

How might we improve math proficiency in Atlanta Public High School students who are struggling with 9th grade algebra?

Problem Statement

Problem:

Through extensive research, expert interviews, field trips in the community, and personal experience, our team has discovered a grand challenge in the field of education, specifically dealing with math education. The problem that we have found is that there is a significant percentage of 9th grade students in Atlanta Public High Schools who are not considered “proficient” in algebra. Math proficiency scores, as measured by the Georgia Milestones End of Course Assessments (EOCs), in Atlanta Public High Schools for the 2014-2015 school year ranged from merely 6% to 67% (*US News*, n.d.). The EOC has four “achievement levels:” “*Beginning Learner*, *Developing Learner*, *Proficient Learner*, and *Distinguished Learner*” (*End-of-Course (EOC) Interpretive Guide for Score Reports*, 2015). A student is considered “proficient” as long he or she is not in the *Beginning Learner* category (Downey, 2015). This lack of proficiency has the immediate effect of the student not passing the Coordinate Algebra EOC, which is a graduation requirement. The long-term impact includes issues for the student beyond ninth grade, both in their educational careers and in their adult life. These unacceptable rates also create bad reputations for schools at which students are consistently not “proficient” in algebra, which also has an impact on their graduation rates.

Significance:

Why is this problem a “grand challenge?” We have found that Algebra 1, commonly taken by 9th grade students in the state of Georgia is one of the most important classes needed for a student to be successful both in high school and beyond. One article from *The Atlantic* claims that 9th grade is one of the most important years in school (Willens, 2013). They claim that this year commonly determines whether a student will drop out of school or continue to graduation. The article also provides data which shows that more students fail 9th grade than any other grade, which causes high school students to fall into a dangerous cycle. Even for students who manage to pass the algebra course eventually, if they are not confident in the material learned, they will run into problems in subsequent math courses, such as geometry, another course in which success on the EOC is a graduation requirement. This poses challenges in their attempts to pursue college or a career, and in life in general. This is detrimental not only to the student involved, but also to the community as well. Parents of these students must support their children for longer amounts of time. Schools with low performing students may not attract new companies, families, and business to the community. One source claims, “our communities and nation also suffer from the dropout epidemic due to the loss of productive workers and the higher costs associated with increased incarceration, health care and social services” (Bridgeland, Dilulio, & Morison, 2006). Overall, society, and in this problem space specifically, the Atlanta community, suffers when students struggle with algebra in 9th grade.

There are many probable causes as to how this problem has come to exist in our society. One cause is that algebra is by nature a difficult topic for some to understand, because, “algebraic thinking is not just arithmetic...it is a different kind of thinking” (*What is algebra and why do students find it so hard?*, n.d.). The first time a student is taught algebra marks a transition in their math abilities that shifts from numbers to letters and symbols. Another possible cause is the negative stigma that is often found attached to math in conversation. Math anxiety is a common phenomenon in which a fear exists that is “associated with manipulation of numbers and solving math problems” (Draznin, n.d.).

Increasing students’ math skills would help not only the students but also society as a whole. According to a study conducted in California, “students failing algebra rarely recover” (Tucker, 2012). Many students who fail algebra and repeat the course continue to fail, which results in a vicious cycle that wastes resources and time and likely frustrates and discourages the student. In this research study, those students who were proficient in Algebra 1 by 8th grade followed an accelerated track throughout high school, while not a single student who earned below a D in 7th grade math went on to take calculus in high school. This demonstrates that algebra provides a foundation for other classes at a time that determines a student’s success in the future.

The skills learned in algebra are critical to all students “even if they do not continue their education beyond high school or do not pursue a math- or science-oriented career” (*Why It Is Important To Learn Algebra*, 2009). With increased math proficiency, people would make more responsible financial decisions. They would understand math concepts that are important for life, including “balancing a checkbook, calculating a tip for a waiter, and making sound financial decisions” (Draznin, n.d.). In addition to day-to-day tasks, algebra is also critical to society as a whole. Algebra is used in “weighing all manner of public policies, from the Affordable Care Act, to the costs and benefits of environmental regulation, to the impact of climate change” (Hacker, 2012).

