

# The positive effects of single-gender classrooms in STEM education

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**Abstract**— In this paper, we address a solution to increasing student achievement in STEM classes through the use of single gender classrooms to reduce some of the social distractions which occur in co-educational classrooms. While previous research focused on short term impact on female students, this work investigates the effect on all students of single gender classes at an urban secondary school. After two years of study, we found positive results for both male and female students over their co-educational peers. While the study is limited in scope and location, we feel these results show promise across all STEM disciplines and is one tool which could help increase the number of students continuing in STEM disciplines.

**Keywords**—single-gender, education, teaching, mathematics, science, engineering, technology, STEM, high-school, secondary classroom

## I. INTRODUCTION

One trend in education, especially in the United States, that is alarming is students reaching lower and lower achievement levels in STEM (Science, Technology, Engineering and Mathematics) classes. [1] Many students, especially in high school, seem to gravitate away from these classes, arguably as they are too difficult, although research shows strong STEM abilities lead to high lifetime earnings. [2] While there are many possible reasons or causes for this, much research is inconclusive or presumably based on the difficulty in isolating variables and/or creating suitable controls.

One *fad* that is discussed to counter this issue is the use of single-gender classrooms. [3] [4] [5] [6] [7] The theory is that students in single-gender classrooms are free from the stress of being judged by the opposite gender. Social interactions and social identities can lead to the dumbing down of students or the effort to be seen as one of the crowd, rather than strive to learn and complete the material to the best of ones abilities. Many times, the discussion revolves around girls, being underrepresented in STEM fields, but the authors wish to investigate the benefits of single-gender classes for both boys and girls. We wonder if removing the gender relationship of the social pressures, will allow for those who would obtain success be allowed to do so once they are freed from societal norms based on their gender and the outcomes they *should* achieve. We further wish to determine if there may be any detrimental effects that may outweigh the benefits of this method of teaching. We are not talking about isolation or segregation, but rather the creation of an environment that allows less posturing or flirtation

to occur, while teaching the expected material from a uniform standard lesson plan following best practices and the experiences of the instructors.

## II. RELATED WORKS

There is a growing body of work that is looking at the use of single-gender classrooms, especially in STEM fields. Many of these studies take place in co-educational settings where at least some of the classes are segregated along gender lines. This allows there to be control groups as well as one or more single gender class for comparison purposes.

In [8], The authors look at the introduction of computer science to girls. In the study, they compare and contrast the impact on girls to this introduction in an all-girls setting versus a co-ed setting. They conclude that the all-girls setting, while conducive to the girls' exploration and success in the computer science concepts, that those girls were more likely to uphold long-standing stereotypes about computer science such as it being made for boys and too hard for girls to do. In reading this study, the authors admit to a few flaws in their design. First, participants themselves self-selected which group (the co-ed control or the single-gender test) they would take part in. This leads to question if the attitudes reflected at the end of the experiment were present before the classes took place, and not a result of the make-up the environment. Secondly, there were only nineteen girls and six boys in the study. The test group contained eight girls and the control had eleven girls and six boys. Due to the low numbers in the study, the results may not be statistically significant. Despite the flaws, the study does have some positives. Not only does it provide an introduction to the topic of single-gender classrooms, it provides the background for why we should be looking at single-gender classes, not only in computer science, but in any STEM class.

In [5], the authors investigate the reasons for underrepresentation of women in computer science. They detail a project undertaken at two diverse universities over several semesters. In the project, women who met specific criteria were invited to a workshop a week prior to registration. The workshop was broken into three parts. In the first part, the authors introduced themselves and presented the opportunities for women in technology. The second part, assisted by upperclassmen women, the participants partook in a programming activity. In the final portion, the group had an informal reception where the participants could interact with

faculty and students in the department. During the sequential semester, the students who chose to take a computer science course were paired with a peer tutor. While the program was successful in increasing and retaining women in computer science, could it have had a larger impact with single-gender classes?

Teaching single-gender classes in software engineering is discussed in [3]. The authors found that shifting from a co-educational to a single-gender environment provides both issues and benefits. They found the switch to single-gender classes to improve the performance from both male and female students. They also found over time that the gap between gender performance decreased. One limitation of this research is the study focused on a single upper level course not multiple or lower level courses.

In [7], The authors investigated single-gender classes in a co-educational primary school in Australia. Through interviews with staff, parents, and students, the authors found girls to be more self-confident and boys to be more motivated. While the authors did not present any quantitative data, they did mention that standardized testing showed no academic difference that could be attributed to the single-gender environment.

In [4], the authors discussed the benefits single-gender environments can have for students. Single-gender classrooms can allow teachers to use teaching strategies that best fit with how genders typically learn. This differentiation addresses the mental and physical developmental differences between girls and boys at different stages of their growth. The author also presents data to support increased engagement with in single-gender classes of both genders over co-educational classrooms.

