

Jack and Jill Went Up the Hill, but Jill Won Both Ways: The True Story about Differential Academic Achievement

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Abstract

This longitudinal study was designed to examine how science, technology, engineering, and mathematics (STEM) project-based learning (PBL) affected the success of high school women in comparison with high school men in mathematics and science, with English performance as a control. We analysed the four-year performance, course-taking, and retention of high school students ($n = 186$) in these three subjects in a school where STEM PBL was enacted. Students' Texas state-mandated high-stakes test scores were collected. A repeated measures MANOVA was used for analysing changes in performance after infusing STEM PBL activities into their classes. The results indicated that there was a statistically significant change in scores for both men and women in mathematics and science; however, the attrition for women was much less than for men. We included implications for how to escalate women's performance and retention in STEM-based areas.

Introduction

The number of students obtaining a post-secondary science, technology, engineering, and mathematics (STEM) degree has been declining. China and India are two countries with the highest number of STEM degrees earned. The proportion of STEM degrees awarded in the United States in 2002 was below the mean for STEM degrees awarded outside the United States (Kuenzi, 2008). However, in 2015, as reported by U.S. News and World Report, 40% of bachelor's degrees earned by men and 29% earned by women are currently in STEM areas (Bidwell, 2015). The greatest source of attrition appears to begin at the high school level. Whether compared longitudinally or across countries, the scores of male students in secondary schools still exceeded the scores of female secondary students in mathematics and science. Scores from 42 participating countries in the Program for International Student Assessment showed that male students outperformed female students in mathematics and science (Van Langen, Bosker, & Dekkers, 2006). In countries where men outperformed women in mathematics and science, females performed better in reading. As found in a study by Wai, Cacchio, Putellaz, and Makel (2010), the difference between male students' and female students' performance in high school mathematics and science has considerably decreased from 30 years ago to now; however, the difference has remained stable over the last 20 years.

Women have continued to outperform men in reading over the same period. These trends may have an impact on how matriculating students choose college majors. Therefore, more studies are needed to understand gender disparity in diverse content areas and to explore factors that contribute to the underrepresentation of women in STEM areas.

Women in STEM

Although studies have shown that women's STEM achievement levels do not vary much from that of men during middle school (Royer, Tronsky, Chan, Jackson, & Marchant, 1999) and that STEM achievement might even slightly favor women during these years (Catsambis, 1994), this trend changes drastically in high school (Legewie & DiPrete, 2012; 2014). Women's high school mathematics and science course-taking choices have been found to depend on many factors. These factors include their projected career decisions, their attitudes about the subjects (Bohlin, 1994), their life aspirations (Oaks, 1990; Zeldin, Britner, & Pajares, 2008), and their social persuasions (Zeldin et al., 2008). The choice-making process for these women appears to start as early as the ninth grade, and their decisions regarding which academic classes to take often dictate the course of their high school academic path. Many women take only the mathematics courses that are required for graduation. As a result, women might choose not to pursue advanced science and mathematics subjects when these subjects become optional even if they performed better than their male counterparts in previous courses (Tyson, Lee, Borman, & Hanson, 2007). For instance, in one study by Catsambis (1994), the number of men interested in pursuing mathematics- or science-related course options was nearly double that of women. The choice to avoid taking advanced courses has severe implications for the students and the future of STEM professions, as not taking advanced mathematics and science courses, especially Algebra II, Calculus, Physics II, and Chemistry II, in high school decreased the probability of students enrolling in a STEM degree in college (Chen, 2009; Gainen, 1995; Tyson et al., 2007). Therefore, understanding this shift in achievement and interest in STEM courses during high school might be a factor to consider when addressing the gender disparity in college STEM courses.

The percentage of women entering STEM areas after high school is also much lower than the percentage of men entering these fields (Chen, 2009). Additionally, as seen in the pattern of high school course taking, after completing basic requirements in college, women again are less likely to enroll in subsequent STEM courses. For those women who do take additional STEM courses in college, the attrition rates are higher than those of their male counterparts (Oaks, 1990). Furthermore, at the college level there are few female professors in STEM fields; this fact compounds the issues faced by female students – not having a gendered role model. Preston (2004) conducted a study to determine the reasons people leave science fields and found that 100% of female students who had a mentor completed their graduate programs, whereas only 60% completed their graduate program when they did not have a female mentor. Thus, prior researchers have indicated that the combined effects of taking fewer STEM courses in high school and having fewer female role models may be two of the contributing factors to female students' college success.

According to prior research, women have navigated away from the STEM pipeline for various reasons. First, while men looked forward to mathematics lessons, women felt uncomfortable, were usually afraid to ask questions (Catsambis, 1994), and were less confident in their capability to do mathematics (Bohlin, 1994; Fouad et al., 2010). Second, historically, women were more interested in human skills and careers connected to social activities (Oaks, 1990); therefore, science and mathematics curriculum was not of interest to many of these women (Blickenstaff, 2005). Third, cultural pressures and traditional gender roles ostracized women

who pursued careers in the STEM pipeline (Blickenstaff, 2005). Furthermore, women often lack female scientists, STEM professionals, and/or STEM teachers as role models (Lam, Cheng, & Ma, 2009). However, leaving the STEM pipeline was not indicative of disinterest among women in earning a bachelor's degree; in fact, women disproportionately earned more bachelor's degrees in non-STEM fields than men (Lam et al., 2009). Mentoring programs can be efficacious in increasing awareness of the challenges of pursuing a career in STEM for female students while concurrently growing confidence and perceptions of their capacity to attain a career in STEM (Dennehy & Dasgupta, 2017; Reid et al., 2016). These attainments and supports for women, while laudatory, did not address the disparity in the STEM professions.

