom instruction and online instruction. These results suggest that the majority of the participants would like to have the teacher in the classroom when learning.

The second research question focused on whether the students learned better using the Virtual Mathematics System (VMS) when compared to traditional instruction. Over half of the participants (65.11%) indicated that the game was easy to learn. The majority of the middle school girls learned better using the VMS when compared to traditional instruction.

The third research question focused on the satisfaction of the students using the VMS system. A majority (61.36%) of the participants reported that the visual look of the system was high or very high. Half of the participants (50%) believed that that the Edutainment Game had an interactive feel. Over half (56.81%) of the participants reported the system was easy to play. The majority of the participants were satisfied using the VMS system.

The fourth research question focused on the recommendation of the VMS system to others. A majority (65.96%) of the participants reported that they would recommend the VMS system to others.

The fifth research question focused on the retention of knowledge acquired from the VMS system. More than half (62.23%) of the participants indicated that they learned with the Edutainment game, which suggests that the participants were able to retain knowledge acquired from VMS.

The sixth research question focused on the satisfaction of the students using the VMS system. A majority (61.36%) of the participants reported that the visual look of the system was high or very high. Half of the participants (50%) believed that that the Edutainment Game had an interactive feel. Over half (56.81%) of the participants reported the system was easy to play. The majority of the participants were satisfied using the VMS system.

Limitations of the Study

The findings of this study cannot be generalized to other populations since the sample was limited to middle school girls in the southeast United States. Other limitations of the study included the use of survey methods. The results of the survey were dependent upon the middle school girls' willingness to report their true feelings and beliefs regarding the VMS. The survey results indicated the middle school girls learned better with the VMS and that the participants were satisfied with the system. Lastly, the study did not explore whether or not there were differences between the participants stated satisfaction and actual practices. Further research must be completed to address these issues.

Chapter 6

Conclusion

This study was exploratory in nature and was designed to assess virtual environments for education and implementing education into 3D video games and applications. It was designed to provide a generic model of virtual environments for education and to explore specific factors such as personal characteristics, demographics, and usability of the system.

The adoption and success of an informal educational online tool and its value as a secure and easy to use and learn tool depends heavily on its usability. Computer supportive collaborative work theory and human computer interaction research provide usability acceptance test knowledge that can support the effective user evaluation acceptance tests of an online based collaborative tool. However, the formulation of an effective and efficient acceptance testing process is made difficult by the plethora of design theories and models that support a novice user in understanding and using a collaborative tool to share best practices. The premise of this research is that user acceptance test can provide a mechanism for identifying a suitable tool that is understandable and easy to use for a novice user. We base the practicality of this approach to the previous research efforts in human studies to test the suitability of software products before deployment in the software engineering development and human-computer interaction fields.

This research examined the issue of proving a collaborative tool to support communities of practice members engaged in informal learning by sharing of best practice and developing a model for managing groups of groups that emerge within the community of practice. This research postulated a hypothesis that students can learn mathematics better using VMS than traditional instruction.

In evaluating the collaborative tool for communities of practice to share best practices, our objective was to validate a tool that supports extension for future research activities based on new collaboration trends. The Edu^{tain}ment system is a suitable tool for communities of practice to share best practices. This research is a first attempt to present empirical user based acceptance tests results to address a variety of usability issues pertaining to virtual environments based tools supporting information learning.

The study to evaluate usability of Edu^{tain}ment website to support a community of practice in sharing best practices yielded significant results. Formulating the usability tasks to be used in the study was a difficult task. However, an empirical usability task list focusing on key tool functionalities was efficient in measuring tool's effectiveness in supporting novice users in sharing best practices. This research was observed and measured users interacting with the system thus we required tasks that did not consume too much time to complete. Due to the limited time available for most community of practice members to engage in informal learning and sharing best practices, a long task evaluation period for a single task was not feasible. To overcome the per task completion time limitation, we explored a minimalist tutorial option and our ability to validate our research efforts can be attributed to the success of the experimental design and the feasibility of the research presented in this dissertation.

Future research is needed to gain more insight on user experiences with the Edu^{tain}ment website. In addition to future research, we will explore possible alternatives to the usability experimental evaluations and model simulations used in the study presented in this research. As a human computer interaction lab, having users test and utilize a tool and provide feedback will yield more insight on how effective the proposed Edu^{tain}ment website is. Also, selecting a different pool of subjects to validate the usability of the Edu^{tain}ment website may yield different results. In our case, the difference between pre-test and post-test yielded positive results, which is an indication that users reacted positively to the tool after use. This is an indication of a positive user experience recommended for a tool adoption for the targeted user group.

Continued empirical usability tests will provide more insight into the viability of the Internet based tool to support communities of practice share best practice effectively as well foster information learning within those communities. Initially our efforts were focused on identifying a viable tool for communities of practice to share best practices and defining a model to aid in increasing mathematics achievement for K–12. The expert survey selected for the Edu^{tain}ment website among other potential candidates has been validated through an acceptance usability survey data from potential users.

The contribution of this research is beneficial to computer supportive collaborative work (CSCW) design, human computer interaction research, virtual environments, online group theory research, informal learning research, and usability studies research. The following contributions have been made:

- A collaborative synergy and collective intelligence of community of practice by supporting them in the easy creation, sharing and reuse of online artifacts, curriculum and other materials is supported
- An Internet based environment for sharing best practices among community of practice members (K–12 educators and Girls Inc.) is validated through usability evaluation.
- A secure bundle system that incrementally offers multimedia-varying collaboration tool in a virtual environment that supports informal learning and sharing of best practices among communities of practice members

- A new method to validate a collaborative tool for operationalize informal learning is presented with the support of a minimalist tutorial
- A Framework for the development of a collaborative tool for online communities for communities of practice to share best practice is validated through human studies.
- A new group management model is developed, validated and discussed in detail.
- Usability studies data measuring the Edutainment system effectiveness as a collaborative tool are discussed.