Stakeholders:

There are numerous groups who are impacted by this issue and believe the problem is important. Four primary stakeholders in our problem space are students, corporations, government, and parents. According to the US Department of Education, at the most basic level, “personal success throughout school” and “future opportunity” are at stake for students (*Engaging Stakeholders*, 2009). Students, specifically students who struggle with math, have the highest stake in our problem. If they are unable to pass their math classes and math-based standardized tests they will not be able to graduate, which means they will not be able to go to college, which means that most of the jobs they are hired for, if any, would make far less money than if they had been able to graduate high school and/or go to college. If they are able to find a job without attending college, a lack of understanding of high school-level math classes means that they will likely not understand math necessary for day-to-day tasks. For example, it is important to have a basic understanding of math in order to understand how much money to save

for retirement, the best type of mortgage, etc. For corporations, the “ability to hire graduates with skills needed” and “community economics” are at stake (*Engaging Stakeholders*, 2009). For parents, “pride, success, and opportunity for the students they care about” are at stake (*Engaging Stakeholders*, 2009). Finally, for government, it is important that students succeed so that they can go on to support the local economy. It is important to engage these four primary stakeholders, as well as others, in order to find a permanent solution to the problem.

Context and Existing Solutions:

The Georgia Department of Education has attempted to fix this problem of a lack of math proficiency by implementing a new Georgia Milestones Assessment in recent years. This new assessment is more conceptual and more rigorous, which in the short term might make EOC scores drop even lower, but the hope is that a more rigorous test and matching curriculum will bring Georgia up to the standards of other, higher-performing states. There is also an increased focus on teacher training; teachers and principals received training on developing quality assessments; and face-to-face and online professional development opportunities and coaching (French, 2015; *Atlanta Public Schools: Georgia Milestones Assessment System*, 2014). However, teacher training will not improve scores if the teachers are not the problem.

Another current solution is that APS will be deploying educational technology that makes it easier to zero in on students’ weaknesses (Castarphen, 2013). Some examples of these resources are Agile Mind, Ascend Math, and First in Math. However, according to a Levels of Technology Innovations test (LOTI), the majority of students do not use these resources. If students are not taking advantage of these current solutions, then these resources will not fix the problem, a potential setback we must consider when developing a solution.

Another model some APS schools are beginning to implement is “blended learning” in which students click through online lessons as teachers supervise (Castarphen, 2013). While this allows students to learn at their own pace and take online classes for credit recovery, it has led to problems such as low attendance rates. There is no way to tell whether students are learning more, and according to Jessica Heppen, “for students who have fallen very far behind... [blended learning] requires students to be self-motivated” (Bloom, 2016).

Why is it still a problem?

While Georgia performance scores were very low when compared to the standards of the national tests, Georgia’s standards were much more relaxed. As mentioned above, In order to improve Georgia’s curriculum and raise it up to the national “gold standard”, new Georgia Milestones Assessments were implemented (French, 2015). This is one reason the scores have dropped recently. Because the test is new, the problem of increasing scores has not yet been addressed. In addition, scores had not increased

significantly in previous years with the easier test, so a new solution is necessary to increase proficiency and scores with the more difficult test.

Proposed Work

Goal:

Our goal is to support Atlanta Public High School students who are failing/falling behind in 9th grade algebra and bring them up to grade level. If our solution is successful, more individuals will pass algebra and the Georgia Milestones Assessment (EOC exam) putting them on a path to graduate high school and have a better understanding of math, which will help them in life beyond high school.

Objective #1:

Although we do not want to encourage “teaching to the test” or placing unreasonable emphasis on standardized test scores, we recognize their importance. The main reason achieving proficiency in algebra as measured by the EOCs is that it is a graduation requirement. The other reason these scores are important is that they greatly affect schools’ reputations. For these reasons, our main objective is to increase the proportion of students in Atlanta Public High Schools that achieve proficiency (above the *Beginning Learner* level) on the Coordinate Algebra EOC.

Our main solution idea is a math tutoring and mentorship mobile application called MathPals where APS high school students will be partnered with Georgia Tech students so that each student can have someone who fully understands the subject act as a supplemental guide through the material. Potential features include one that identifies math standards that are potentially tested on the EOC. We also plan on including a progress tracker to indicate which topics a student has mastered since the beginning of the course. Our program would act as support for the student’s current math course as well as a review of the past few years of mathematics in middle school if needed.