Finally, in [6], the author studied a group of middle school students in single-gender mathematics classes within a co-educational school setting. Specifically, the author examined the problem-solving approach of the students to determine the difference between the strategy level applied by each gender. While the author concluded that the proportion of boys and girls that used mature problem-solving strategies were essentially equal, there were also approximately double the number of girls who employed low level strategies compared to boys.

While these studies have presented mixed results in the effectiveness of single-gender classes, none of these studies has looked at the upper secondary level student nor looked at longer term results. We extended the timeframe to be an entire school year and ran two cohorts of students to see if the initial results were repeatable.

### III. FRAMEWORK

We choose an urban public high school for this case study with approximately 1,600 students. The student body is 30% white, 32% black, 31% Hispanic, and 7% other. It is approximately 63% free and reduced lunch and 29% special education. Approximately 68% of the senior class graduated each year.

The course we targeted was considered remedial math, concentrating on prerequisite skills for high school Algebra, called Integrated Math. Most students in the course were not college bound and a majority had already failed the class at least

once before. Class rosters mirrored the school population demographics, while students from freshmen to seniors would be enrolled in the course. Many of the students were 4 to 7 years behind in mathematics. In the three years prior to the case study, the class averaged around a 23% success rate of students earning 60% or above which allowed them to move on to the next course in the sequence and progress toward graduation.

Discouraged by the failure rate, and general distraction of students in class, the mathematics department discussed changing the structure of the course. While several options were discussed, one teacher had read an article in a local paper about a science class in a nearby district, which had found success for students in single-gender classes.

### IV. CASE STUDY

Over the summer prior to the case study, we revised the scope and sequence of the course, as well as adopted common class policies and expectations. The revised course was a blending of previous expectations and did not reduced the expectations or material which was to be covered. From an administrative perspective, the scheduling principal created an equal number of sections that were all male, all female, and additional sections which were co-educational. To introduce the topic and increase buy-in, a parent meeting was scheduled prior to the start of the semester to discuss the changes to the course. All parents received letters of invitation to attend this informational listening session. Approximately 20% of students' parents attended this meeting.

To help control the effect the gender of a teacher may have on a STEM class, we had two teachers, one male and one female working in this study. Each teacher taught two sections of single-gender classes, and three co-educational sections the first year. The enrollment the following year was lower, and each teacher taught one section of each single-gender, and two sections of co-educational. See Table I for enrollment details.

Over the summer during scheduling, students were randomly assigned to one of the three sections. During the informational meeting before the start of the school year, students and parents were informed that they could request a transfer out of or into a single-gender section if they wished. The first year of the study, we had four students opt out of a single -gender section. The following year, no-one opted out, and two females opted in to a single-gender section.

The teachers did not work completely independently. Over the course of the year, the teachers collaborated and supported each other with the new scope and sequence, as well as unexpected challenges of single-gender-classes. At the end of the first year, we adjusted some of the pacing in the course, but left the general structure alone for the following year.

TOTAL STUDENT ENROLLMENT

School Years	Total Student Enrollment				Totals
	Single-Gender		Co-educational		
	Female	Male	Female	Male	
2008/09	49	57	72	100	278
2009/10	57	45	37	57	196
<b>Totals</b>	106	102	109	157	474

Over the course of the study, we analyzed the pass rate of the students, both as an aggregate, by class type (all girls, all boys, and co-educational) and by each teacher quarterly. We also had the students assess the effectiveness of the course eight times each year in their daily math warm-up journals. Any student with less than 60% attendance, as lack of attendance, for any reason, could be a factor in lack of success in a course. Table II contains the enrollment numbers of students included in the analysis.

It should be noted, while the school and teachers had planned on not only continuing the study, but also expanding it to other low-level mathematics courses, the school district eliminated all courses lower than Algebra. Since there had not been the same issues in courses at the Algebra level and above, the school dropped the study. However, in 2018/19, the idea of single-gender classes is once again being discussed for the following year in all classes that are primarily freshmen.

## V. DATA AND ANALYSIS

For our analysis, we defined success as earning a passing grade (60% or better) in the course for both semesters, thus earning a credit of math towards the two credits required for graduation and able to move on to the next course in the sequence, Algebra 1.

At the end of the 2008/09 school year, 29% of students in co-educational classes successfully completed the course, while 63% of the girls and 48% of the boys in single-gender classes successfully completed the course. We then followed these students for an additional year to see if they would continue to be successful in their math education. For those students that successfully completed Integrated Math and moved on to Algebra 1, 60% of co-educational students and 76% of single-gender students continued finding success.

At the end of the 2009/10 school year, 40% of students in co-educational classes and 62% of both girls and boys in single-gender classes successfully completed the course. Again, students who successfully complete Integrated Math and moved on to Algebra 1 continued to succeed at a rate of 61% for co-educational students and 74% for single-gender students.

Not only did we observe a much higher pass rate than had been previously seen, we also observed continued higher than averages rates of success as they moved through the math sequences toward graduation.