The researcher has offered suggestions to expand upon this study and to further investigate in other regions of the United State to obtain results regarding implementing virtual environments for three-dimensional education. In addition, the researcher suggests that the Edu^{tain}ment website be enhanced and expanded to include other content besides Algebra.

REFERENCES

[1] Virtual. (n.d.). *The American Heritage® Dictionary of the English Language, Fourth Edition*. Retrieved April 12, 2010, from Dictionary.com website: http://dictionary.reference.com/browse/virtual

[2] Heppell, S. *Virtually There Learning Platforms*. Retrieved on April 1, 2010, from http://keithphippsordpress.com/learning-and-teaching-group/vles/

[3] Pimentel, J. R. (1999). Design of net-learning systems based on experiential learning. *Journal of Asynchronous Learning Networks 3*(2), 64–90. Retrieved October 11, 2010, from http://www.aln.org/publications/jaln/v3n2/v3n2_pimentel.asp

[4] Britain, S., & Liber, O. *A framework for pedagogical evaluation of virtual learning environments*, London: JISC. (JTAP Report No. 041) 1999. Retrieved November, 22 2010, from http://www.jisc.ac.uk/uploaded_documents/jtap-041.doc

[5] Dillenbourg, P., Schneider, D. K., & Synteta, P. (2002). Virtual learning environments. In A. Dimitracopoulou (Ed.), *Proceedings of the 3rd Hellenic Conference 'Information & Communication Technologies in Education*' (pp. 3–18). Kastaniotis Editions, Greece. Retrieved on November 2, 2010, from edutice.archives-ouvertes.fr/docs/.../Dillernbourg-**Pierre**-2002a.pdf

[6] Maharg, P. (2003). *Virtual communities on the web: Transactional learning and teaching*. In A. Vedder (Ed.), *Aan het werk met ICT in het academisch onderwijs- RechtenOnline (At work with ICT in academic education-Law Online)*. Nijmegen: Wolf Legal Publishers.

[7] Felder, R. M. & Soloman, B. A. (2000). *Learning styles and strategies*. Retrieved on November 7, 2010 from http://www2.ncsu.edu/unity/lockers/users/f/felder/public/ILSdir/styles.html

[8] Leite, W. L., Svinicki, M., & Shi, Y. (2009). Attempted validation of the scores of the VARK: Learning Styles Inventory with Multitrait–Multimethod Confirmatory Factor Analysis Models (p. 2). SAGE Publications.

[9] Giles, E., Pitre, S., & Womack, S. (2003). Multiple intelligences and learning styles. In M. Orey (Ed.), *Emerging perspectives on learning, teaching, and technology*. Retrieved November 1, 2010, from http://projects.coe.uga.edu/epltt/index.php?title=Multiple_Intelligences_and_Learning_Styles

[10] Eslinger, C. (1993, Fall). *Education: The encyclopedia of virtual environments*. Retrieved on October 29, 2010 from http://www.hitl.washington.edu/scivw/EVE/.

[11] Prensky, M. (2002) *What kids learn that's positive from playing video games*. Retrieved November 7, 2004 from http://www.marcprensky.com/writing/

[12] Prensky, M. (2001). Digital natives, digital immigrants. *On the Horizon, 9*(5), 1–2. Retrieved on November 7, 2010 from www.marcprensky.com/writing/Prensky%20%20Digital%20Natives,%20Digital%20Immigrants%20-%20Part1.pdf

[13] Prensky, M. (2003). Really good news about your children's video games. Retrieved November 7, 2004 from http://www.marcprensky.com/writing/Prensky%20%20Really%20good%20news.pdf

[14] Shaffer, D. W., Squire, K. D., Halverson, R., & Gee, J. P. (2005). Video games and the future of learning. *Phi Delta Kappan, 87*(2), 104–111. Retrieved on November 10, 2010 from http://edr.sagepub.com/content/35/8/19.shor

[15] Prensky, M. (2001*).* Fun, play and games: What make games engaging. In M. Prensky (Ed.), *Digital game-based learning*. New York: McGraw-Hill. Retrieved November 7,

2004 from http://www.marcprensky.com/writing/Prensky%20-%20Digital%20Game-Based%20Learning-Ch5.pdf

[16] Prensky, M. (2003). Really good news about your children's video games. Retrieved November 7, 2004 from http://www.marcprensky.com/writing/Prensky%20%20Really%20good%20news.pdf

[17], [20], [21] Sedighian, K, & Sedighian, A. (n.d.). *Can educational computer games help eucators learn about the psychology of learning mathematics in children?* Manuscript submitted for publication, Department of Computer Science, The University of British Columbia, Vancouver, Canada. Retrieved on November12, 2010 from http://74.125.155.132/scholar?q=cache:fffdIg2XjV8J:scholar.google.com/+Kamran+Sedighian&hl=en&as_sdt=8000o

[18] Dweck, C. S. (1986). Motivational processes affecting learning. *American Psychologist*, *41*(10), 1040–1048.

[19] Klawe, M. M. (1992). Bringing mathematical research to life in the schools. *Proceedings of the 7th International Conference on Mathematics Education*, Quebec, Canada.