STEM project-based learning

When introducing STEM project-based learning (PBL) lessons in schools, student achievement results have been favorable (Erdogan, Navruz, Younes, & Capraro, 2016; Han, Rosli, Capraro, & Capraro, 2016). When teachers are motivated and excited about implementing PBL (Chalmers, 2017), student motivation has been shown to increase (Capraro, Capraro, & Morgan, 2013; Han, Capraro, & Capraro, 2014; Seet & Quek, 2010). Students showed greater interest in learning new concepts when they realized that their new knowledge would allow them to successfully complete their PBL activities (Bicer, Capraro, & Capraro, 2017; Boaler, 2008; Craft & Capraro, 2017; Oner, Nite, Capraro, & Capraro, 2016). Additionally, engaging in PBL activities has been reported to allow students to work in teams, conduct research (Kurubacak, 2007), and demonstrate and learn management skills (Ratvitz, 2008). While engaging in PBL activities, students appeared to experience increases in their intrinsic motivation as they persevered after failure, and thus their final success was more meaningful and connected to what they were learning (Holubova, 2008; Oner et al, 2016). Engaging in PBL increased learning and made it "varied and fun" (Ratvitz, 2008, p. 4) and permitted students to discover their learning with greater complexity. This process of exploration was reported to stimulate creativity (Holubova, 2008), analysis (Burlison, 2009), and success (Han et al., 2016; Johnson, 2009), ensuring vast conceptual understanding. Thus, using inquiry and cooperative learning when teaching science and mathematics through PBL activities has been shown to improve students' achievement.

STEM PBL activities require collaboration on the part of the students (Han et al., 2016). During STEM PBL activities, students engage collaboratively to work on a project and "to seek out the answers for their questions" (Seet & Quek, 2010, p. 10). While engaging in STEM PBLs, students participate in an inquiry-based methodology using experimental design to attain their final product. STEM PBL "provides the contextualized, authentic experiences necessary for students to scaffold learning and build meaningfully powerful STEM concepts" (Capraro & Slough, 2013, p.2). Students must actively participate in their own learning, leading to self-actualization and scholarly development (Capraro & Slough, 2013). Female students generally prefer complexity when they learn (Blickenstaff, 2005; Boaler, 2008). Thus, STEM PBL might encourage women to enroll in upper-level STEM subjects and pursue STEM professions.

Women and STEM PBL

Female learning patterns differ from those of men. Women do not benefit equally from conventional teaching as men do (Bohlin, 1994). As stated by Oaks (1990), "women have a greater interest in people than in things... and may respond more positively to ideas in context than in isolation" (p. 41). Thus, using cooperative learning groups and scientific inquiry was recommended to increase the number of women in science professions (Blickenstaff, 2005). Boaler (2008) proposed that women like working in cooperative groups because they believe

it allows them an opportunity to work with their classmates and increase their social skills. Thus, novel methodologies for teaching science and mathematics, such as STEM PBL, afford students with opportunities to contextually ponder about and extensively use discourse during STEM classes in a group setting. This characterizes STEM PBL teaching because STEM PBL creates an avenue for working in groups and completing real-world, context-driven projects (Capraro & Slough, 2013). Student engagement in PBL and cooperative learning has been connected to greater student motivation (Boaler, 2008; Seet & Quek, 2010) and student enrollment into higher level and more rigorous subjects (Fredricks, Hofkens, Wang, Mortenson, & Scott, 2018; Lent et al., 2018;). Additionally, upper-level course enrollment in science and mathematics has demonstrated an improvement in students' motivation to pursue post-secondary STEM pathways (Gainen, 1995). Therefore, the incorporation of STEM PBL can encourage a greater number of women to enroll in upper-level science and mathematics courses thereby preparing them for STEM majors.

Based on what the research currently states, it is important to study how the incorporation of STEM PBL in high school impacts female students' academic performance. The authors of this paper believe that the incorporation of STEM PBL will improve female students' interest in taking upper-level science and mathematics courses, which will in turn also have a positive impact on their academic success. Using longitudinal analysis, the research goal for this current study was to determine how STEM PBL affected the success of female high school students in mathematics and science longitudinally in comparison to their male counterparts. If female students are successful in upper-level science and mathematics courses, they may be more likely to pursue and persist in STEM fields.

Method

Research design

The design is a longitudinal analysis of students whose teachers participated in a 4-year-long STEM PBL professional development with a state of Texas comparison group using released data. The scores from mathematics, science, and English achievement tests were collected for four years. English was a tested subject however, unrelated to the professional development provided to the teachers. Additionally, STEM PBL was not implemented in the English classes; thus, the scores should move independently of the mathematics and science scores (see Shadish et al., 2002). If there was a strong relationship among all three scores, then it was likely that some other lurking variables were the cause. We used a non-equivalent design because all the science and mathematics teachers participated in the professional development and students in the school had the teachers with the highest levels of fidelity across indicators initially and across all four years (Shadish et al., 2002). Therefore, using the released statewide performance scores was the best indicator for comparison to examine changes in performance. Because this was a longitudinal study, we estimated attrition to be around 45%. Therefore, we used a priori power analysis using G*power (Faul, Erdfelder, Buchner, & Lang, 2009). The factors for the power analysis were set to detect a moderate effect size using a repeated measures multivariate test. The suggested sample size was 65. Therefore, we set a goal of recruiting 145 students to participate.

