1. Technical Area Chosen

I have chosen education technology with a focus on grade school math. Education tech is important in many ways; (1) making education, especially math, available anywhere is crucial, (2) educating children is the most important tool for success around the world, (3) individualized education is the most effective teaching technique.

2. Importance of Education Technology

The world is experiencing a technological revolution spanning all STEM disciplines. This includes organ growth and repair, smart materials, robot swarms, advanced communications, reusable rockets, driverless vehicles, smart grid and much more. The need for engineers has never been greater [6]. With only 7% of all U.S. BS degrees going to engineers and 10% for STEM total, the National Science Foundation (NSF) has created special programs to significantly increase the number of individuals pursuing STEM degrees (e.g. NSF S-STEM program) [7].

Providing effective, reliable, and personalized education accessible from anywhere in the world is revolutionary. Students would be able to strengthen their knowledge from anywhere and at any time. In this technological revolution, it is inevitable that the emphasis of technology in the classroom will continue to grow tenfold in the years to come. In fact, within the next 10 to 20 years education technology will impact every school around the world.
“By 1999, there was one computer for every six children.1 Yet despite this massive infusion of technology, overall improvements in education have been minimal.” [1]

“A system based on fixed time and variable learning is not an educational institution, it is a filtering institution: it separates those who learn quickly from those who do not. Rather than address the needs of each learner, we label some children as "slow learners," and relegate them to the scrap heap of society. While it might be argued that, in the past, those who lacked the capacity to fit into the mold of schooling could still find gainful employment, those days are fast diminishing. Lifelong learning is the norm, and jobs that can be done by those with little education are either being automated out of existence or are being exported to other countries where low-wage jobs still support viable lifestyle.” [8]

3. **Problem to be Pursued**

The primary goal of this work is to implement a fun and engaging tool that would help effectively teach a critical front-of-the-engineering-pipeline course: algebra. During the Spring, Dr. Rodriguez and I designed and implemented our Algebra Made Wonderful iOS learning application. The purpose of the app is to seamlessly bring fun interactive gaming and research-based learning principles together to provide an enhanced learning experience that can be accessed anywhere in the world at any time.

So far, the app has the following capabilities:

- User individualized login/password
- Three main menu options:
o WORK: this portal permits students to learn and practice their skills through online media and quizzing; tokens can be earned as students’ progress through the material;

o PLAY: this portal permits students to play games and navigate through different levels - earning tokens as they progress;

o SHOP: this portal permits students to use the tokens they have earned through the WORK and PLAY portals to buy incentives; e.g. advanced characters with significant powers (e.g. aerospace engineer, chemical engineer, biologist, etc.), valuable weapons, etc.;

- Notifications/Alerts: students can set notifications to practice skills and schedule alerts to be sent to their phone. Spaced practice is critical for “making it stick” [9], [2], [10], [11].

Toward the above goals, we will continue to follow core guiding principles that incorporate effective research-based learning principles [9], [2], [10], [9], [11]:

1) **Motivation - Capture Imaginations**: Concepts will continue to be well motivated - students are encouraged to earn tokens and buy new characters with unique capabilities; while doing so students are introduced to how the concepts they are being taught will translate to potential STEM careers;

2) **Level Assessment**: Self-regulated quizzing will encourage the student to test their level of achievement and they will be rewarded with tokens for their investment in their learning. As the student passes quizzes and earns tokens they will be able to buy more advanced characters (and capabilities) that will extend their reach within the game;
3) **Quiz-Based Modules**: Students will be able to choose to go to WORK and earn more tokens which can be used to buy items and characters from the STORE within the app. During their WORK, they will go through modules where they will be taught valuable techniques to help them learn new algebra concepts through on-line resources (e.g. Khan Academy, etc.) and shortly after, they will be quizzed on their ability to retain these concepts;

4) **Thorough Finest-Grain Coverage**: Central concepts should be covered thoroughly - a finest grain approach so “nothing important is overlooked;”

5) **Feedback**: Student quiz results will provide targeted feedback to the student after “goal-directed practice” [9], [2], [11];

6) **Interactivity**: Modules should be interactive multimedia; learning should be active whereby students are “doing”- not just reading; here, interactivity and multimedia are intended to adequately address distinct learning styles; e.g. (1) visual, (2) auditory, (3) verbal, (4) physical (using arrow keys), (5) logical (sequential), (6) social (group), (7) solitary;