[22] Provenzo, E. F. (1991). *Video kids: Making sense of Nintendo*. Cambridge, MA: Harvard University Press.

[24] Franco, J., & Deus Lopes, R. (2009). Three-dimensional digital environments and computer graphics influencing K–12 individuals' digital literacy development and interdisciplinary lifelong learning. *ASIA '09: ACM SIGGRAPH ASIA 2009 Educators Program*, *1*(15), Retrieved on March 19, 2010 from http://portal.acm.org/citation.cfm?id=1666626

[25], [26] Hew, K., & Cheung, W. (2010). Use of three-dimensional (3-d) immersive virtual worlds in K–12 and higher education settings: A review of the research. *British Journal*

of Educational Technology, *41*(1), Retrieved on March 19, 2010 from http://web.ebscohost.com/ehost/detail?vid=1&hid=107&sid=313a8f24-4645-4f5b-bdde-bad2a467056c%40sessionmgr111&bdata=JnNpdGU9ZWhvc3QtbGl2ZQ%3d%3d#db=a9h&AN=47051418

[27] Galloway, W., Boland, S., & Benesova, A. (2002, February). *Virtual learning environments*. Retrieved on March 30, 2010, from http://www.dcs.napier.ac.uk/~mm/socbytes/feb2002_i/3.html

[28] Rosenberg, M. J. (2001). *E-learning: Strategies for delivering knowledge in the digital age*. New York: McGraw-Hill.

[29] Kay, A. (2007). *Computer, networks and education*. Retrieved July 29, 2009, from Squeakland Home of Squeak Etoys Web site: http://www.squeakland.org/school/HTML/sci_amer_article/sci_amer_01.html.

[30] Educate to Innovate. The White House. 9 Sept. 2009. [online]. http://www.whitehouse.gov/issues/education/educate-innovate.

[31] Thorpe, J. (2010) *Artificial intelligence as a medium for learning*. Summer 2010 REU. Auburn University.

[32] Glassner, A. (1997). *Some thoughts on game design.*

[33] Squire, K. *Video games in education.*

[34] Arikan A. (1989). "Retelling the Story: Official Tales of Technology and Head Start Teachers' Technophobia". Annual Meeting of American Educational Research Association on Monday, April 9, 2007 in Chicago.

[35] McGettrick, A. (2014). Education, always. Communications of The ACM, 57(2), 5. doi:10.1145/2534706.2534707.

[36] Cerf, V. G. (2013). Computer science education–Revisited. Communications of The ACM, 56(8), 7. doi:10.1145/2492007.2492009.

[37] Santa-Rosa, J. (2012). Participatory design in the project of virtual learning environment of histology. Work, 41, 1157-1159.

[38] Evans, S. (2012). Virtual selves, real relationships: An exploration of the context and role for social interactions in the emergence of self in virtual environments. *Integrative Psychological & Behavioral Science, 46*(4), 512–528. doi:10.1007/s12124-012-9215-x.

[39] Kassner, M. P., Wesselmann, E. D., Law, A., & Williams, K. D. (2012). Virtually ostracized: Studying ostracism in immersive virtual environments. Cyberpsychology, Behavior & Social Networking, 15(8), 399–403. doi:10.1089/cyber.2012.0113.

[40] Schafer, A. Y., & Ustinova, K. I. (2013). Does use of a virtual environment change reaching while standing in patients with traumatic brain injury? Journal of Neuroengineering & Rehabilitation (JNER), 10(1), 1–11. doi:10.1186/1743-0003-10-76.

[41] Hardey, M. (2012). New visions: Capturing digital data and market research. *International Journal of Market Research*, *54*(2), 159–161. doi:10.2501/IJMR-54-2-159-161.

[42] Gütlein, M., Karwath, A., & Kramer, S. (2012). CheS-mapper — chemical space mapping and visualization in 3d. *Journal of Cheminformatics*, *4*(1), 7–22. doi: 10.1186/1758-2946-4-7.

[43] Vidal, E. (2012). Virtual environments: The Avatar approach to employee relations. Employment Relations Today (Wiley), 39(1), 17–21. doi:10.1002/ert.21.

[44] Davis, M. R. (2012, June 12). Cracking the code: Computer coding lessons expanding for K–12 students. *Education Week: Digital Directions*, *6*(3), 28, 30–31. Retrieved from http://www.edweek.org/dd/articles/2013/06/12/03game-coding.h06.html

[45] Barr, V., & Stephenson, C. (2011, March). Bringing computational thinking to K–12: What is involved and what is the role of the computer science education community? *ACM InRoads*, *2*(1), 48-54. Retrieved from https://www.iste.org/docs/nets-refresh-toolkit/bringing-ct-to-K–12.pdf?sfvrsn=2

[46] Girls Inc. (2016). Retrieved from http://www.flsouthern.edu/getattachment/faculty/garr-melissa/latinas_us_demographics_factsheet.pdf

[47] New York Life. (2016). Retrieved from http://www.newyorklife.com/about/new-york-life-foundation-awards-support-girls-inc-program-expansion-serve-more-middle-school-aged-girls

[48] A Vision for School Mathematics. (2009). National Council for Teachers of Mathematics. Principals and Standards for School Mathematics. Retrieved from www.nctm.org

[49] Hannum, W., & Briggs, L. (1982). How does instructional system design differ from traditional instruc*tion? Educational Technology, 22(1),* 9–14.