Teacher In-service Professional Development

The teachers participated in professional development that was presented by STEM center researchers in Texas for a sustained period of 30 days (seven hours a day each year). During year one of data collection, teachers did not participate in STEM PBL professional

development; thus, year one scores were considered baseline data. During year two, STEM PBL professional development was delivered during the summer between year one and year two and continued throughout the study period. Throughout years two, three, and four, teachers were supported in designing STEM PBL lessons and were provided feedback on their lesson plans and enactments following lesson observations by the professional development providers. Teachers were scored on their implementation using the STEM PBL Observation Instrument (Stearns et al., 2016). These high-implementing educators were examined every school year to observe the characteristics of their STEM PBL practices and given ratings, ranging from one to five, on 27 indicators distributed across six key classifications. An average score of three on each classification was measured as a typical implementation; thus, summing the averages of the six classifications, an overall rating of 18 was measured as being a typical implementation. At the end of year three, these educators were judged to be higher than average in implementing STEM PBL and were narrowly categorized across the six classifications (see Figure 1). Teachers were observed by the research team, the school administrators, and by the department chairs. However, only scores from research team members were used in computing fidelity of implementation. There was a minimum of five observations by research team members each year, with each lasting a whole day rather than a single class period.

STEM PBL activities

Students and teachers in the selected school were continuously involved in the infusion of STEM PBL from 2008 to 2010. The teachers attended a series of professional development workshops designed by researchers from the university (cf. Lang, Powell, Moore, & Ibrahim; 2018). Researchers and teachers collaborated in developing STEM PBL lesson plans and activities that focused on real-life problems relevant to the students in order to scaffold students' knowledge construction (Bicer et al., 2017; Capraro & Slough, 2013; Han et al., 2016). Each of the lesson plans provided objectives that allowed students to develop knowledge and skills in mathematics and science. An example of the lesson plans and activities is shown in the Appendix section of Han et al. (2016). Teachers integrated these STEM PBL lesson plans and activities in their mathematics or science classrooms for three to five days or more depending on the schedule. Throughout the implementation of STEM PBL, teachers acted as facilitators and supporters in helping and nurturing their students' understanding of specific basic content knowledge while accomplishing the tasks (Capraro & Slough, 2013). The students engaged in STEM PBL lessons were required to present their experiences, outcomes, and products after the completion of each activity.

Participants

The secondary school participants were in classes whose teachers possessed the highest training in implementing and presenting STEM PBL lessons. The same students were followed over the four years of their high school career, beginning in ninth grade and continuing until twelfth grade. At the time these participants were enrolled in ninth grade, their teachers had not participated in any professional development focusing on PBL, so the student participants were not exposed to STEM PBL during this year. In the tenth, eleventh and twelfth grades, however, the participants engaged in numerous PBL lessons during their science and mathematics classes. During year one of data gathering, when the participants were in ninth grade, there were 186 participants total. Due to the large district attrition rate, only 127 participants attended the school for their entire high school career. Of the 127 participants who remained at the school for all four years, 24 were missing scores for certain years and thus were removed from the current study. The ending sample size contained 103 participants (52 women and 51 men). This sample exceeds the necessary sample size as determined in the a priori power analysis.

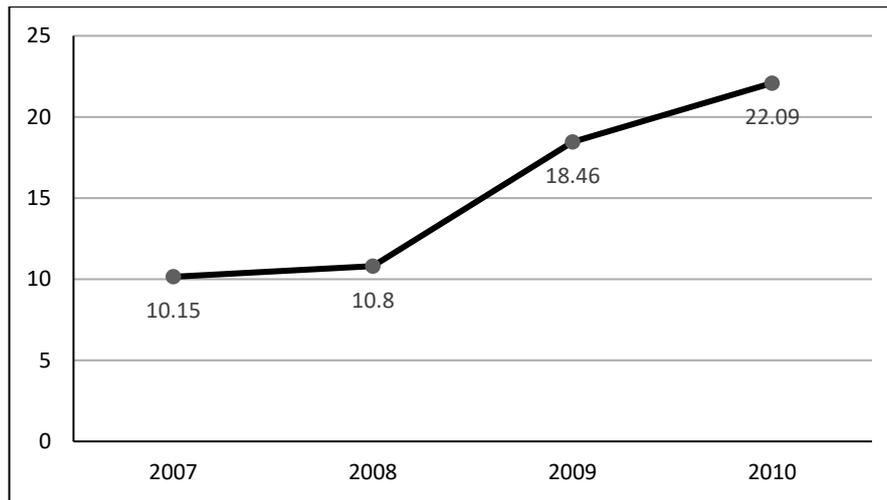


Figure 1. The longitudinal mean scores across categories for teacher fidelity to STEM PBL instruction.