7) **Spaced Quiz-Based Practice**: Learning will be primarily based on interactive “spaced” quizzing as discussed within the research-based foundational publication: Make It Stick: The Science of Successful Learning [2]; here, the term “spaced” is intended to allow a little time for forgetting in order to force students to try and recreate what was forgotten, strengthen neural connections and transfer knowledge from short- to long-term memory [2]; quiz-based calibration helps realign and consolidate learning; it helps one focus on central precepts; identify weaknesses, arrest forgetting and pursue mastery;
8) **Interleaving (Mixing) Relate Topics**: Reviewing a mixture of topics rather than “blocked practice” helps one better prepare for the real exam – just like taking random pitches during batting practice helps one better prepare for hitting during a real baseball game;

9) **Career-Steering/Shaping Projects**: Each module should point to relevant career-steering/shaping projects that students can pursue; this permits students to explore how the material is applied in practice;

10) **Critical Reminders – Time Management**: Students are reminded what to do and when to do it – consistent with teachings in Dr. Donna O. Johnson’s Guaranteed 4.0 Learning System [10]; this includes reading ahead and bullet pointing what you’ve read; reading ahead opens up your mind to the subject when the material is covered; it also includes: summarizing a module with bullet points; summarizing a graded quiz – why items were correct and wrong – emphasizing key concepts;

11) **Climbing Bloom’s Learning Pyramid**: We want all learners to climb Bloom’s taxonomy pyramid (1956) [12]. A bottom-up mnemonic for this climb is RESTED: (1) Remember, (2) Explain, (3) Solve, (4) Test, (5) Evaluate and (6) Design.

4. **Importance of the Problem to be Pursued**

In this day in age pursuing higher education is a necessity for people seeking general success and security. And the role primary education plays in the path towards obtaining a degree is extremely important. If technology and education could be integrated efficiently, it would have an abundance of positive effects on the general population.
More students would have confidence in their abilities, a better relationship with learning, and more goals centered around higher education.

My main motivation for this education-based algebra-directed project is to create a platform where minority groups (e.g. women and girls) feel encouraged to pursue and welcomed in STEM fields. And since my ultimate goal is to become a Senior Software Engineer with a focus on education technology analytics this would allow me to be a part of improving the lives of children all over the world through education and fundamentally impacting the way the education system works as a whole.

5. Relevant Career Prospects

Some relevant companies I may pursue in the future would be Pearson, Edupoint, and Stormwind. They are all known for their innovated approach to educating the future. Edupoint is a synergy education platform with an emphasis on a combination of information, learning, and individuated education management for K-12 school districts. Pearson’s mission is to work with educators and institutions to help every student succeed from anywhere. And lastly, Stormwind aims to use “Hollywood style production” to grab and keep students’ attention and create a fun and effective learning environment. All of the companies have headquarters in Arizona which is where I want to stay and all have opportunities that interest me. I have applied for several internships. I am currently looking for something to help me advance my resume and provide me with real life experience so that when I go to apply for a future career with Pearson, Edupoint, or Stormwind I will be a viable candidate. The worst possible scenario in terms of my
career would be to work independently on different projects from home. This would not be the worst situation to end up in for a while if my corporate career path did not work out. I would be able to build my resume up with projects and real-world experience. I would also love to get involved in projects focused on increasing the number of female and minority students into S.T.E.M related fields. Many students shy away from programs involving engineering disciplines because they believe it is dull, difficult, and only achievable for certain groups of people. When developing this proposed software and app design, it's motivation will be to change the way students view S.T.E.M all together and provide opportunities to student who may not have had otherwise. “Looking specifically at women’s participation in higher education and engineering education over nearly four decades using HESA and UKDA data we can see clear trends emerging. Firstly, women’s access to higher education in general has increased significantly, from 32% in 1972 to 55% in 2008. Secondly, we can see that women’s participation in engineering education has also increased from 4% in 1972 to 18% in 2008.” [3]
Below is a graph showing the improvement of the number of women entering STEM fields in higher education in UK from 1972-2008.

6. **Approaches: State-of-the-Art**

   Some state of the art approaches to education technology involve the implementation of virtual reality (VR) and augmented reality (AR). This approach contributes to the visual appeal of the learning application. This element helps users stay actively participating in their studying and learning practice. Some current mobile application utilizing virtual reality are VR Math and DragonBox. Both have integrated VR and AR into their application in a game like atmosphere while reiterating mathematical concepts.

7. **My Approach to the Problem**
My approach is similar to these states of the art approaches because I am also researching the idea of playing with VR and AR within education technology. My goal is to develop an algebra game that allows the user to learn graphing virtually. The game would consist of the user’s current space with the addition of shapes and grids that are seamlessly integrated into their world. The user would be able to magically plot graph points and equations and connect their shape and slope with the real world around them.