[50] Novak, J. (1998). *Learning, creating and using knowledge: Concepts maps as facilitative tools in schools and corporations* (pp 24–25). New Jersey: Lawrence Erlbaum Associates, Inc.

[51] Relan, A., & Gillani, B. J. (1997). Web-based instruction and the traditional classroom: Similarities and differences. In B. Khan (Ed.), *Web-based instruction* (pp. 25–37). New Jersey: Educational Technology Publications.

APPENDICES

APPENDIX A

INFORMED CONSENT LETTER AS APPROVED BY

AUBURN UNIVERSITY INSTIUTIONAL REVIEW BOARD (IRB)

AUBURN UNIVERSITY INSTITUTIONAL REVIEW BOARD for RESEARCH INVOLVING HUMAN SUBJECTS

REQUEST for PROJECT RENEWAL

For information or help completing this form, contact: THE OFFICE OF RESEARCH COMPLIANCE (ORC), 115 Ramsay Hall
Phone: 334-844-5966 e-mail: [illegible] Web Address: [illegible]

Revised 2.1.2014 Submit completed form to [illegible] or 115 Ramsay Hall, Auburn University 36849.

Exempt Activities: Must be renewed at least every 3 years.

Expedited and Full Board Protocols: Must be renewed at least annually, prior to the expiration date of the protocol.

If you do not plan to collect additional data and/or you do not have access to identifiable data (code lists, etc.) you may be able to file a "FINAL REPORT" for this project. Contact the ORC for more information.

1. Protocol Number: 13-138 EP 1404
2. Original IRB Approval Dates: From: 4/9/2104 To: 4/8/2015
3. Requested Renewal Period (ONE YEAR MAXIMUM): From: 04/2015 To: 04/2016
4. PROJECT TITLE: Virtual Environments for Education: An Empirical Study of Implementing Education into 3D Games and Applications
5.

Cheryl Swanier	PhD Candidate	CSSE	706-561-5053	soseca@auburn.edu
PRINCIPAL INVESTIGATOR	TITLE	DEPT	PHONE	AU E-MAIL
[signature]	7435 McKee Road, Upatoi, GA 31829			cswanier@msn.com
PI SIGNATURE	MAILING ADDRESS			ALTERNATE E-MAIL
Cheryl Seals	[signature]	CSSE	334844631[illegible]	sealscd@auburn.e[illegible]
FACULTY ADVISOR	SIGNATURE	DEPT	PHONE	AU E-MAIL

Name of Current Department Head: Kai Chang AU E-MAIL: changka@auburn.edu

6. Current External Funding Agency and Grant number: NA
7. a. List any contractors, sub-contractors, other entities associated with this project: NA

   b. List any other IRBs associated with this project: NA

Received
MAR 23 2015
Research Compliance

8. Explain why you are requesting additional time to complete this research project.
We need more time to conduct our experiment as we plan on this being a logitudinal work. We plan to perform a study this Spring and will continue this work.

The Auburn University Institutional Review Board has approved this Document for use from 3/27/15 to 4/8/16
Protocol # 13-138 EP 1404

FOR ORC OFFICE USE ONLY

DATE RECEIVED IN ORC:	by		RENEWAL #	
DATE OF IRB REVIEW:	by		PROTOCOL APPROVAL CATEGORY	
DATE OF IRB APPROVAL:	by		INTERVAL FOR CONTINUING REVIEW	

COMMENTS:

1 of 3

9. **Briefly list** *(numbered or bulleted)* **the activities that occurred over the past year, particularly those that involved participants.**
NA

10. **Do you plan to make any changes in your protocol if the renewal request is approved?**
(e.g., research design, methodology, participant characteristics, authorized number of participants, etc.)

(●) NO ( ) YES

(If "yes", please complete and attach a "REQUEST for PROTOCOL MODIFICATION" form.)

11. **PARTICIPANT INFORMATION**

a. **How many individuals have actually participated in this research?** None
If retrospective, how many files or records were accessed? ____________

b. **Were there any adverse events, unexpected difficulties or unexpected benefits with the approved procedures?**

(●) NO ( ) YES

If YES, please describe.

d. **How many participants have withdrawn from the study?** ____________ ☑ NA
If participants withdrew from the study, please explain.

e. **How many new participants do you plan to recruit during the renewal period?** ____________ ☑ NA

f. **During the renewal period, will you re-contact any individual that has already participated in your research project?** ☐ NA

(●) NO ( ) YES

If "YES", please explain reasons for re-contacting participants. (If "YES" and the procedure to re-contact has not been previously approved, please complete and attach a "REQUEST for PROTOCOL MODIFICATION" form.)

12. PROTECTION OF DATA

a. Is the data being collected, stored and protected as previously approved by the IRB?

○ NO ◉ YES

If NO, please explain.

b. Are there any changes in the "key research personnel" that have access to participants or data?
Attach CITI completion reports for all new key personnel.

◉ NO ○ YES

If YES, please identify each individual and explain the reason(s) for each change.

c. What is the latest date (month and year) you now expect all identifiable data to be destroyed?
(Identifiable data includes videotapes, photographs, code lists, etc.)

DATE: ____________________

☑ Not Applicable – no identifiable data has been or will be collected.

11. [illegible]
(Information letters, Informed Consents, Parental Permissions, flyers etc.)

