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Factors Influencing Advanced STEM Course Enrollment for Females

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Abstract

This action research study investigated the reasons that female students enroll in high school elective STEM classes in a rural Iowa high school. The participants were 52 students currently enrolled in an earth science class who responded to an anonymous survey centered around three themes: stereotypes, females in education, and the roles that adults and peers play. The survey clearly showed no significant differences between the perceptions of male and female participants. The results of the survey found that all students, both male and female, do not believe the traditional stereotypes held regarding STEM classes and careers. The results also indicate the need for adults, both family and school personnel, to become more prominent as to encourage advanced STEM class enrollment.

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Action Research Report Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Education

Factors Influencing Advanced STEM Course Enrollment for Females

By

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Action Research Report
Submitted in Partial Fulfillment
Of the Requirements for the
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Table of Contents

List of Tables

Tables:

List of Figures

Figures:

Abstract

This action research study investigated the reasons that female students enroll in high school elective STEM classes in a rural Iowa high school. The participants were 52 students currently enrolled in an earth science class who responded to an anonymous survey centered around three themes: stereotypes, females in education, and the roles that adults and peers play. The survey clearly showed no significant differences between the perceptions of male and female participants. The results of the survey found that all students, both male and female, do not believe the traditional stereotypes held regarding STEM classes and careers. The results also indicate the need for adults, both family and school personnel, to become more prominent as to encourage advanced STEM class enrollment.

Keywords: STEM, females, high school

If you enter a secondary English classroom in America, you will find both male and female students engaged in learning but when you enter a high school math or computer science class, you will likely see more males than females (Brown et al., 2017). This reality has persisted for years in the American education system as STEM classes, that include advanced math and science classes, as well as technology and engineering were originally tailored to traits valued in males (Legewire & DiPrete, 2014). Females continue to learn in STEM classroom environments suited more to males which makes it difficult for them to see themselves in the STEM field (Kim et al., 2018). The number of STEM jobs created each year continues to increase, faster than many other fields (Milgram, 2011). The changing world now puts these STEM fields in high demand while we continue to experience a shortage of workers to fill an ever-growing number of jobs (Milgram, 2011). Females represent an untapped potential to fill this growing field.

Males continue to dominate these traditionally technical fields as females often underestimate their potential of success and fall victim to long-held stereotypes (Hand et, al., 2017). A common stereotype is that females are less capable, especially intellectually, of succeeding in STEM fields. Males are expected to be more successful in STEM subjects such as math and science. These stereotypes have a large impact on how females view themselves and their abilities (Hand et al., 2017). Believing the long-held stereotypes does a disservice to all females and the potential they are ignoring. God has given females specific talents that should be used to care for His creations. However, when females deny their gifts, and only choose careers outside of the STEM field, humanity is losing the impact females could bring to change the world. Females bring a different perspective to the STEM field and may hold the answers to many problems we currently face and challenges that may arise in the future (Milgram, 2011).

High schools play an influential role in preparing students, especially females, for STEM fields. Schools are working to keep up with the changing field by implementing systemic improvements to prepare students for STEM opportunities. Many states have adopted new curriculum standards that include numerous standards in STEM fields (Faller, 2019). Students have more classes to choose from as schools offer technology classes and engineering programs that appeared in the last decades. Clubs and after school programs are being formed around this growing field to spark interest and to provide female role models that exhibit success in STEM fields (Hand et al., 2017).

Purpose of the Study

The purpose of this study was to determine the reasons that female students enroll in high school STEM classes to implement steps that increase female participation in the future. At Ogden High School, there are a limited number of females that choose to enroll in STEM classes, especially advanced elective classes. To increase the number of students who are interested in STEM, a study was conducted to determine methods to increase enrollment, especially of females, in these advanced classes. This study, while specifically focused on Ogden High School will have wider implications. This study was seeking to determine how student perceptions, specifically females, determined the STEM classes taken during their high school years.

Research Questions

1. