# STEMinism: Evaluating the Attitudes of Middle-School Girls Towards their STEM Abilities in an All-Female Environment

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**ABSTRACT**

This thesis attempts to better understand the attitudes and motivations that drive middle-school girls to enter Science, Technology, Engineering, and Mathematics (STEM). By both examining the mindsets of middle-school girls as they age and measuring what factors encourage them to enter STEM, this thesis attempts to unearth the key factors necessary to encourage young women to enter STEM in hopes of tackling the lack of gender diversity that currently persists in STEM fields. Analyzing middle-school children is especially important because many of the opinions that individuals develop about themselves and society are solidified during these formative years. Using original data collected from The Hamlin School, a K-8 all girls' school in San Francisco, I examine the responses of eighty-nine middle-school girls in response to a survey they completed regarding their attitudes towards their abilities in STEM. This is the first paper to make use of this data set and serves as a motivator to understand why fewer women choose to study STEM fields and pursue STEM-related professions. The results gathered suggest that proper role models, specialized and early intervention to help raise female self confidence in STEM are necessary because of the impact societal beliefs have on such girls over time. Moreover, one of the novel findings of this thesis is that there are factors beyond one's environment contributing to the lack of females in STEM as this thesis eliminates the role of having boys in the classroom as a factor in diminishing female confidence as many other studies suggest.

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[1] I would like to express extreme gratitude towards my advisor David Card for his guidance and wisdom during the creation of this thesis, as well as towards The Hamlin School for their unwavering support and dedication to improving the experience of young girls in STEM.

**Contents**

# I. Introduction and Literature Review

## Introduction and Literature Review

Few would question the undisputable progress and success of women in contemporary society. Indeed, women now make up the majority of graduates in law, education, medicine and several other professional programs. Despite this progress, females continue to lag behind to a staggering degree in one area, Science, Technology, Engineering, and Mathematics (STEM). Not only are there fewer women taking STEM classes at lower levels, but at the professional level there are fewer women entering industry level STEM-related jobs. Having fewer women in these fields is especially problematic as advancements in technology are creating a surplus of STEM job opportunities around the world, which need to be filled by all parts of the population in order to create successful and sustained economic growth. Moreover, the lack of women in STEM at all levels is harmful not only economically, as women make up half the population and therefore possess a lot of potentially untapped talent, but also socially, because it perpetuates gender stereotypes that create a culture lacking in diversity of thought and ability.

Although women today are choosing to study topics in Science, Technology, Engineering, and Mathematics (STEM) at higher rates than ever before in history, the number of women entering into careers in STEM has remained drastically smaller as compared to their male counterparts (Corbett and Hill 2015). According to the U.S. Department of Commerce, Economics and Statistics Administration, even though women make up 47% of all jobs in the United States, they hold only 24% of STEM-related jobs and make up only 30% of all STEM degree holders, which is a troubling statistic because of the continual development of new technology and high demand for STEM-based jobs in our society (Noonan 2017). Despite this disparity, many would be surprised to learn that although women on average perform just as well as men in areas like math, they still pursue fields in technology and mathematics at drastically lower rates (Hill et al. 2010). So, one might ask, what *is* holding women back from pursuing STEM*?* Several research studies reveal that gender bias and the impact of stereotypes are to blame for the increasing gender gap (Corbett and Hill 2015). Interestingly, "girls seem to learn stereotype bias in school. For instance, Cvencek, Meltzoff, and Greenwald (2011) reported that by second grade, both boys and girls had implicitly associated the word 'math' with [the] category 'males'" suggesting that the longer students are in school, the more entrenched these stereotypes become (Kahn and Ginther 2018). Not only do these biases impact the way women think and feel about their own performance, but they also forecast their own economic potential as women in STEM-related jobs have been found to earn 35% more than women in non-STEM jobs (Noonan 2017).

Additionally, when looking at the U.S. on the global stage, many researchers recognize a "critical need for 'broadening participation' in STEM fields, to increase…talent…and keep the United States competitive…in innovation, and discovery" as compared to other prominent countries (Sekaquaptewa 2011). This fact underscores the need for more women in technology. Yet, even when women do perform well in STEM fields, they still often discredit their own skills or ability, as the "lack of other women or biased treatment of women, lead women to spontaneously discount the successes of women's successes in science," demonstrating the implicit bias that further perpetuates the lack of women in STEM (Sekaquaptewa 2011). Studies also show that women experience "lower self-efficacy for STEM careers and…lower social belongingness," meaning that they perceive themselves as not belonging in the STEM arena due to a lack of belief in their own potential (Tellhed et al. 2017). Furthermore, American elementary schools show that even at early ages, "girls rate their own ability lower than boys," revealing how deeply entrenched current attitudes and beliefs about women have become (Fredericks and

Eccles 2002). In order to change female attitudes in STEM it is therefore imperative to recognize just how early these thoughts develop and how long they persist.

Aside from social aspects that determine female attitudes about STEM, role models have been demonstrated to play a significant role in the development of female attitudes and performance in STEM. Specifically, "Antecol et al. (2015) found that primary school girls randomly assigned to teachers got better math scores if taught by women rather than men," suggesting that female role models in STEM have a significant influence on the performance of young women (Kahn and Ginther 2017). Furthermore, even above the gender of the teacher, the fact that "girls and women perform less well than boys and men in competitive environments…[especially] when it comes to competing against boys and men" is a further testament to the need for women in STEM fields, where the culture is notoriously competitive, in order to shift the workplace norms in STEM professions (Shurchkov and Eckel 2018).

Therefore, given the current need for women in STEM and existing attitudes and biases towards females in STEM fields, this paper investigates the opinions and beliefs of $5^{th}$, $6^{th}$, $7^{th}$, and $8^{th}$ grade students at an all-female, private school with regards to several STEM areas including mathematics, science, and technology. This paper will analyze the survey responses received from these children as a means to better understand how middle school girls schooled in a supportive all-female environment, measure their own ability and success in STEM. Additionally, by analyzing these responses, this paper hopes to reveal several areas of improvement to help eradicate the gender disparity in STEM in the future. While it is true that there is significant change that must occur in this area in order to improve gender ratios in STEM at all educational and professional levels, this paper hopes to offer the beginning steps towards progressing in a positive direction for women in STEM.