12. **If you plan to recruit participants, or collect human subject data during the renewal period,** [illegible] **<u>you will use during the extension.</u>**

(Be sure to review the ORC website for current consent document guidelines and updated contact information [illegible] *)*

AUBURN UNIVERSITY
SAMUEL GINN COLLEGE OF ENGINEERING
DEPARTMENT OF COMPUTER SCIENCE AND SOFTWARE ENGINEERING

Information Letter
For a Research Study entitled

Virtual Environments for Education: An Empirical Study of Implementing Education into 3D Video Games and Applications

You are invited to participate in a research study to explore your experiences with virtual environments in education using 3D video games and applications and introduce a new tool that could be adopted for use by communities of practice members to promote mathematical learning in a virtual environment. The purpose of this research is to address the need of increasing student achievement in mathematics through virtual environments. The primary focus is to create an environment where students in K-12 education can develop mathematical simulations while learning a visual programming language at the same time and for sharing best practices among members of a community of practice. This research is being conducted by Cheryl Swanier under the direction of Dr. Cheryl D. Seals in the Auburn University the Department of Computer Science and Software Engineering. You were selected as a possible participant because associated with K-12 education or the Girls, Inc. group which are the targeted potential users for the tool.

What is being involved if you participate? Your participation in this research study is voluntary. If you decide to participate, the study will be conducted in three parts. If you decide to participate in this research study, you will first be asked to fill out a questionnaire for general background information. The purpose of the questionnaire is to obtain demographic information and some basic information regarding your experience with virtual environments and online educational tools. The total time commitment for part one is approximately 7 minutes. At the end of the pre-questionnaire you will be presented with a task-list and link to the prototype environment. The time to accomplish part two the task list for guided exploration of how to muse the collaboration tool is approximately 20 minutes. The purpose of the task-list will be to introduce you to the mathematical virtual learning environment. After completion of the task-list, successfully or unsuccessfully, you will be given a link to the final questionnaire. Your total time commitment to part three will be approximately 10 minutes. This study will take approximately six hours to complete over the next three months.

Are there risks or discomforts? There are no perceived risks associated with this study.

Are there any benefits to yourself or others? Information collected during this study will help us indentify how effective and intuitive the virtual learning system is in supporting collaborative activities online and advance unstructured learning in a virtual environment in relation to Girls, Inc. and K-12.

Will you receive compensation for participating? No compensation for participating will be given.

Are there any costs for participating? There are no costs associated with participating.

To change your mind about participating, you can withdraw at any time during the study by simply closing your browser or returning your handout survey to the supervisor. Once you have submitted anonymous data, it cannot be withdrawn since it will be unidentifiable. Your decision about whether or not to participate or to stop participating will not jeopardize your future relations with Auburn University, Department of Computer Science and Software Engineering.

We will keep the data from this study anonymous. All data is stored in a password protected electronic format. To help protect your confidentiality, the surveys will not contain information that will personally identify you. The results of this study will be used for scholarly purposes (publishing in professional journals, theses and dissertations and presentations in professional meetings) only and may be shared with Auburn University representatives.

If you have any questions about the research study, please ask now or contact Cheryl A. Swanier at ijoseca@auburn.edu (706)577-2184 or Cheryl D. Seals at (334)844-6319, sealscd@auburn.edu.

This research has been reviewed according to Auburn University IRB procedures for research involving human subjects.

For more information regarding your rights as a research participant you may contact the Auburn University Office of Human Subjects Research or the Institutional Review Board by phone (334)844-5966 or email at hsubjec@auburn.edu or IRBChair@auburn.edu.

HAVING READ THE INFORMATION PROVIDED, YOU MUST DECIDE IF YOU WANT TO PARTICIPATE IN THIS STUDY. IF YOU DECIDE TO PARTICIPATE, THE DATA YOU PROVIDE WILL SERVE AS YOUR AGREEMENT TO DO SO. THIS LETTER IS YOURS TO KEEP.

Cheryl A. Swanier 3/29/2012

Investigator's Signature Date

Cheryl A. Swanier, PhD Candidate
Print Name

To begin the study please visit the link below or utilize the survey pamphlet or booklet provided to you at the beginning of the session to do the study

Link: http:// http://www.surveymonkey.com/s/WDBSP7C

The Auburn University Institutional Review Board has approved this document for use from 3/27/15 to 4/8/16 Protocol # 13-138 EP 1404

The Auburn University Institutional Review Board has approved this document for use from March 27, 2015 to April 8, 2016. Protocol #13-138 EP 1404.

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ADULT CONSENT FORM

Title: Virtual Environments for Education Study

You are invited to participate in a research study to explore your experiences with virtual environments in education using 3D video games and applications and introduce a new tool that could be adopted for use by communities of practice members to promote mathematical learning in a virtual environment. The purpose of this research is to address the need of increasing student achievement in mathematics through virtual environments. The primary focus is to create an environment where students in K-12 education can develop mathematical simulations while learning a visual programming language at the same time and for sharing best practices among members of a community of practice. This research is being conducted by Cheryl Swanier under the direction of Dr. Cheryl D. Seals in the Auburn University the Department of Computer Science and Software Engineering. You were selected as a possible participant because you are over the age of 19 and have expertise in evaluating interactive applications. Please reply the research team if you would like to participate in this study. This study will take approximately six hours to complete over the next 3 months.

If you have any questions about the research study, please ask now or contact Cheryl A. Swanier at ijoseca@auburn.edu (706)577-2184 or Cheryl D. Seals at (334)844-6319, sealscd@auburn.edu.

This research has been reviewed according to Auburn University IRB procedures for research involving human subjects.

For more information regarding your rights as a research participant you may contact the Auburn University Office of Human Subjects Research or the Institutional Review Board by phone (334)844-5966 or email at hsubjec@auburn.edu or IRBChair@auburn.edu.