Instrument

Students were administered the Texas Assessment of Knowledge and Skills (TAKS) at the end of each year. The TAKS examination was utilized as the research instrument that provided empirical data from the years 2007 to 2010. The test was used because the subscales measured the same content taught by the teachers and was sufficient to estimate student performance, course-taking, and retention. Students take the mathematics portion of the test each year starting in grade 3 and complete the test every year thereafter until grade 10; after grade 10, students must pass the exit level test of the TAKS in either grade 11 or 12. Students take the science portion of the test in grades 5, 8, and 10 and in the exit level test (either grade 11 or 12). Students take the English portion in reading from grades 3 through 9 and in reading and writing (ELA [English and Language Arts]) in grade 10 and in the exit level test (either grade 11 or 12). In mathematics and science, the test items are multiple-choice items. On the 10th grade and exit level ELA tests, two additional question formats are included: a) open-ended short-answer questions and b) a written composition. None of the tests are timed, so students are permitted the time they need to complete the test, and some even stay after regular school hours to finish. Seniors are required to pass the exit level test in order to graduate from high school (Texas Education Agency, 2004).

Procedures

Mathematics, science, and English state-mandated high-stakes test scores were collected for each of the students from 2007 to 2010. The study was a longitudinal design with extant groups using multiple time point measures. There were three time points for mathematics and English and two for science. Students can take their exit level tests in grade 11; as a result, a large number of students did not have scores for grade 12. Therefore, grade 12 scores were not included in the study. In addition, because there is no state test for science in grade 9, science scores for grade 9 were also not included. Consequently, state test scores in mathematics and English were collected for grades 9, 10, and 11, while state test scores in science were collected for grades 10 and 11 only. English scores were included to provide a basis for comparison because STEM PBL was not enacted in these classrooms and the STEM professional development did not focus on English learning objectives. Shadish, Cook, and Campbell (2002) contended adding a non-equivalent dependent variable, in our case English scores, would

improve the cohort designs. Therefore, changes in English scores should not mirror any changes in mathematics and science scores, and the graphs should appear differently if STEM PBL had an impact on mathematics and science achievement but not on English achievement. As such, it was expected that changes in mathematics and science would be uncorrelated with changes in English scores when the changes are attributable to the STEM professional development, given that no professional development was provided for English. The school's yearly roster was used to calculate each year's attrition rate for the original sample of 186 students. The procedure used matched students' names for each two consecutive years, which resulted in the percentage attrition for female and male students. The diagram below illustrates the intervention and data collection scheme.

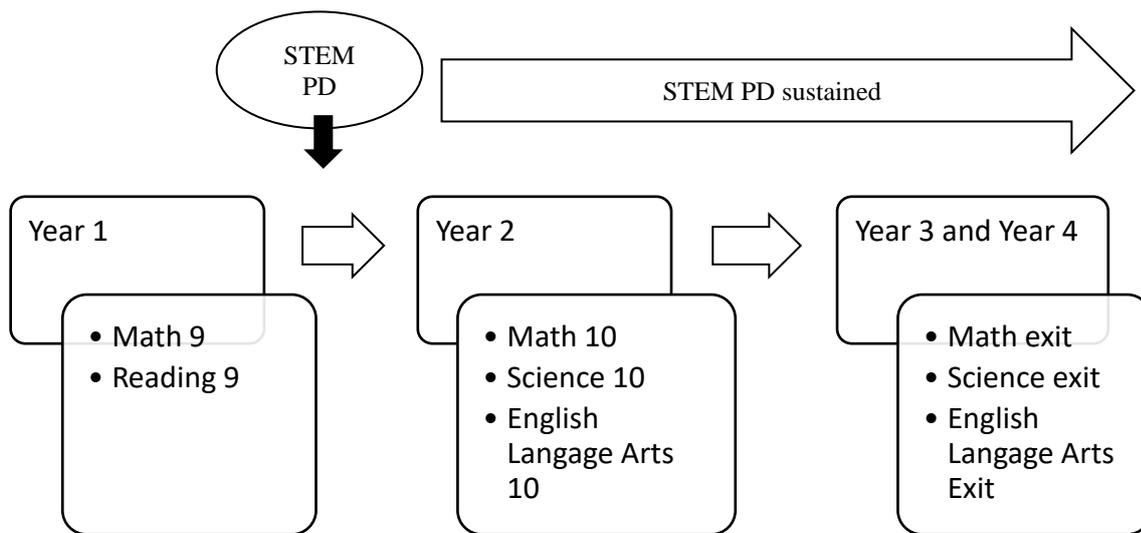


Figure 1. The intervention and data collection scheme.