## Hypothesis

In examining the experimental results, I will strive to answer three main questions:

I. *How do the attitudes of female students in STEM change from 5th to 8th grade?*

II. *What influence do external factors, such as having an older sibling or close family member in STEM, have on one's desire to pursue STEM in the future?*

III. *Does being in an honors math track change female self-confidence about math and the probability of pursuing STEM in the future?*

In terms of the first question, I hypothesize that in older grade levels, students will be more influenced by societal stereotypes and as a result, demonstrate more negative attitudes towards their abilities and potential in STEM. I hypothesize that the effects of these social stereotypes may be smaller in an all-female environment. Thus, any measured decline in attitudes and self confidence in my sample is likely to represent a lower bound on the declines that occur in other, less supportive environments.

In terms of the second question, I hypothesize that having an older sibling or family member in STEM will positively affect a girl's desire to enter STEM and provide confidence in her STEM abilities. Because mentorship is crucial at such a formative age, I expect that these girls will feel more supported and thus demonstrate a more positive outlook about their potential in STEM.

Lastly, in terms of the third question, I hypothesize that girls in the honors math track will show an increased desire to enter STEM and exhibit increased confidence in their skills in comparison to those in a non-honors math track. Not only will these girls be exposed to more advanced material, but I expect that their higher performance will result in higher confidence.

## III. Experimental Design

### Background

The survey was conducted at The Hamlin School, a private all-girls school in San Francisco, California. The 150-year-old school teaches kindergarten through eighth grade and has a total of approximately 400 students annually. The mission of The Hamlin School is to "educate girls to meet the challenges of their time," as the school emphasizes the importance that young women can accomplish anything they desire (https://www.hamlin.org/page).

Specifically, in terms of their educational model, The Hamlin School focuses on teaching its girls "critical thinking and problem solving, effective oral and written communication, collaboration, and creativity" (Hamlin 2019). Due to the emphasis of technology in the 21st century, the school has a particularly strong emphasis on STEM, while offering classes in science, technology, and mathematics. As a result, the girls at The Hamlin School develop and evolve surrounded by messages promoting women in STEM and their limitless potential.

### Administration of Survey

Data was collected by surveying 89 of the 194 potential middle school students at The Hamlin School with an online survey modeled off of The Friday Institute *Student Attitudes Toward STEM (S-STEM) Survey - Middle and High School Students,* a survey created to help assess how students evaluate their own ability and potential capability in several STEM areas (S-STEM Survey 2012). The survey was created off of the S-STEM Survey because of its appearance in other science-related research and well-respected format. In order to distribute the survey, grade-level teachers in 5th, 6th, 7th, and 8th grade administered the survey to each of the grades separately and students were given as much time as they needed to complete the survey.

The survey itself was broken up into three main categories: ranking your opinion, where students were asked to rank their attitudes towards statements, self-reflection, where students answered questions about their own perception of their abilities, and family reflection, where students were asked to reflect on their families. Students were asked questions about science, technology, engineering, and mathematics. Many of the survey questions were based off of the Likert scale, where students were given the option to respond with *Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, or Strongly Agree* to a given statement. Other questions were formatted with Yes-No responses or a variety of answers from which students could select.

After collecting the survey results, individual rankings were obtained from The Hamlin School administration for each of the students to be used in the data analysis. Rankings were determined by first using students' current grades, and then accounting for common assessments, teacher assessments, ERB scores for grades $5^{th}$, $6^{th}$, and $7^{th}$, and school-wide math competition scores, known as *Math Olympiads*, in order to settle any idiosyncrasies.

## III. Results

***How do the attitudes of female students in STEM change from 5th to 8th grade?***

The first question we examine when looking at the data is: *How do the attitudes of female students in STEM change from 5th to 8th grade?* Notably, there were several significant results that emerged when looking at grade comparisons. When analyzing the results of the survey, I first created three indices, *math_index, science_index,* and *techeng_index,* which captured the girls' response on a Likert scale towards positive and negative statements about math, science, and technology/engineering respectively. Each student could have a minimum value for each index of 0 and a maximum value of 1. When creating the indices, statements such as "I can get good grades in math" or "I am sure of myself when I do science" were considered positive, and statements such as "Math is hard for me" or "I can handle most subjects well, but I cannot do a good job in science" were considered negative in calculating the indices. As a result, the indices were calculated as the following:

$$math\_index = (-m1n + m2n - m3n + m4n - m5n + m6n + m7n + m8n)/ 8$$

$$science\_index = (s1n + s2n + s3n + s4n + s5n + s6n + s7n - s8n + s9n)/ 9$$

$$techeng\_index = (et1n + et2n + et3n + et4n + et5n + et6n + et7n + et8n + et9n)/ 9.$$

I then compared these indices by grade to determine whether students harbored different attitudes according to their age.

As can be seen in Figure 1, the *math_index* demonstrates a large decrease between 6$^{th}$ and 7$^{th}$ grade, which is evident by the fact that the average *math_index* in 7$^{th}$ grade starts nearly below the 90% confidence interval in 6$^{th}$ grade, or below the bottom whisker of the 6$^{th}$ grade bar. Interestingly, however, according to Figure 1, it can be seen that the *math_index* level appears to level off to about 0.4 by 8$^{th}$ grade, but it still appears lower in 7$^{th}$ and 8$^{th}$ grade than in the preceding years. Turning to Table 1, this table confirms that the biggest difference is between 6th and 7th grade with a P-value of 0.218, but since P is still greater than 0.1, the results are not statistically significant at the 10% level, although they are very close to being noteworthy.

Next, looking at Figure 2, it can be seen that the *science_index* increases slightly by grade, with a small decrease in 8th grade. None of the results appear to be statistically significant from the graph, but the largest difference between grades appears to be between 5th and 7th grade. Interestingly, the graph shows that each grade seems to have a similar mean for their *science_index*. Turning to Table 2, it is evident that the largest difference between grade is between 5th and 7th grade with a P-value of 0.378, but since the P-value is greater than 0.1, the results are not statistically significant at the 10% level.

Looking at Figure 3, it can be seen that *techeng_index* appears the greatest in 6th grade and then appears to level off by 8th grade at a mean of about 0.35. The largest gap between grades appears to be between 6th and 7th grade, which can be seen by the fact that the mean of the 7th grade index nearly starts below the 90% confidence interval of the 6th grade. Table 3 confirms this result as it shows the biggest difference between grades is between 6th and 7th grade which have a P-value of 0.217, which is only slightly larger than 0.1 and therefore nearly statistically significant at the 10% level.