HAVING READ THE INFORMATION PROVIDED, YOU MUST DECIDE IF YOU WANT TO PARTICIPATE IN THIS STUDY. IF YOU DECIDE TO PARTICIPATE, THE DATA YOU PROVIDE WILL SERVE AS YOUR AGREEMENT TO DO SO.

______ Yes, I would like to participate in the study.

______ No, I do not want to participate in the study.

____

Printed Name of Subject

______________________________ ______________

Signature of Subject Date

INVESTIGATOR Cheryl A. Swanier, PhD Candidate. - Office: (706) 577-2184

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PARENTAL PERMISSION FORM

Title: Virtual Environments for Education Study

You are invited to permit your child to participate in this research study. The following information is provided in order to help you to make an informed decision whether or not to allow your child to participate. If you have any questions please do not hesitate to ask. Your child is eligible to participate in this study because your child is in the ages of 7-18. Your child will also be asked if he/she is willing to participate. This study will take place at your child's camp, club, or afterschool program. The purpose of this research is to address the need of increasing student achievement in mathematics through virtual environments. This study will take approximately six hours to complete over the next three months.

The evaluation tasks include a pre/post test and a survey. Your child will be asked to complete a multiple-choice assessment and an attitudinal questionnaire, and a workforce readiness survey. The assessment will attempt to measure their current knowledge of concepts to be covered during the afterschool program or summer camps. The questionnaire is designed to measure your child's attitude towards math. The workforce readiness survey is to examine teamwork and information skills learned in the activities. Next, your child will complete the on-line activities as they learn about math. Once the mathematics program is complete your child will be asked to complete a multiple-choice assessment, attitudinal questionnaire, and a workforce readiness survey. Finally, your child will be asked to complete a content survey about how they liked or disliked the mathematics curriculum.

There are no known risks associated with this research.

As a result of participation in this research, it is possible that your child may learn concepts in technology, engineering and math. The information obtained from this study may help us to better understand the use of virtual environments as an educational tool.

Any information obtained during this study which could identify your child will be kept strictly confidential. The files will be kept in a locked file in the investigator's office for 3 years and then will be destroyed. The information obtained in this study may be published in scientific journals or presented at scientific meetings, but your child's identity will be kept strictly confidential.

Your child's rights as a research subject have been explained to you. If you have any additional questions about the study, please contact me at (706) 577-2184. If you have any questions about your child's rights as a research participant that have not been answered by the investigator or to report any concerns about the study, you may contact the Auburn University Institutional Review Board (AU IRB), telephone (334) 844-5966.

___________Parent's Initials

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You are free to decide not to enroll your child in this study or to withdraw your child at any time without adversely affecting their or your relationship with the investigator or the Auburn University. Your decision will not result in any loss of benefits to which your child is otherwise entitled.

DOCUMENTATION OF PARENTAL PERMISSION:
YOU ARE VOLUNTARILY MAKING A DECISION WHETHER OR NOT TO ALLOW YOUR CHILD TO PARTICIPATE IN THE RESEARCH STUDY. YOUR SIGNATURE CERTIFIES THAT YOU HAVE DECIDED TO ALLOW YOUR CHILD TO PARTICIPATE. HAVING READ AND UNDERSTOOD THE INFORMATION PRESENTED. YOU WILL BE GIVEN A COPY OF THIS CONSENT FORM TO KEEP.

____
Child's Name (Printed)

____
Printed Name of Parent/Guardian

______________________________ ____________
Signature of Parent/Guardian Date

IN MY JUDGEMENT THE PARENT/LEGAL GUARDIAN IS VOLUNTARILY AND KNOWINGLY GIVING PERMISSION FOR HIS/HER CHILD TO PARTICIPATE AND POSSESSES THE LEGAL CAPACITY TO GIVE PERMISSION TO PARTICIPATE IN THIS RESEARCH STUDY.

Cheryl A Swanier 4/15/15
Signature of Investigator Date

IDENTIFICATION OF INVESTIGATORS
PRIMARY INVESTIGATOR
Cheryl A. Swanier, PhD Candidate Office: (706) 577-2184

The Auburn University Institutional Review Board has approved this document for use from 3/27/15 to 4/8/16 Protocol # 13-138 EP 1404

Page 2 of 2

girls inc.

AUBURN UNIVERSITY

YOUTH ASSENT FORM

Title: Virtual Environments for Education Study

We are inviting you to participate in this study because you are between the ages of 7-18, and we are interested in how the use of virtual environments in education can help you learn mathematics. This study will take place at your Girls, Inc. summer camp, club, or afterschool program. This study will take approximately six hours to complete over the next three months.

The evaluation tasks include quizzes and surveys. First, you will be asked to complete a multiple-choice quiz, an attitude survey, and a workforce skills survey. Next, you will complete the on-line activities as you learn about mathematics. Once you have finished the mathematics lessons you will complete a multiple choice quiz, an attitudinal survey, and a workforce readiness survey. You will also be asked to complete a survey on the classes you take in school each fall. Your responses will be confidential; your answers will not be shared. We may publish a summary of everybody's responses or present such a summary at a scientific meeting, but your identity and your responses would be totally confidential. Being in the study may help you to learn about mathematics and the technology that make them work. We will also ask your parents for their permission for you to do this study. Please talk this over with them before you decide whether or not to participate. You can decide to stop participating in the study at any time. If you have any questions at any time, please ask the researcher. If you check "yes," it means that you have decided to participate and have read everything that is on this form. You and your parents will be given a copy of this form to keep.