8. **Rationale for My Approach**

I believe my approach could change the way students and teachers view mathematics and add another learning styles to the mix. Students that enjoy and benefit from visual learning would profit significantly from an application like this one. Scientifically, students learn better and retain the information better when they actively participate in their learning hands on. Virtual reality would open doors for students to connect to their learning better than ever.

9. **Risk-Reward Assessment**

The risks of this approach are monetary. Suppling each student with VR/AR headsets can be expensive and education in the United States is not well funded. If the benefit of VR/AR in the classroom ended up being rather insignificant then the money spent of equipment could be a waste of an already small budget. Although the rewards, if technique is proven beneficial, would be abundant. Students could explore and advance their learning in a dreamlike way. Combining both their imaginations and education.
Some obstacles I foresee as I approach a career in education technology are improper use of the worldwide web, noncompliance with teachers, faculty, and school districts, and “people in order disciplines (e.g. language arts and social science) have noticed – and complained about- students’ reliance on the Web for information, to the exclusion of libraries and physical books.” [5] Below is a graph of the six most general obstacles faced.

![Graph Showing Relative Frequency of Barriers](image)

**Relative frequency in which the barriers were mentioned in the past studies**

“It is worth being suspicious of any use of software that proposes to replace teachers, for it must be based on an impoverished view of mathematics in education” [5]. “In this technological age, teachers are more necessary than ever; this is why professional development is so important, as teachers' roles are changing from being lecturer to facilitator or, as one common slogan goes, from being "the sage on the stage to the guide on the side."” [5].
10. Preparation to Date


I have had the opportunity to work Dr. Armando Rodriguez on 2 funded FURI and WAESO projects. I also worked on the ASAP project scholarship this previous 2018 summer. All of my research projects revolve around education technology in the form of iOS mobile applications. We have focused on teaching the front-of-the-engineering-pipeline course Algebra through the scenically tested learning techniques outlined in “Make It Stick.” We are also currently conducting research into the
implementation of virtual and augmented reality into the application to support 
deepened learning.

11. Special Relevant Skills

My math, programming, and engineering courses have steadily steered, guided, and 
prepared me for my career path and to face these obstacles. More specifically, my courses 
in data structures and algorithms, Java/C/C++ programming, software quality and 
assurance testing, intelligent interactive instructional systems, and theoretical computer 
science have provided a very good foundation for my proposed work and career 
objectives. As engineers, it is our greatest accomplishment to be leading innovators. 
Education is one of the only fields left that has not been significantly improved with the 
help of technology. And since education is the foundation of all creativity and innovation, 
I believe adding to the research of education technology is one of the most important 
roles I will ever play in my professional career.

12. Required Resources and Budget

The following resources are requested to complete the proposed project:

- $1000 student stipend per student; 1 student will work on the proposed project
- $300 for materials and supplies.

Materials and supplies will include:

- Books and purchases of published research papers to further elaborate on learning 
techniques and practices
- Purchase graphics, animations, and backgrounds for front-end application design

Receipts can be provided for all expenditures.
13. Timeline

Week 1 – 3
Background research i.e. books, academic journals, theses, etc.

Week 2 – 9
Prototyping Application

Week 9 – 10
App Initial Quality Assurance Testing by advisor Dr. Armando A. Rodriguez (Professor of Electrical Engineering)

Week 10 – 15
Product Testing with Students

Week 12 – 13
Final App Quality Assurance Testing

Week 11 – 15
Prepare Research Report

14. Future Plans

I plan to conduct case study using TestFlight software through Apple.

(1) The case study will use TestFlight Beta Testing. We will be able to share our beta builds with up to “10,000 external testers using just their email address”. [16]

(2) Smaller break tests will be administered for each feature of app and will be tested frequently and securely; UI testing, function testing, security testing, etc.

All tests will be reported and documented effectively for review

In addition, a sixth-grade class in the Osborne Arizona School District has agreed to participate in the app’s quality assurance software testing and give valuable feedback which will be used to improve the capabilities and design of the application.

I am passionate about education technology because I am passionate about education, children, and technology. My main motivation for pursuing education technology is to establish a foundation for a senior design project and future career path. My ultimate goal
is to become a Senior Software Engineer with a focus on education technology analytics. This would allow me to be a part of improving the lives of children all over the world through education and help change the way the education system works as a whole.

15. References