The most obvious outcome that would come out of this is a potential increase of EOC scores. With increased preparation for the examinations, students should perform better. In conjunction with trying to solidify conceptual understanding, students would be able to answer more conceptual questions that arise on the exam rather than guessing on them. With only 57.9% of APS high school students achieving proficiency on the 2015 Coordinate Algebra EOCs, we would hope to increase this percentage so that students can not only graduate, but the APS district can begin to repair its reputation (Downey, 2015).

Of course, there will be some teachers that are hesitant to allow outside forces to attempt to change the dynamic. After discussing with Tamara Pearson from CEISMIC at Georgia Tech, teachers tend to feel like the outside force will either criticize them or completely take over. She described to us that the best course of action when dealing

with that fear is to be more of a resource to the teacher that can offer guidance to enrich education rather than replacing their methods. Other potential issues would include administrative approval from both the school and the school board. The politics of educational districts involved in getting plans approved would severely have a strain on any potential solution. Finally, and perhaps the most daunting, is that we could face the possibility of students not being motivated enough to succeed in learning algebra. If we can gain the contacts, develop a strong base of teachers to try our intended solution, overcome the politics of the school board, and find an optimal solution to not only teach the test but instill the concepts, a student could still deny the program. Our methods to accomplishing better EOC scores should be something that targets the root of the problem while having an effortless implementation that even a portion of the unmotivated could get on board with.

Objective #2:

Ninth grade algebra is a critical skill that students need in order to be successful not only through the rest of high school, but also throughout the rest of their lives. Because of this, it is essential that students build their fundamental understanding of algebra during their ninth grade course, as failing to properly learn the material will cause future issues. We aim to increase the proportion of students passing ninth grade algebra.

The courses following Algebra I set by the Georgia Department of Education use and/or build on skills and concepts from algebra. Students without an understanding of variable manipulation and functionality of systems of equations are at a much higher risk of not succeeding in later courses. In the next course in the Georgia math track, Analytic Geometry, students learn how to manipulate geometric formulae to find unknown distances and think critically upon the notion of cross sections and how they relate to their three-dimensional shapes. Because of the heavy algebraic influences, we wish to build a strong foundation within the first few weeks of the course, so that students do not fall behind and are stuck attempting to relearn the skills. We want students to not only pass, since schools have been known to pass their students to improve their appearance as an institution of learning; instead we propose to increase the number of students getting B or better. Creating a solid understanding of the material in students would set them up to be more prepared for tasks in life, as well as future classes.

Using our MathPals app, we will be able to track the progress of our cohort by implementing the progress tracker as mentioned in Objective 1. Also, since we are implementing social networking attributes within the program, the app will encompass a messaging service that can be used by teachers, parents, students, and GT mentors to timely address questions from the students even at later hours for more involved students who start on their homework late whether it be because of sports practices or competitions. Since Georgia Tech students on average work throughout the night, our APS cohort would have access to 24 hour tutoring services holding students accountable for their work. With help at the palm of the student's fingertips and mentors to know where the high school student is having trouble, they will not have an excuse to not learn the concepts.

Of course, there will be challenges along the way. First and foremost, if we find that the curriculum itself might be stunting students' growth in the subject, we would want to either supplement the material or instead replace it with a more in-depth baseline. Both solutions have the drawback of increasing the workload of students struggling in the course as is. This could potentially lead to discouragement as the workload increases compared to previous levels. It would seem repetitive to be re-taught a lesson, which might result in disengagement. On the other hand, the process of revamping a curriculum as we discussed with Tamara Pearson, Associate Director of School and Community Engagement at CEISMIC, who has had experience as an advisor in writing curriculums, is very intricate. It involves meeting with state administrators and veteran teachers to develop a state curriculum. It also involves political oversight. Both issues build a barrier on our reach for the project.

Project Team:

Our team would have a total of six students. Their profiles are as follows:

Team Member 1: This member has an intensive programming background involving mobile app development, web development, and machine learning allowing us to make any digital implementations across various platforms. This member is also great at forming connections with potential contacts to endorse and implement our possible solution to solve this grand Challenge.