Parents: Your child's rights as a research subject have been explained to you. If you have any additional questions about the study, please contact me at (706) 577-2184. If you have any questions about your child's rights as a research participant that have not been answered by the investigator or to report any concerns about the study, you may contact the Auburn University Institutional Review Board (AU IRB), telephone (334) 844-5966.You are free to decide not to enroll your child in this study or to withdraw your child at any time without adversely affecting their or your relationship with the investigator or the Auburn University. Your decision will not result in any loss of benefits to which your child is otherwise entitled.

______ Yes, I would like to participate in the study.

______ No, I do not want to participate in the study.

Printed Name of Subject	Date
Signature of Subject	Date
Signature of Parent/Guardian Date	Printed Name of Parent
Cheryl A. Swanier	6/5/2013
Signature of Investigator	Date

INVESTIGATOR Cheryl A. Swanier, PhD Candidate. - Office: (706) 577-2184

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APPENDIX B

WORKSHOP TASK LIST

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Edutainment Workshop Task List

http://spider.eng.auburn.edu/bic/edutainment/index.php

http://tinyurl.com/edutainMath

Week 1

- ☐ Complete the ~~PreSurvey.~~
  https://www.surveymonkey.com/s/F9MXB3C
- ☐ Monday
  - ☐ Go to Edutainment website
  - ☐ Go to Algebra
  - ☐ Do Lesson 1
  - ☐ Do Video Week 1
  - ☐ Do Assessment Week 1
  - ☐ Do Game Week 1
- ☐ Wednesday
  - ☐ Go to Edutainment website
  - ☐ Go to Algebra
  - ☐ Do Lesson 2
  - ☐ Do Video Week 2
  - ☐ Do Assessment Week 2
  - ☐ Do Game Week 2

Week 2

- ☐ Monday
  - ☐ Go to Edutainment website
  - ☐ Go to Algebra
  - ☐ Do Lesson 3 & 4
  - ☐ Do Video Week 3 & 4
  - ☐ Do Assessment Week 3 & 4
  - ☐ Do Game Week 3 & 4
- ☐ Wednesday
  - ☐ Go to Edutainment website
  - ☐ Go to Algebra
  - ☐ Do Lesson 5
  - ☐ Do Video Week 5
  - ☐ Do Assessment Week 5
  - ☐ Do Game Week 5
- ☐ Complete the ~~PostSurvey.~~
  https://www.surveymonkey.com/s/FYTZLNP

Retrospective Interview with participants

1. What's the most interesting thing about the website?
2. What do you think you learned?
3. Do you like doing math through games?

APPENDIX C

PRE-SURVEY AND POST-SURVEY

Edutainment PreSurvey

1. What is your gender?

◯ Female

◯ Male

2. What grade are you entering?

◯ 6th Grade

◯ 7th Grade

◯ 8th Grade

3. What is your race?

◯ Black/African American

◯ White/Caucasian

◯ Latina/Hispanic

◯ Asian

◯ Other

4. What do you normally use a computer for? (Select all that apply)

☐ Email

☐ Homework

☐ Surfing the net

☐ Blogging

☐ Maintaining social network like Facebook, twitter etc

☐ Playing Games

Other (please specify)

5. Where have you used a computer before?

- [ ] Home
- [ ] School
- [ ] No where
- [ ] Other (please specify)

6. Do you have prior experience using an online learning environment?

- ◯ Yes
- ◯ No

7. Have you taken any course over the Internet?

- ◯ Yes
- ◯ No

If Yes, Please specify the name of the course.

8. Do you feel that online materials can enhance traditional classroom materials?

- ◯ Yes
- ◯ No

9. Do you like to play games?

- ◯ Yes
- ◯ Sometimes
- ◯ No

10. Have you tried any of game based learning tools?

- ◯ Yes
- ◯ No
- ◯ Don't Know

2

11. Do you like math?

◯ Yes

◯ No

◯ Not sure

Please explain your choice.

12. Select your level of proficiency in solving Linear Equations

Edutainment PreSurvey

Linear Equation Types Quiz

Quiz on Linear Equation Types

* 13. Solve. 22 = x + 3

◯ 17

◯ 18

◯ 19

◯ 22

* 14. Solve. 3x = 21

◯ 5

◯ 7

◯ 6

◯ 8

3

* 15. Which number is the solution of 5x + 6 = 3x +10

◯ 2

◯ 4

◯ 3

◯ 6

* 16. Which number is the solution of 8x - 6 = 42

◯ 3

◯ 4

◯ 5

◯ 6

* 17. Solve. x/5 = 3

◯ 13

◯ 14

◯ 15

◯ 16

* 18. What is the Absolute Value of |-6+2|

◯ -8

◯ -4

◯ 4

◯ 8

* 19. What is the Absolute Value of |3-9| * |3|

◯ -36

◯ 36

◯ -18

◯ 18

4

* 20. Solve for x. $|3x+9| = 12$

- ○ {1, 3}
- ○ {1,-7}
- ○ {-1,-7}
- ○ {1, 7}

* 21. Solve for x. $|x+5| = -3$

- ○ {-2,-8}
- ○ {8,2}
- ○ {-1,-3}
- ○ {empty set}

Edutainment PostSurvey

Edutainment Game Post survey

1. What is the overall reaction to the Edutainment Game

	Strongly Agree	Agree	Neutral	Disagree	Strongly disagree
The game is attractive	◯	◯	◯	◯	◯
Easy to use the system	◯	◯	◯	◯	◯
The game is easy to learn to use	◯	◯	◯	◯	◯
Fun	◯	◯	◯	◯	◯
Interesting	◯	◯	◯	◯	◯
The game is flexible to play	◯	◯	◯	◯	◯
Based on this experience, I will play this game again	◯	◯	◯	◯	◯