However, since we changed the scope and sequence the summer prior to the study, that created an additional variable, and are hesitant to compare our results to the years prior to the study. While the material did not change, the way we linked it together did and that is a variable, we cannot separate in our study. Nevertheless, compared to the co-educational classes,

STUDENTS WITH MORE THAN 60% ATTENDANCE

School Years	Student Enrollment with > 60% Attendance				Totals
	Single-Gender		Co-educational		
	Female	Male	Female	Male	
2008/09	39	46	58	87	230
2009/10	48	35	31	45	159
<b>Totals</b>	87	81	89	132	389

girls in single-gender classes experienced 107% (08/09) and 55% (09/10) higher success rate. The single-gender boys experienced 65% (08/09) and 55% (09/10) higher success rate than their co-educational peers. Furthermore, single-gender students showed a 27% (08/09) and 21% (09/10) higher continued success rate in future math classes.

While the increased success rate of the single-gender classes showed positive results, we wanted to determine if the results were a result of the single-gender classroom or was it a coincidence. We used a Chi Squared test of Independence on the data to determine the statistical significance of the single-gender classroom on the increased success rate. Our null hypothesis was there is no interaction between being in a single gender class and success rates by gender while our alternate hypothesis was there is a connection between being in a single-gender class and success rate. We tested at a 10% level of significance with one degree of freedom. For school year 2008/09 we have a  $\chi^2_{calc}$  of 0.819 which causes us to not reject the null hypothesis. For school year 2009/10 we have a  $\chi^2_{calc}$  of 2.383 which causes us to not reject the null hypothesis. For the collective data of both years we have a  $\chi^2_{calc}$  of 3.157 which causes us to reject the null hypothesis.

## VI. RESULTS

In addition to the analysis showing students did better in single-gender classes, the first year brought up an intriguing pattern in both the quantitative data as well as observational data. For the male teacher, the all-girl section had a higher success rate and higher overall grades, while the opposite was true for the female teacher. We initially hypothesized that the teacher / student cross gender might have an impact in the single-gender classroom, however, the following year, the pattern reversed itself, and the higher performing classes had matching genders between teacher and students. So, while we do not know the significance of this, we do think more study is needed to see if there is a correlation.

Student response to the single-gender format was homogeneous each time we asked for the students' thoughts on the effectiveness of the new format. In the single-gender classes, during the first quarter, both the girls and boys commented on the fact that they missed the other gender in class, that the class was boring without the other gender, or they needed some "eye candy" in class. As the year went on, and the students became more comfortable with the class make-up, the students became more vocal on the fact they enjoyed not having to look too smart / dumb in front of the other gender, they could be themselves, or they wished more of their classes would be single-gender.

On the other side, early in the year the co-educational student would tell us they were glad they were not forced to be in the single-gender classroom. However, as the year went on, and the students talked outside of class about what the experience was like, the co-educational students would start talking about how they wish they did not have to put up with the other gender in class.

From the standpoint of the teachers, there were several unexpected results, both positive and negative, of having single-gender classes. Neither teacher was prepared for many of the negative issues, especially the first year, and both teachers

struggled to address or accommodate the issues. On the flip side, both teachers were surprised by most of the positive side effects and moving into the second year were pleased to see these effects continue.

The largest issue for teachers, and the one they felt least prepared for, was the fact that there was only a single-gender of students in the classroom. While the teachers knew this fact well in advance and thought they had prepared for it, in actuality they were unprepared for the repercussions of this fact. As the classes settled into a comfortable environment for the students to learn, and the students became accustomed to being in a single-gender classroom, they also felt more comfortable to discuss issues of more personal natures with their classmates. While the teachers were glad to see the students form this bond, especially with the cross gender between teacher and students, there were times the conversations became uncomfortable for the teachers, even if they never came close to being inappropriate.

As in most co-educational classes, many students are reticent to participate in class, many only talking if directly asked by the teacher. By contrast in the single-gender classroom, not only did most students participate in the classroom discussions, they did so without prompting. Additionally, the students were much more willing to show support for their peers in the class, particularly if the student was working at the board and had gotten stuck. In the all-boys class, another student in the class would offer support and encouragement through teasing, self-depreciation, and hints. While in the all-girls class, several other students would approach the board and coach their classmate through the problem. The single gender classrooms appeared to create supportive learning communities, a side effect we did not predict.

## VII. CONCLUSION AND FUTURE WORK

Our study suggests that there may be positive effects for both males and females taking single-gender classes in STEM fields. We saw a higher success rates in single-gender classes as compared to the co-educational classes. We also noticed that students in the single-gender classes were more willing to volunteer in class and support each other in their learning. Additionally, the students that had found success in the single-gender classes generally faired better in future math classes than those that found success in the co-educational classroom.

Our results may not show that the single-gender classroom had a statistically significant impact on the success rates of the students. Although, based on the results of the Chi-Squared Test run on the combined data, we may not have had a significantly large enough sample to draw conclusions from. In future studies, we would suggest that researchers focus not just on gender, but also social economic status and ethnicity. Additionally, we would suggest looking not just at the pass rate, but at actual grades in the analysis. Future research in this topic will need to address the issues of students who do not identify with their biological genders, which was not an issue we had to address at the time of our research.

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