Results and Discussion

Change in scores

To determine the extent of the change in scores across time for science, mathematics, and English, a MANOVA with repeated measures was used. For both male students ($p_M < .001$; partial $\eta^2 = 73\%$) and female students ($p_F < .001$; partial $\eta^2 = 65\%$), there was a statistically significant change in mathematics performance across time. The partial eta squared effect sizes were large and indicated meaningful gains (Capraro, 2004; Capraro & Capraro, 2002) in mathematics learning. Seventy-three percent of the variation in mathematics performance was accounted for by being male and 65% by being female. Based on the repeated measures MANOVA, the means were statistically significantly different across time ($\bar{X}_{F_{2007}} = 33.7$; $\bar{X}_{F_{2008}} = 36.6$; $\bar{X}_{F_{2009}} = 41.3$; $\bar{X}_{M_{2007}} = 34.5$; $\bar{X}_{M_{2008}} = 36.9$; $\bar{X}_{M_{2009}} = 43.8$). Prior to the introduction of STEM PBL, male students slightly outperformed female students; however, after a year of the intervention, the means of the two groups were nearly identical. In the final year of the study, the two groups grew apart, with male students slightly outperforming female students. However, the difference was not statistically significant (see Figure 3). The graph of the state data shows that on average students in the state outperformed the treatment group at the onset and remained fairly consistent across years, with state male students' scores and female

students' scores showing little difference at the end. The observed differences are likely unremarkable.

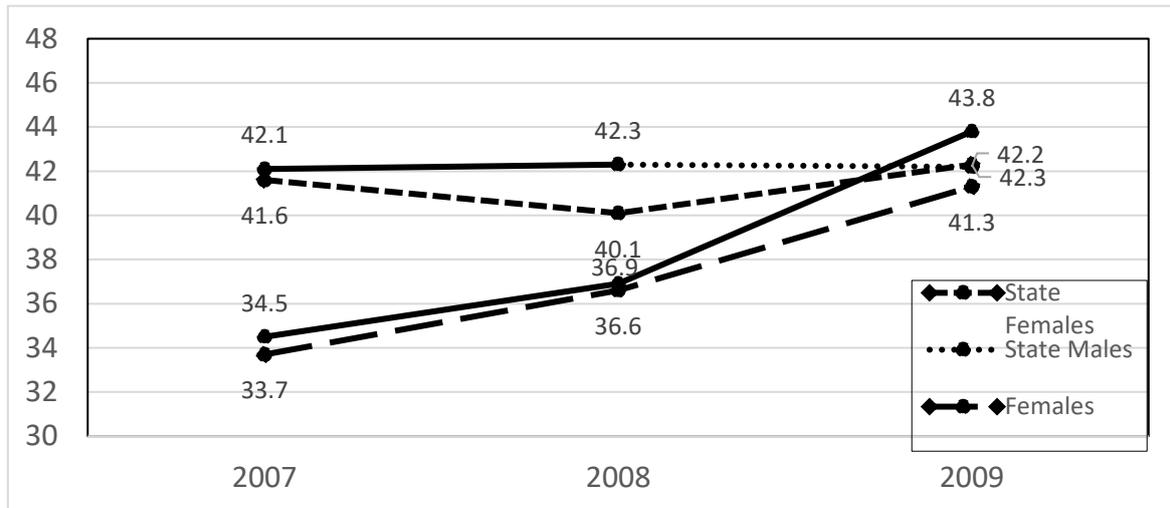


Figure 3. Longitudinal Mathematics mean scores by gender.

There was a statistically significant change in science scores for both female students ($p_F < .001$; $\text{partial } \eta^2 = 28\%$) and male students ($p_M = .044$; $\text{partial } \eta^2 = 7.9\%$). Most importantly, the effect sizes were large and indicated a narrowing of the knowledge gap, which was accomplished by narrowing the variance within female students' scores. The effect was nearly three times that of male students', another important metric for interpreting effect size. The longitudinal performance for male students was statistically significant; however, the effect size was modest and does not seem to exceed performance gains one might expect longitudinally. The slopes for both groups were positive, while the slope for female students was steeper, indicating a closing of the performance gap. While female students' scores increased more rapidly, male students continued to outperform them (see Figure 4). The state data shows a relatively stable performance with negligible differences that are likely attributable to measurement error. The slight decline is not remarkable.

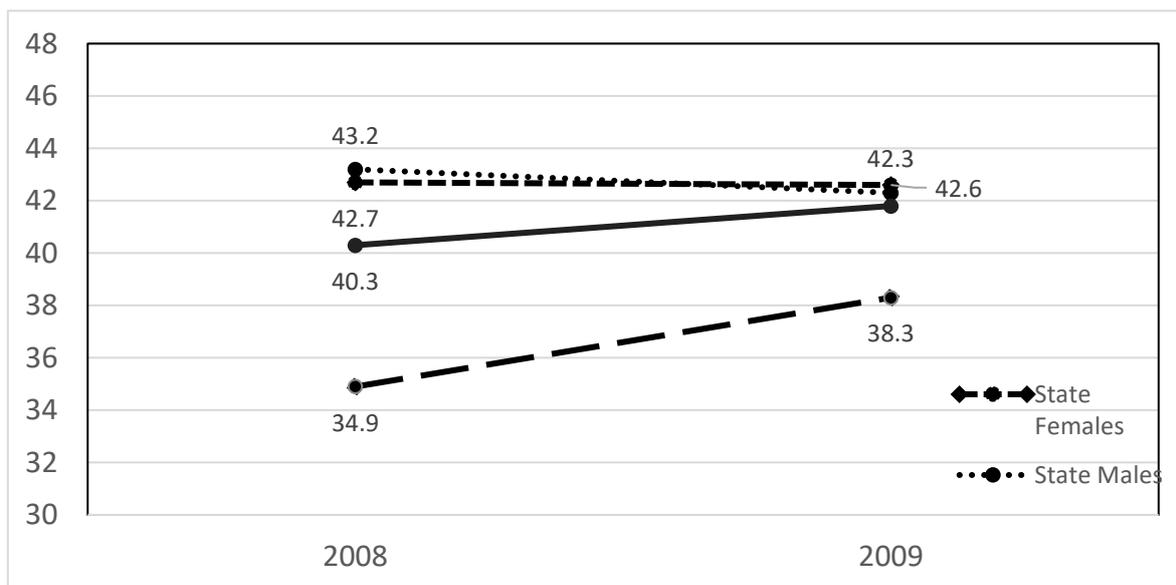


Figure 4. Longitudinal Science mean scores by gender.

The English scores for both groups were statistically significantly improved over time ($p_F < .001$; $partial \eta_F^2 = 96\%$; $p_M < .001$; $partial \eta_M^2 = 85\%$). The mean changes in year one were strongly positive yet nearly equal across both genders. In the third year, the changes in scores were again similar; however, male students' scores increased slightly more ($\bar{X}_{M_{2007}} = 32.3$; $\bar{X}_{F_{2007}} = 32.0$; $\bar{X}_{M_{2008}} = 46.1$; $\bar{X}_{F_{2008}} = 46.4$). The change, however, was not statistically significant (see Figure 5). One factor that might account for the erratic pattern may be attributable to changes in testing format. Regardless, there was no meaningful difference in performance by gender nor is the change correlated with the observed changes in mathematics and science. The state scores are both stable and similar with the observed performance of the treatment group. STEM PBL was not active in the English classes, meaning that English scores were independent of mathematics and science scores.

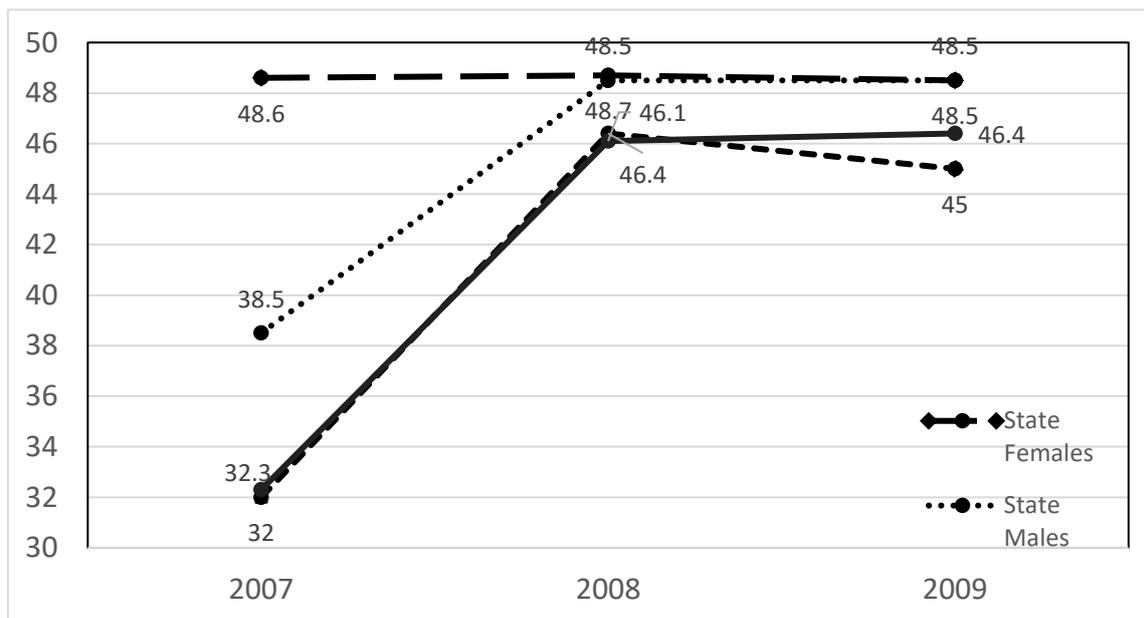


Figure 5. Longitudinal English mean scores by gender.

The English test changed from reading to an English Language Arts focus. In grade 9, the test primarily consisted of reading short passages and choosing the correct answer from a set of multiple-choice responses. However, in grade 10, the test was used to examine both reading and writing, and multiple-choice items were replaced by essay-style short answers and a five-paragraph expository composition. The subjective nature of these short questions and composition sections might help students improve their scores because they can receive partial credit on this grade-level test, which was not possible on previous tests.

The validity construct of maturation states that by simply living an organism changes. This change is a threat to validity and, when uncontrolled or without any reasonable estimator, can make the best designed study yield fallible results. However, we believe that maturation is not likely to be a factor accounting for the observed changes in the mathematics and science scores of female students in the current study. The test was designed to yield the same score when students gained one year's knowledge. In other words, a student scoring a 32 in one year and a 32 in the next year was said to have made one year's progress even though the score did not change. Had a student scored a 32 in one year and a 36 in the next year and the standard deviation was 8, the student would have increased academic performance by 1.5 years. Therefore, maturation would likely have resulted in just a single year's growth and not an increase in the rate of learning as seen in both the mathematics and science scores. As such, we

conclude that maturation is not likely responsible for the observed changes. Had maturation been the contributing factor, then progress would have been stable and reflected one year's growth (see mean performance across years for the state scores). In addition, effect sizes increased remarkably and so did the slopes for female students' scores across both science and mathematics. STEM PBL activities were used only in mathematics and science classes but not in English class and the English teachers were not provided with professional development in STEM PBL. Given that the state scores remained relatively stable across years, our argument has broad support in the overall data pool.