2. Please rate Edutainment Game with respect to following aspects:

	Very High	High	Moderate	Low	Very Low
Flexibility	◯	◯	◯	◯	◯
User Experience (Good feeling about the system)	◯	◯	◯	◯	◯
Learnability	◯	◯	◯	◯	◯
Visual look of the system	◯	◯	◯	◯	◯
Interactive feel of the system	◯	◯	◯	◯	◯
Playability (Easy to Play)	◯	◯	◯	◯	◯

3. Do you feel that online materials can enhance traditional classroom materials?

◯ Yes

◯ No

1

4. Overall, I would recommend the tool to others.

◯ Yes

◯ No

5. Which ways do you learn better?

◯ Classroom Instruction

◯ Online Instruction and Games

◯ Both

6. Please list the most positive aspects of the Edutainment Game you observed

[ ]

7. Please list the most negative aspects of the Edutainment Game you observed

[ ]

Edutainment PostSurvey

Quiz on Linear Equation types

* 8. Solve. 22 = x + 3

◯ 17

◯ 18

◯ 19

◯ 22

* 9. Solve. 3x = 21

◯ 5

◯ 6

◯ 7

◯ 8

2

* 10. Which number is the solution of 5x + 6 = 3x + 10

- ◯ 2
- ◯ 4
- ◯ 3
- ◯ 6

* 11. Which number is the solution of 8x - 6 = 42

- ◯ 3
- ◯ 4
- ◯ 5
- ◯ 6

* 12. Solve. x/5 =3

- ◯ 13
- ◯ 14
- ◯ 15
- ◯ 16

* 13. What is the Absolute Value of |-6+2|

- ◯ -8
- ◯ -4
- ◯ 4
- ◯ 8

* 14. What is the Absolute Value of |3-9| * |3|

- ◯ -36
- ◯ 36
- ◯ -18
- ◯ 18

* 15. Solve for x. |3x+9| = 12

- ◯ {1, 3}
- ◯ {1,-7}
- ◯ {-1,-7}
- ◯ {1, 7}

* 16. Solve for x. |x+5| = -3

- ◯ {-2,-8}
- ◯ {8,2}
- ◯ {-1,-3}
- ◯ {empty set}

4

APPENDIX D

RESPONDENTS' COMMENTS

Q6 Please list the most positive aspects of the Edutainment Game you observed

Answered: 41 Skipped: 6

#	Responses	Date
1	VERY HARD	7/16/2015 11:01 AM
2	Play the games and watching videos	7/16/2015 11:00 AM
3	Tiny Url games	7/16/2015 11:00 AM
4	there are a lot of games	7/16/2015 10:54 AM
5	helps you learn	7/16/2015 10:50 AM
6	That you can learn new things in a positive way.	7/16/2015 10:50 AM
7	nothing really	7/16/2015 10:48 AM
8	IT'S LEARNING	7/15/2015 11:38 AM
9	even though its kinda hard at the same time its also very fun and very educational and to me its actually real easy ig.	7/15/2015 11:35 AM
10	The game is sooooooo lame	7/15/2015 11:32 AM
11	You learn stuff.	7/15/2015 11:30 AM
12	learning new things	7/15/2015 11:29 AM
13	Nothing	7/15/2015 11:29 AM
14	nothing	7/15/2015 11:27 AM
15	The game is sooooooo lame	7/15/2015 11:27 AM
16	The website is educational	7/15/2015 11:25 AM
17	The games are fun and educational.	7/15/2015 10:34 AM
18	LOTS OF LEARNING	7/15/2015 10:33 AM
19	This game helps prepare me for middle and it also gives me ideas of how to teach other people	7/15/2015 10:32 AM
20	It's fun and easy to play.I like it a lot.	7/15/2015 10:32 AM
21	The games helped me understand more, and it helped me get a idea of what they are going to do in middle school.	7/15/2015 10:30 AM
22	GAMES AND THE TEACHER	7/15/2015 10:30 AM
23	I liked the fact that the creator made it fun and did not make it all work. She made sure that kids could enjoy this cite.	7/15/2015 10:30 AM
24	COMUPER	7/15/2015 10:28 AM
25	really easy to solve the problems.	7/14/2015 11:01 AM
26	putting in as a game	7/14/2015 10:52 AM
27	One of the most positive aspects of the Edutainment Game that i observed was the instructions were fairly understandable.	7/14/2015 10:46 AM
28	clearer understanding of materials	7/14/2015 10:43 AM
29	Practice questions	7/14/2015 10:43 AM
30	Interesting and fun	7/14/2015 10:42 AM
31	Mostly the learning materials	7/14/2015 10:40 AM
32	tinyurl	7/14/2015 10:25 AM
33	ALEABRA	7/14/2015 10:23 AM
34	tinyurl	7/14/2015 10:20 AM

35	ADDING AND SUBTRACTING	7/14/2015 10:19 AM
36	ADDING AND SUBTRACTING	7/14/2015 10:18 AM
37	it is kind of fun	7/14/2015 10:18 AM
38	ZOMBIE 1	7/14/2015 10:16 AM
39	ME	7/14/2015 10:16 AM
40	yes i do	7/14/2015 10:14 AM
41	Zombie1	7/14/2015 10:13 AM