In addition to looking at the above binary indices, I also calculated another binary index, the *attitudes_index* which was the average of the girls' attitudes on several gender-based statements related to their ability in STEM. For example, one of the assertions was "Men are better than women at math" was calculated as a negative index value when averaging the statements. In Figure 4, it can be seen that the *attitudes_index* appears to decrease over time, with the largest difference between grades being between 5th and 8th grade. Looking at Table 4, the pairwise comparison of means for the *attitudes_index*, the P-value for the difference between 5th and 8th grade is 0.074 and therefore less than 0.1, demonstrating that the results are statistically significant at the 10% level. When comparing 6th and 8h grade the results are also nearly statistically significant at the 10% level given that $P = 0.104$ and is therefore almost less than 0.1. Thus, the trend appears to be that as the grade level increases, the *attitudes_index* decreases, suggesting that as girls become older, their attitude towards their gender and corresponding abilities in STEM seemingly decreases.

Lastly, in order to thoroughly summarize the difference in STEM confidence between grades, I also created a summary index called the *STEM_index,* which was calculated as:

$$STEM\_index = (math\_index + science\_index + techeng\_index)/3.$$

Using the *STEM_index* to compare the values among the girls, I divided the students into two groups: high rank and low rank. The *high_rank* group consists of the girls with $rank > rank\_median$ and the *low_rank* group consists of girls with $rank < rank\_median$. Turning to Figure 5, it can be seen that for all grades except for the 8th grade the difference between the *high_rank* group colored red and the *low_rank* group colored blue is statistically significant at the 10% level. As a result, it appears that on average, the *high_rank* group reports a higher *STEM_index* than the *low_rank* group. Interestingly, as can be seen in the figure, the gap between the two groups becomes relatively smaller over time, converging to an average value by the 8th grade where there is essentially no gap between the two groups at all. Additionally, the mean of the *STEM_index* appears to decrease over time, which is illustrated by the fact that the height of the bars and therefore the average *STEM_index* lowers as the grade level increases.

In order to fully examine all of these indices, I also generated descriptive statistics of each index by grade that can be seen in Table 8. Looking at the descriptive statistics for

*STEM_index* in more detail, one can see that the 5th and 6th grade means are the highest at 0.3124143 and 0.3699074 respectively, with the mean for 6th grade being the overall highest. After the 6th grade, the *STEM_index* drops off in the 7th grade to 0.2956924 and levels out slightly in the 8th grade to 0.3040123. Therefore, there appears to be a general downward trend in the STEM_index as grade level increases, indicating that STEM confidence decreases with age. The rest of the indices can be studied more carefully in Table 8, which reveals grade level trends like that the *math_index* is highest for 6th grade, the *science_index* is highest for 7th grade, the techeng_index is highest for 6th grade, and the *attitudes_index* is highest for 5th grade.

In addition to examining the *STEM_index* for each grade, I also regressed the *STEM_index* on whether students had a family member in STEM captured by the binary variable *family_in_STEM,* and on their rank, captured by the variable *rank,* resulting in the regression equation $STEM\_index_i = \beta_0 + \beta_1 rank_i + \beta_2 family\_in\_STEM_i + \varepsilon_i$. Looking at the 5th grade regression results, one can see that the coefficient on *rank* is negative 0.0066711 and is statistically significant at the 1, 5, and 10% significance levels since P is less than 0.01. The coefficient on *family_in_STEM* is positive 0.1255999 and is statistically significant at the 10% significance level since P is less than 0.1. These results suggest that students with a lower rank have a higher level of STEM confidence and that having a family member in STEM results in a higher level of STEM confidence. Similar analysis can be completed for grades 6, 7, and 8. Notable trends of this regression are that grade 7 had the largest negative coefficient on *rank*, which was statistically significant at the 1, 5, and 10% significance levels since P is less than 0.01. Additionally, the largest coefficient on *family_in_STEM* was found in grade 8 and was approximately statistically significant at the 10% significance level since P is less than 0.1.

***What influence do external factors, such as having an older sibling or close family member in STEM, have on one's desire to pursue STEM in the future?***

The second question we look to when examining the collected data is: *What influence do external factors, such as having an older sibling or close family member in STEM, have on one's desire to pursue STEM in the future?* Specifically, in order to answer this question, I performed several regressions on *STEM_classes_index.*

$$STEM\_classes\_index = (math\_class + science\_class + engtech\_class)/3$$

Each of the class variables is a binary variable that captures whether a student indicated an interest in taking classes in that STEM area in the future. As a result, the *STEM_classes_index* captures the average interest a student has in pursuing STEM classes after middle-school. The regression of the *STEM_classes_index* on the variable *older_sibling_STEM*, which captures the causal relationship between having an older sibling in STEM on a student's desire to pursue STEM in the future, resulted in a positive coefficient of 0.1428063 that was statistically significant at the 5 and 10% significance levels since P is less than 0.05. Next, I ran a regression of the *STEM_classes_index* on the variables *parent_scientist*, *parent_engtech*, and *parent_math*. Each of the parent variables is a binary variable that represents whether a student has a parent in the corresponding field. This regression resulted in positive coefficients for all three parent variables, but was only statistically significant for *parent_math,* which was significant at the 5 and 10% significance levels since P is less than 0.05.

In addition to looking at the effect of having a family member in STEM on a girl's desire to pursue STEM classes in the future, one can also look at how having a family member in STEM impacts a girl's confidence in STEM, using the variable *STEM_index* computed previously. Specifically, one can examine whether girls with higher rank have increased STEM confidence and whether girls with higher rank and family members in STEM have the highest STEM confidence. To create this regression, I regressed the *STEM_index* on three variables: *high_rank*, *family_in_STEM*, and an additional created variable, *hr_family,* in order to capture the causal effect by grade of having a family member in STEM on high rank students. In order to compute this regression, I calculated *hr_family* as the following:

$$hr\_family = high\_rank * family\_in\_STEM.$$

The multivariate regression equation can be written as $STEM\_index_i = \beta_0 + \beta_1 high\_rank_i + \beta_2 family\_in\_STEM_i + \beta_3 hr\_family_i + \varepsilon_i$. Looking at the regression results, one can see that grade 6 had the largest positive coefficient on *high_rank* of 0.4027778, which was statistically significant at the 1, 5, and 10% significance levels since P is less than 0.01 and the largest positive coefficient on *family_in_STEM* of 0.2021605, which was approximately statistically significant at the 10% level since P is close to less than 0.1. Grade 7 had the largest positive coefficient on *hr_family* of 0.2025683, but it was not statistically significant since P is greater than 0.1. The remainder of the results for this regression can be seen in Table 10.