One possible explanation for the observed changes in science and mathematics scores can be attributable to STEM PBL, as there were no other school-level innovations or activities implemented at the school during these four years. The school focus was on the implementation of the STEM PBLs and the concerted effort to improve teacher implementation from lesson to lesson (Capraro & Slough, 2013). Moreover, because of the incremental improvements, the STEM PBL activities were more refined and carefully implemented (Capraro & Slough, 2013). Students also became very accustomed to the learning style and expectations. The combination of teacher expertise and students fully understanding what was expected of them likely led to the obtained effect (Bicer et al., 2017; Han et al., 2014; 2016). Perhaps the level of teacher pedagogical expertise and student educational experiences coalesced to yield the results. Because STEM PBL relies on high degrees of communication and peer-to-peer interaction through collaborative work (Bicer et al., 2017; Capraro et al., 2013; Han et al., 2014), it is also possible that prior gaps in content knowledge were incidentally addressed through the requisite conversations to achieve grade-level competencies. Perhaps this incidental learning, which may have filled educational voids from prior years, is also accountable for some of the obtained effects. It is additionally difficult to disentangle the effect that the on-going professional development and classroom observations had on the outcome (Capraro et al., 2013; Capraro & Slough, 2013). Perhaps the external influence of professional development providers and lesson observers had an important effect on the obtained results. The slopes for both groups in English scores differed from the longitudinal changes observed in both science and mathematics. Therefore, the foundational causes responsible for the changes were different for mathematics and science as compared to changes in English scores. This provides some level of support for the claim that the change observed in the mathematics and science scores were likely attributable to the intervention (Han et al., 2016).

Course taking and retention

All students took Chemistry, Biology, Algebra I, Algebra II, and Geometry. Approximately half of the students chose to take Integrated Physics and Chemistry, 51% of the female students and 50% of the male students. Only 16% of the male students chose to take Physics, while 42% of the female students took Physics. Sixty percent of the female students and 68% of the male students enrolled in Pre-Calculus, whereas, 16% of female students and 26% of male students took Advanced Placement (AP) Calculus. Female students participated slightly more heavily in Advanced Placement Biology (15%) as compared to their male counterparts (14%; see Figure 6).

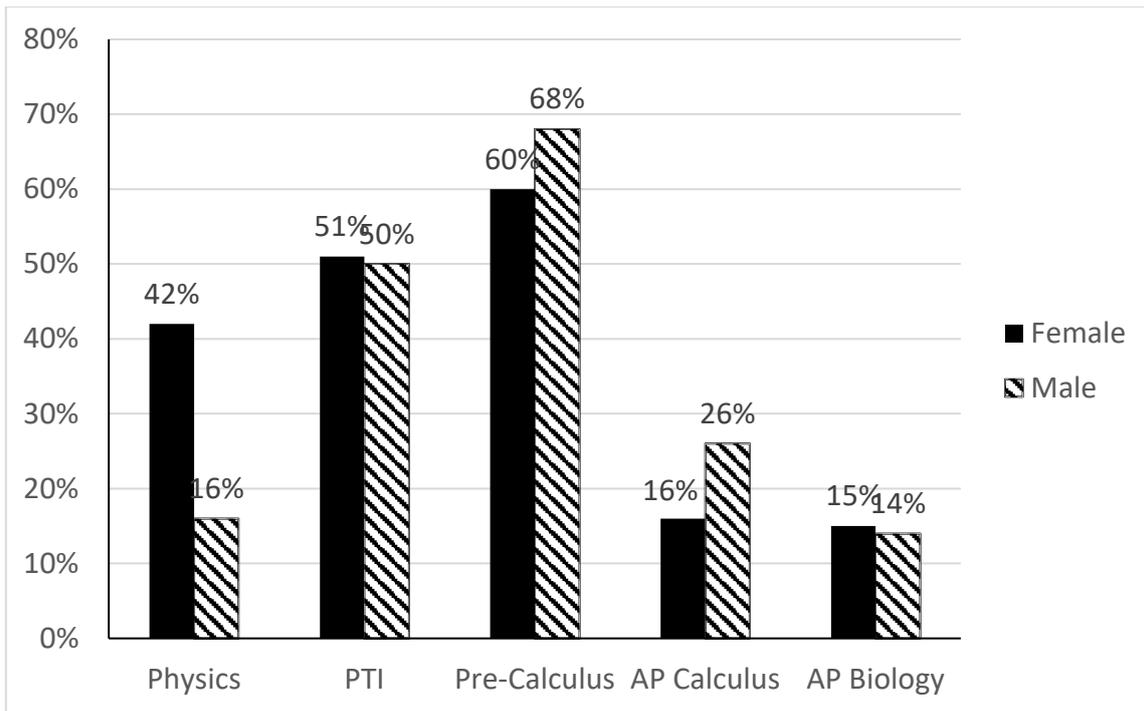


Figure 6. Course taking by gender.