Team Member 2: This member has a strong background in mathematics, and decent proficiency in computer programming. This member is capable of performing thorough statistical analysis of data collected over the course of our experiment, assist in the development of any digital solutions, and contributing the perspective of a math-minded individual.

Team Member 3: This member has a strong background graphic design, so she would be able to help with the user interface of MathPals such as the mobile application and website as well as the design of any promotional materials needed. Creating and sustaining relationships in the local education community will be one of her greatest assets to the team. As a liberal arts major, she will advocate that the proposed solution direction and implementation is ethical and decidedly human-centered, viewing individuals of the target audience holistically as members of the community.

Team Member 4: This member is organized. She will ensure that deadlines are met and things are implemented in a timely manner. She is communicative and therefore able to remain in contact with the schools. She has a strong understanding of algebra, so she will be able to review and proof any problems that appear on the app and website. Also, she has basic coding skills in Java, Python, and Matlab and can potentially help in coding the app.

Team Member 5: This member has strong communication and organization skills. As a business major, she has experience with marketing and is proficient in excel. She can help promote and market MathPals; one of the main problems with current solutions in the problem area is lack of awareness and use. She also has experience in graphic design, and can help with the visuals of the app and website.

Team Member 6: This member is organized, motivated, and passionate in the subject area. She has many networking connections in education in the metro Atlanta area, and the communication skills to make new connections with professionals in APS. She has had lots of experience with professional leadership development training both as someone attending training and someone teaching the workshops. Her experience in team projects leaves her with effective presentation skills and the ability to see a need and step up to fill it.

We also have three possible mentors that can assist us in developing and implementing MathPals. Ms. Tamara Pearson from CEISMIC at Georgia Tech would serve as our potential mentor for developing the program's "curriculum." Being that she has been an educator for over twenty years, worked at the administrative level, and acted as a third-party supplement to education, she has seen the various ins-and-outs of the profession and could offer various insights toward the cohesion of our group to a potential school we would implement our solutions to. In recent outreach sessions conducted by our group, we met with Mallory Chapman, a Pre-Calculus teacher at Booker T. Washington High School. Through our discussions with her and possibly her student, we can make sure that our program is something that students would actually be interested in using. Finally, we have Mar-De Kilcrease who works for CEISMC as well as at Booker T. Washington High School as an advisor who primarily focuses on STEM. Her role as an advisor would be to help us understand the test space of conducting these types of programs in terms of what works or does not work under the scope of what we would like to implement.

Timeline:

Fall 2017:

Work on developing the MathPals application and website

Spring 2018:

Research/Development of Program

Fall 2018:

Implementation of MathPals in an Atlanta Public High School

Spring 2018:

Continued Implementation

Analysis/Critique of Program Conceptually

Summer 2018:

Analysis of Metric (EOC Assessment and percentage of students passing algebra)

Budget:

To develop and application and website, we will not need an abundance of funds.

Materials and Supplies (\$0):

We would not need funds for materials and supplies.

Equipment (\$0):

Not applicable. Our program solution at most would involve students using their own technology such as smartphones and tablets.

Services (\$1200):

Most services such as app and website development and marketing can be done by members of the group. We would however need funds to host a website, which would cost about \$50/month.

Travel (\$200):

During the development phase, we will likely continue our on-site research to check in with Atlanta Public high schools and make sure the solution we are developing is something they would be interested in implementing. In order to travel to Atlanta Public High schools, we would need funds for gas or for public transportation. Although we are working in Atlanta, it is difficult to get around without proper transportation.

Expected Outcomes and Future Directions:

After the 2017-18 academic year when we will develop the MathPals program, we plan on working with CEISMIC to implement to use their institutional knowledge to facilitate their strengths and learn from their weaknesses. We will focus on Atlanta Public High Schools; specifically in a lower performing schools compared to the average. After the first year of implementation (2018-2019), we will measure the change that our program has shown. We hope to see an increase in the percentage of students considered "proficient" in algebra based on EOC scores, and we hope to see an increase in the percentage of students passing algebra. Although we are placing an emphasis on the test as an objective, it is with the intention of using the test as a quantitative measurement of our progress. After we analyze the impact (negative, positive, or neutral) and work on improving our solution, we would like to eventually be funded by the district in order to ensure our program sustainable.

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