In order to truly capture the causal effect of whether having a family member in STEM has a greater impact on STEM confidence for high rank girls, one computes the sum of $\beta_1 + \beta_3$ to see if it is greater than $\beta_1$ alone for each grade. Looking at Table 11, one can see that for 5$^{th}$ grade, $\beta_1 + \beta_3 =$ 0.195409, which is greater than $\beta_1 = 0.1912294$, and is statistically significant at the 1, 5, and 10% levels since P is approximately less than 0.01. For 6$^{th}$ grade, $\beta_1 + \beta_3 =$ 0.1535494, which is less than $\beta_1 = 0.4027778$, which is not statistically significant. For 7$^{th}$ grade, $\beta_1 + \beta_3 = 0.273071$, which is greater than $\beta_1 = 0.0705027$, and is statistically significant at the 10% significance level since P is less than 0.1. Lastly, for 8$^{th}$ grade, $\beta_1 + \beta_3 = -0.0482253$, which is greater than $\beta_1 = -0.0824074$, but is not statistically significant. As a result, it appears that the strongest effect of having a family member in STEM on high rank girls is in the $7^{th}$ grade.

***Does being in an honors math track change female self-confidence about math and the probability of pursuing STEM in the future?***

The final question I attempt to answer based upon the data is: *Does being in an honors math track change female self-confidence about math and the probability of pursuing STEM in the future?* In order to answer this question, the ranking of each girl was considered in order to split the girls into two groups based upon their math class level, *honors*, and *non-honors*. Notably, the results include only girls in $6^{th}$, $7^{th}$, and $8^{th}$ grade since the $5^{th}$ grade does not offer an honors math course. When looking at ranking in Figure 6, students who perform better in the class are assigned a lower rank, with rank 1 being the best possible rank a student can receive. Looking at the two groups, the cut-off for girls in honors and non-honors appears to occur just at rank 15, with some outliers.

The results of the linear regression discontinuity as can be seen in Figure 6 demonstrate a negatively sloping line for both the *honors* and *non-honors* students, with a jump at the cut-off as would be expected. The negatively sloping lines suggest that students who are more highly ranked, and therefore have a lower rank value, illustrate a higher intention to take STEM classes in the future. The jump at the cut-off tells us that students who are in honors are more likely to intend to take STEM classes in the future than those who are not in honors.

## IV. Conclusion

In order to improve the rate at which women enter STEM and attempt to break the glass ceiling, it is important to analyze the attitudes of middle school girls in an empowering environment like The Hamlin School to gain insight into the attitudes of the next generation. Several important findings have emerged from the results collected in this study.

First, when looking at the attitudes of $5^{th}$ through $8^{th}$ grade students over time, one of the most important findings is that middle school girls show decreased confidence levels and attitudes towards STEM as their grade level increased. While many studies cite the influence of male classmates and male teachers as the root cause of decreasing STEM confidence in female students, it is evident that there is some other factor that increases with age that is the cause of decreasing STEM confidence because there were no male classmates or male teachers present in the environment tested in this study. While it is unclear from the study what this other factor may be, it is possible that societal stereotypes and influences become more prevalent as young girls become older, and therefore influence their self-assessment of their abilities. Importantly, these factors are strong enough to overcome the empowering environment at The Hamlin School.

Second, when examining the influence of family members in STEM on middle school girls and their opinions towards STEM, it appears that when comparing the STEM confidence of high rank girls to that of high rank girls with family members in STEM, those with family members in STEM receive an extra boost of confidence in STEM. Additionally, this effect appears even bigger as grade levels rise with the biggest change emerging in the $7^{th}$ and $8^{th}$ grade. These results suggest that girls with family members in STEM who serve as role models in STEM show higher STEM confidence levels, especially at older ages. In conjunction with the previous finding, it appears that when girls are most vulnerable to societal beliefs in $7^{th}$ and $8^{th}$

grade, they also benefit the most from having role models in STEM, suggesting the need for structured programs to provide girls the support they seek.

Third, when looking at the impact of an honors math program, the results show that girls who are in honors math are more likely to pursue STEM in the future. This finding suggests that girls may benefit from more specialized STEM classes and programs, adjusted to their aptitude level as it provides them with better support and the capacity to succeed.

The findings of this report are particularly interesting because they cancel out a lot of the beliefs that surround the lack of women in STEM. Rather than male attitudes being the sole contributor to fewer females in STEM, it appears that STEM confidence breaks down even in all-female environments where support and advocacy towards STEM is in abundance. Even in a single-sex school that promotes a spirit of innovation and entrepreneurship, girls seek specific role models, and intimate relationships with those in STEM in order to create tangible connections to a world that feels seemingly out of reach. In order to reverse the harmful trend of having minimal women in STEM it is therefore necessary to intervene not just at early ages, but in middle school when girls are most susceptible to societal beliefs.

Despite these conclusions, there were several limitations to the scope of this study that could have influenced the results. The most significant limitation was the size of the study, which with more time and resources would have been conducted with a larger sample size. In addition, in order to avoid sample bias, the study ideally would have been conducted at several all-female schools, and also at co-ed schools to ensure the validity of the results. The study was also subjected to omitted variable bias because it is likely that there were many confounding factors to STEM confidence aside from those that were measured in the study. Such factors include overall self-confidence, exposure to social media, and social confidence among others.