School retention favored female students. Across time, female students were retained at a greater rate than male students (see Figure 7).

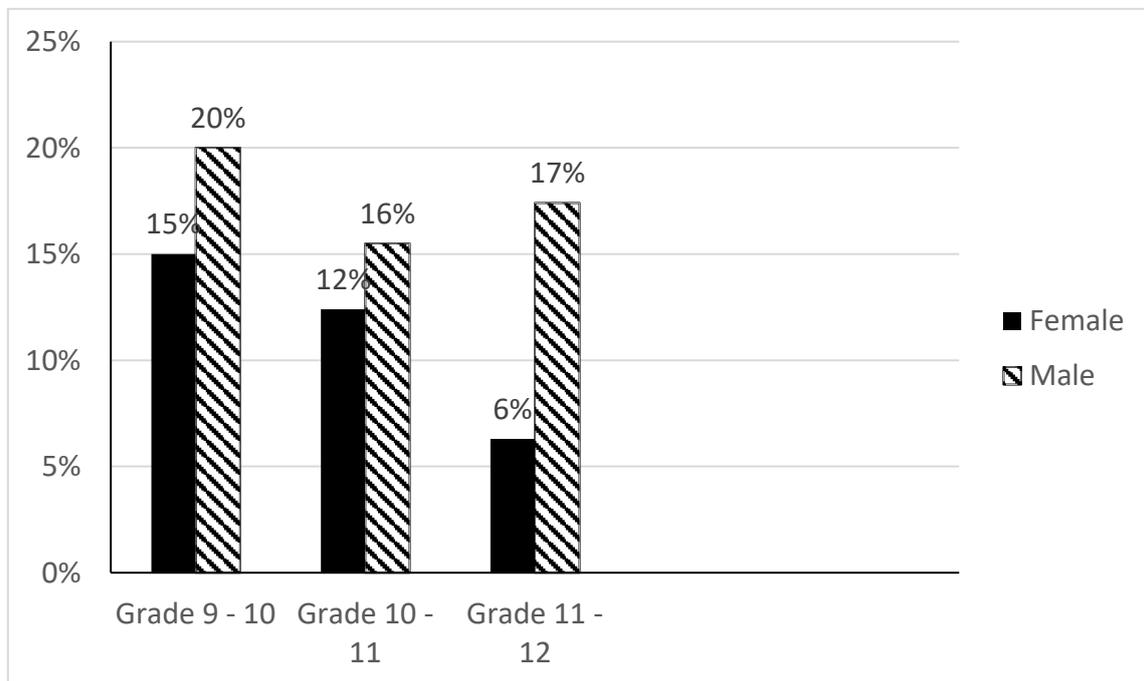


Figure 7. Longitudinal attrition by gender.

There were 186 students at study inception. The four-year retention rate was good, with 127 students present for all four years of the study. Fifty-nine students left the study by the end of four years; many of them ($n = 34$) left in the first year. The remaining 24 left over the course of the last three years, or about an average of 8 per year.

To compare the results obtained in this study to the broader literature, we used an article recently published (Kraft, 2020). The benchmark effect sizes used to evaluate the effect of pre-K–12 educational interventions on educational achievement are the following: small—less than 0.05, medium—less than 0.20, and large—greater than 0.20. Kraft (2020) based these on over 700 studies reporting 1,942 effect sizes from educational interventions. We converted our partial eta squared effect sizes to the Cohen's d metric (see Cohen, 1988). For mathematics, the Cohen's d effect size was 3.464 for male students and 2.726 for female students. For science, the Cohen's d effect size was 0.586 for male students and 1.247 for female students. Thus, the effect sizes reported in our study are considered large because they are greater than 0.20. It has been argued that STEM PBL activities might contribute to the retention of women in high school (Blickenstaff, 2005; Boaler, 2008; Oaks, 1990). The percentage of female participants who left high school declined over the years after the implementation of STEM PBL. One could argue that many students who lost interest in high school and left did so after their first year. However, the percentage of attrition for male students leaving the high school in the current study was constant and greater than female student attrition. When considering female student attrition, there was a consistent decrease across time, and female students also took substantially more mathematics and science courses even after satisfying graduation requirements.

Conclusion

The research literature indicated that women were usually found to outscore men in English, while men usually performed better in mathematics and science. In the case of this study, although the men outperformed the women in science, the women's scores improved substantially more than men's scores. This improvement shows that the experiences of the treatment group narrowed the difference between female students and male students in science and increased their performance relative to the state scores. In English, though, the men's scores improved more than the women's scores, but not to a practically important degree. These analyses in total show that female students' scores did not show the changes predicted from the literature. Furthermore, the attrition of female students declined over the years. Whether STEM PBL was the direct factor for the increase in scores and a decrease in attrition cannot be answered by this study alone, and many more studies need to be conducted with different samples and sampling strategies to be able to isolate this finding. Research on strategies aimed at increasing women's interest in STEM careers continues, with much focus on attempting to reduce the gap in STEM course enrollment between men and women and female attrition in the STEM pipeline. This study sheds light on how infusing STEM PBL in classrooms might help with narrowing the enrollment gap and reducing the attrition of women in STEM. Additional quantitative and qualitative studies are needed that follow women who are exposed to STEM project-based learning through tertiary education.

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