## V. Appendix

### Figures -

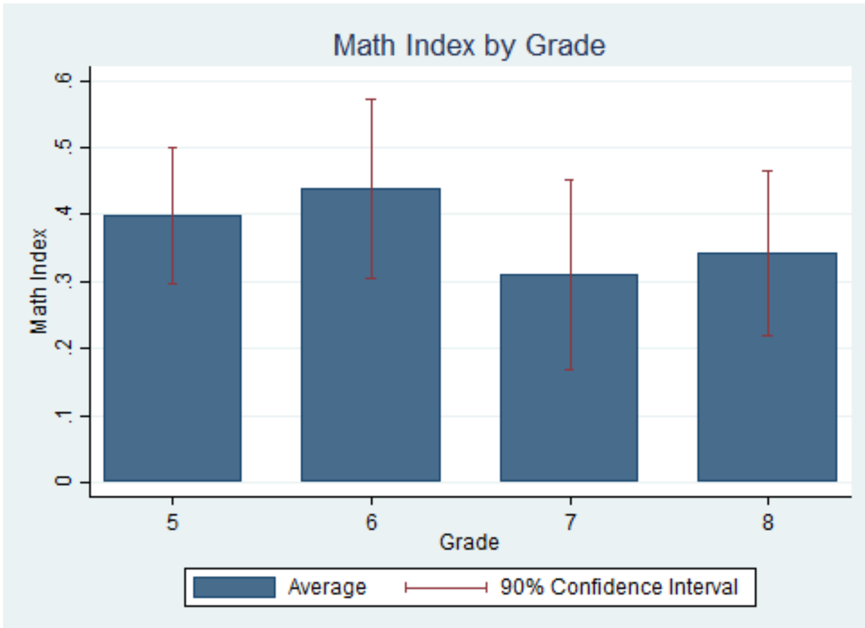


Figure 1: Math Index by Grade

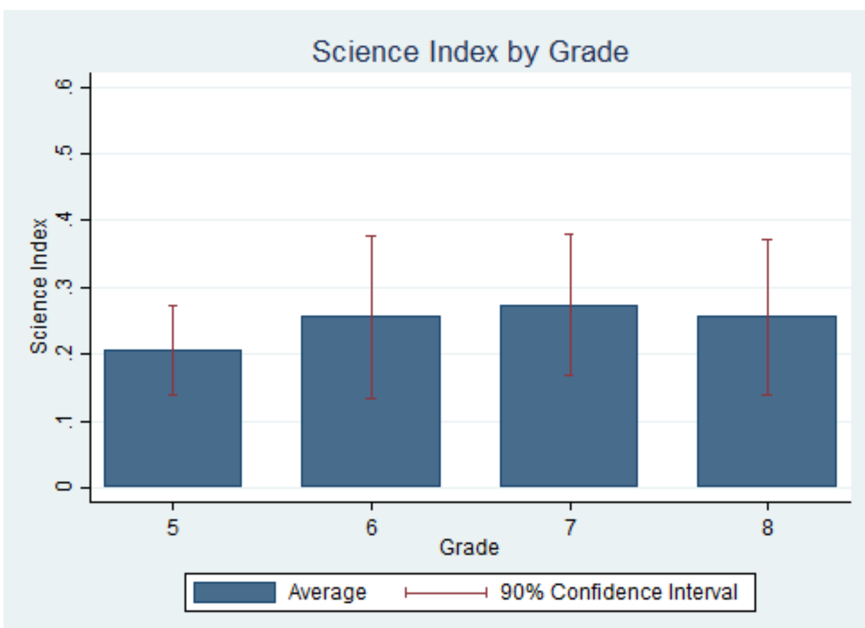


Figure 2: Science Index by Grade

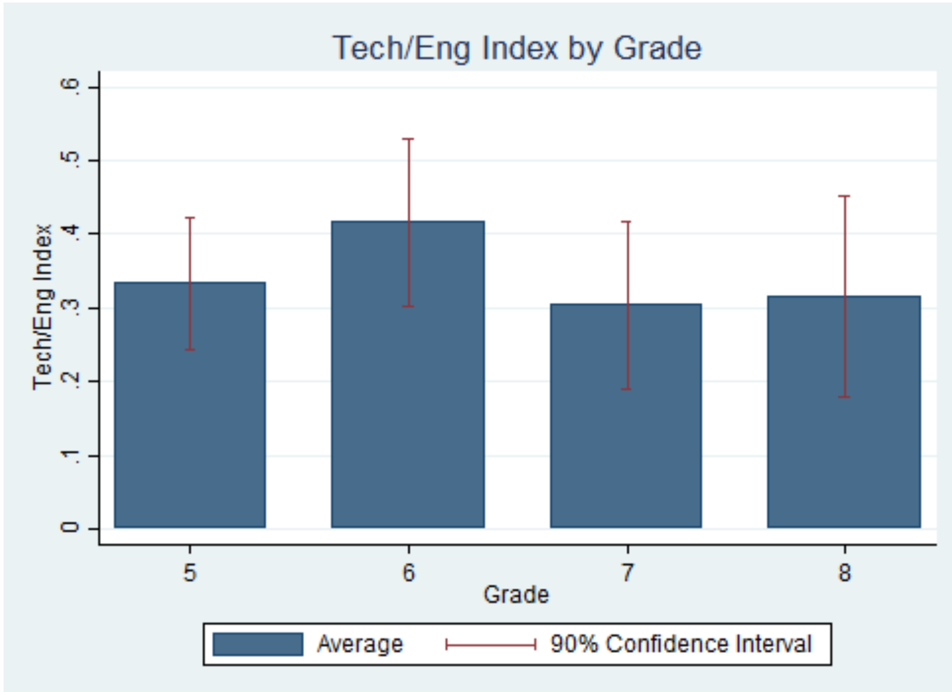

Figure 3: Tech/Eng Index by Grade

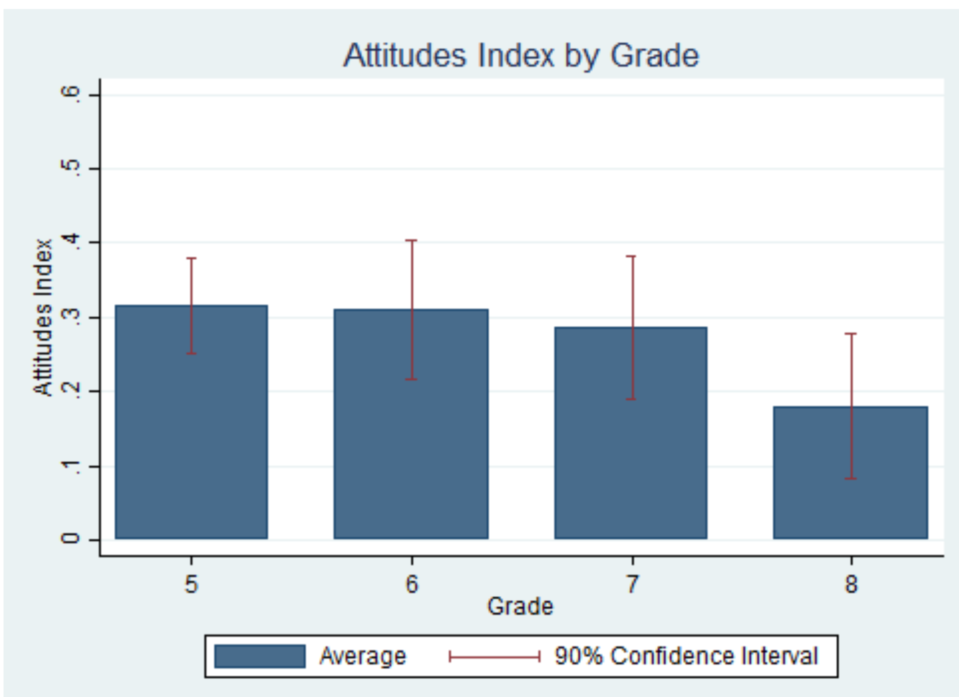

Figure 4: Attitudes Index by Grade

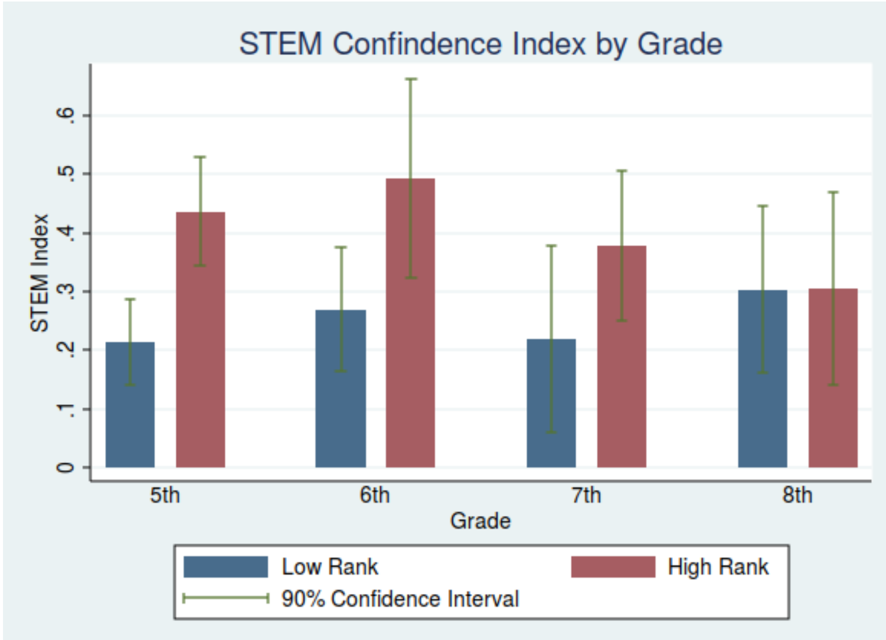

Figure 5: STEM Confidence Index by Grade

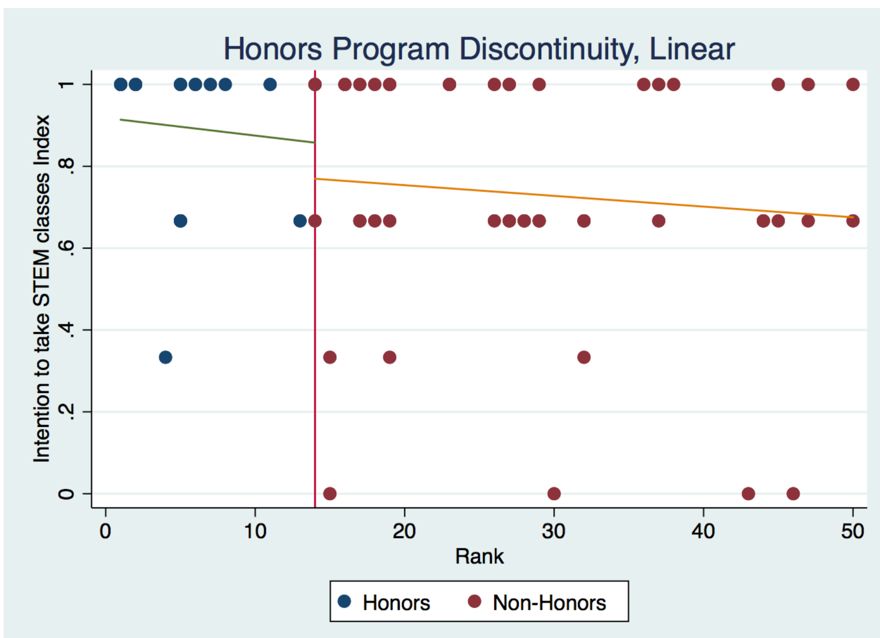

Figure 6: Honors Program Regression Discontinuity

**Tables -**

Table 1: Pairwise Comparison of Means for Math Index by Grade

| math_index | Contrast | Std. Err. | Unadjusted t | Unadjusted P>\|t\| | Unadjusted [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| grade | | | | | | |
| 6 vs 5 | .0393519 | .0991687 | 0.40 | 0.693 | -.1579627 | .2366664 |
| 7 vs 5 | -.0883655 | .0953809 | -0.93 | 0.357 | -.2781437 | .1014126 |
| 8 vs 5 | -.0564815 | .1082479 | -0.52 | 0.603 | -.2718609 | .1588979 |
| 7 vs 6 | -.1277174 | .1027727 | -1.24 | 0.218 | -.3322028 | .076768 |
| 8 vs 6 | -.0958333 | .1148142 | -0.83 | 0.406 | -.3242777 | .132611 |
| 8 vs 7 | .0318841 | .111559 | 0.29 | 0.776 | -.1900834 | .2538515 |

Table 2: Pairwise Comparison of Means for Science Index by Grade

| science_in~x | Contrast | Std. Err. | Unadjusted t | Unadjusted P>\|t\| | Unadjusted [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| grade | | | | | | |
| 6 vs 5 | .0497942 | .0787904 | 0.63 | 0.529 | -.1069739 | .2065624 |
| 7 vs 5 | .0671855 | .075781 | 0.89 | 0.378 | -.0835949 | .217966 |
| 8 vs 5 | .0497942 | .0860039 | 0.58 | 0.564 | -.1213266 | .2209151 |
| 7 vs 6 | .0173913 | .0816538 | 0.21 | 0.832 | -.1450742 | .1798568 |
| 8 vs 6 | -1.24e-10 | .0912209 | -0.00 | 1.000 | -.1815011 | .1815011 |
| 8 vs 7 | -.0173913 | .0886346 | -0.20 | 0.845 | -.1937464 | .1589638 |

Table 3: Pairwise Comparison of Means for Tech/Eng Index by Grade

| techeng_in~x | Contrast | Std. Err. | Unadjusted t | Unadjusted P>\|t\| | Unadjusted [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| grade | | | | | | |
| 6 vs 5 | .0833333 | .0871108 | 0.96 | 0.342 | -.0899898 | .2566565 |
| 7 vs 5 | -.0289855 | .0837836 | -0.35 | 0.730 | -.1956886 | .1377176 |
| 8 vs 5 | -.0185185 | .0950861 | -0.19 | 0.846 | -.20771 | .170673 |
| 7 vs 6 | -.1123188 | .0902766 | -1.24 | 0.217 | -.291941 | .0673033 |
| 8 vs 6 | -.1018519 | .100854 | -1.01 | 0.316 | -.3025197 | .098816 |
| 8 vs 7 | .010467 | .0979946 | 0.11 | 0.915 | -.1845115 | .2054455 |

Table 4: Pairwise Comparison of Means for Attitudes Index by Grade

| attitudes_~x | Contrast | Std. Err. | Unadjusted t | Unadjusted P>\|t\| | Unadjusted [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| grade | | | | | | |
| 6 vs 5 | -.0048148 | .0683066 | -0.07 | 0.944 | -.1407235 | .1310938 |
| 7 vs 5 | -.0278583 | .0656976 | -0.42 | 0.673 | -.158576 | .1028594 |
| 8 vs 5 | -.1348148 | .0745603 | -1.81 | 0.074 | -.2831664 | .0135368 |
| 7 vs 6 | -.0230435 | .070789 | -0.33 | 0.746 | -.1638914 | .1178044 |
| 8 vs 6 | -.13 | .0790831 | -1.64 | 0.104 | -.2873506 | .0273506 |
| 8 vs 7 | -.1069565 | .0768409 | -1.39 | 0.168 | -.2598459 | .0459329 |

Table 5: Linear Regression Older Sibling on STEM_classes_index

```
Linear regression                               Number of obs     =         85
                                                F(1, 83)          =       4.59
                                                Prob > F          =     0.0350
                                                R-squared         =     0.0322
                                                Root MSE          =     .28519

--------------------------------------------------------------------------------
                |               Robust
stem_classes_~x |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
----------------+---------------------------------------------------------------
older_sibling~M |   .1428063   .0666336     2.14   0.035     .0102747    .2753378
          _cons |   .7546296   .0350556    21.53   0.000     .6849056    .8243537
--------------------------------------------------------------------------------
```

Table 7: Linear Regression Parents Index on STEM_classes_index

```
Linear regression                               Number of obs     =         85
                                                F(3, 81)          =       1.72
                                                Prob > F          =     0.1694
                                                R-squared         =     0.0404
                                                Root MSE          =     .28746

---------------------------------------------------------------------------------
                 |               Robust
stem_classes_i~x |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-----------------+---------------------------------------------------------------
parent_scientist |   .0305358   .0852658     0.36   0.721    -.1391163     .200188
  parent_engtech |   .0102178   .0718899     0.14   0.887    -.1328206    .1532563
     parent_math |   .1223309   .0546809     2.24   0.028      .013533    .2311287
           _cons |   .7374915   .0457877    16.11   0.000     .6463884    .8285946
---------------------------------------------------------------------------------
```

Table 8: Descriptive Statistics of Indices by Grade

```
Mean estimation                   Number of obs   =         84

            5: grade = 5
            6: grade = 6
            7: grade = 7
            8: grade = 8

-----------------------------------------------------------------
           Over |       Mean   Std. Err.     [95% Conf. Interval]
----------------+------------------------------------------------
math_index      |
              5 |   .3981481   .0588451      .2811283     .515168
              6 |      .4375   .0773481      .2836848    .5913152
              7 |   .3097826    .082186      .1463467    .4732185
              8 |   .3416667   .0700411      .2023823    .4809511
----------------+------------------------------------------------
science_index   |
              5 |   .2057613   .0387558      .1286912    .2828315
              6 |   .2555556   .0702035      .1159483    .3951628
              7 |   .2729469   .0615867       .150475    .3954187
              8 |   .2555556   .0665784      .1231571    .3879541
```

```
----------------+-----------------------------------------------
techeng_index   |
              5 |   .3333333   .0528795      .2281766    .4384901
              6 |   .4166667   .0656724      .2860699    .5472635
              7 |   .3043478   .0659815      .1731364    .4355592
              8 |   .3148148   .0773736      .1609489    .4686807
----------------+-----------------------------------------------
attitudes_index |
              5 |   .3148148   .0376306      .2399823    .3896473
              6 |        .31   .0542412      .2021355    .4178645
              7 |   .2869565   .0559871        .17562    .3982931
              8 |        .18   .0553775      .0698758    .2901242
----------------------------------------------------------------
stem_index      |
              5 |   .3124143   .0385598       .235734    .3890946
              6 |   .3699074   .0566426      .2572674    .4825474
              7 |   .2956924   .0581788      .1799974    .4113874
              8 |   .3040123   .0539717      .1966837     .411341
----------------------------------------------------------------
```

Table 9: Effect of Family Member in STEM and Rank on STEM Confidence by Grade

```
-> grade = 5

Linear regression                               Number of obs     =         27
                                                F(2, 24)          =       6.75
                                                Prob > F          =     0.0047
                                                R-squared         =     0.3632
                                                Root MSE          =     .16642

------------------------------------------------------------------------------
             |               Robust
  stem_index |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        rank |  -.0066711    .002379    -2.80   0.010    -.0115812    -.001761
family_in_STEM |   .1255999   .0654088     1.92   0.067    -.0093973     .260597
       _cons |   .3797222   .0802679     4.73   0.000     .2140574     .545387
------------------------------------------------------------------------------
-> grade = 6

Linear regression                               Number of obs     =         19
                                                F(2, 16)          =       3.95
                                                Prob > F          =     0.0403
                                                R-squared         =     0.1991
                                                Root MSE          =     .23422

------------------------------------------------------------------------------
             |               Robust
  stem_index |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        rank |  -.0068066   .0032863    -2.07   0.055    -.0137732    .0001599
family_in_STEM |  -.0220867   .0873777    -0.25   0.804    -.2073192    .1631458
       _cons |   .5335147   .0782159     6.82   0.000     .3677043     .699325
------------------------------------------------------------------------------
```

```
-> grade = 7

Linear regression                               Number of obs     =         23
                                                F(2, 20)          =       3.96
                                                Prob > F          =     0.0356
                                                R-squared         =     0.2435
                                                Root MSE          =     .25452

--------------------------------------------------------------------------------
               |               Robust
    stem_index |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
---------------+----------------------------------------------------------------
          rank |  -.0100176   .0035749    -2.80   0.011    -.0174748   -.0025604
family_in_STEM |  -.1337449   .1112358    -1.20   0.243    -.3657788    .0982889
         _cons |   .5682856   .1239819     4.58   0.000     .3096639    .8269073
--------------------------------------------------------------------------------
-> grade = 8

Linear regression                               Number of obs     =         15
                                                F(2, 12)          =       1.53
                                                Prob > F          =     0.2554
                                                R-squared         =     0.0663
                                                Root MSE          =     .21816

--------------------------------------------------------------------------------
               |               Robust
    stem_index |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
---------------+----------------------------------------------------------------
          rank |   .0023314   .0056404     0.41   0.687    -.0099579    .0146207
family_in_STEM |    .130524    .077262     1.69   0.117    -.0378154    .2988633
         _cons |   .1882404   .1083365     1.74   0.108    -.0478045    .4242853
--------------------------------------------------------------------------------
```

Table 10: Effect of High Ranking and Having Family Member in STEM on STEM Confidence by Grade

```
------------------------------------------------------------------------------------
-> grade = 5

Linear regression                               Number of obs     =         27
                                                F(3, 23)          =       4.34
                                                Prob > F          =     0.0146
                                                R-squared         =     0.3861
                                                Root MSE          =     .16692

--------------------------------------------------------------------------------
               |               Robust
    stem_index |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
---------------+----------------------------------------------------------------
     high_rank |   .1912294   .1102742     1.73   0.096    -.0368902     .419349
family_in_STEM |   .1063529   .0760671     1.40   0.175    -.0510039    .2637097
     hr_family |   .0041795   .1331547     0.03   0.975    -.2712719     .279631
         _cons |   .1710391    .062495     2.74   0.012     .0417584    .3003198
--------------------------------------------------------------------------------
```

```
-> grade = 6

Linear regression                               Number of obs     =         20
                                                F(3, 16)          =       4.28
                                                Prob > F          =     0.0213
                                                R-squared         =     0.2812
                                                Root MSE          =     .23404

--------------------------------------------------------------------------------
               |               Robust
    stem_index |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
---------------+----------------------------------------------------------------
     high_rank |   .4027778   .1311369     3.07   0.007       .12478    .6807756
family_in_STEM |   .2021605   .1340909     1.51   0.151    -.0820996    .4864206
     hr_family |  -.2492284   .2014384    -1.24   0.234    -.6762588    .1778019
         _cons |   .1219136   .1201843     1.01   0.325    -.1328658     .376693
--------------------------------------------------------------------------------

-> grade = 7

Linear regression                               Number of obs     =         23
                                                F(3, 19)          =       1.44
                                                Prob > F          =     0.2630
                                                R-squared         =     0.1387
                                                Root MSE          =     .27864

--------------------------------------------------------------------------------
               |               Robust
    stem_index |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
---------------+----------------------------------------------------------------
     high_rank |   .0705027   .1818553     0.39   0.703    -.3101249    .4511302
family_in_STEM |  -.1781085    .169996    -1.05   0.308    -.5339142    .1776973
     hr_family |   .2025683   .2273877     0.89   0.384    -.2733595    .6784962
         _cons |   .2943122   .1315853     2.24   0.037      .018901    .5697233
--------------------------------------------------------------------------------

-> grade = 8

Linear regression                               Number of obs     =         15
                                                F(2, 11)          =          .
                                                Prob > F          =          .
                                                R-squared         =     0.0702
                                                Root MSE          =      .2274

--------------------------------------------------------------------------------
               |               Robust
    stem_index |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
---------------+----------------------------------------------------------------
     high_rank |  -.0824074   .1164756    -0.71   0.494    -.3387685    .1739537
family_in_STEM |   .1135803   .1420528     0.80   0.441    -.1990759    .4262365
     hr_family |   .0341821   .1750723     0.20   0.849    -.3511495    .4195137
         _cons |   .2606481   .1164756     2.24   0.047     .0042871    .5170092
--------------------------------------------------------------------------------
```

Table 11: Computed Sum of High Rank Students and Having Family in STEM on STEM Confidence

```
-> grade = 5
 ( 1)  high_rank + hr_family = 0 (grade == 5)

------------------------------------------------------------------------------
  stem_index |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |    .195409   .0746309     2.62   0.015     .0410232    .3497947
------------------------------------------------------------------------------

-> grade = 6
------------------------------------------------------------------------------
  stem_index |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |   .1535494    .152907     1.00   0.330    -.1705989    .4776977
------------------------------------------------------------------------------

-> grade = 7
------------------------------------------------------------------------------
  stem_index |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |    .273071   .1365057     2.00   0.060    -.0126387    .5587806
------------------------------------------------------------------------------

-> grade = 8
------------------------------------------------------------------------------
  stem_index |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |  -.0482253   .1307048    -0.37   0.719    -.3359047    .2394541
------------------------------------------------------------------------------
```

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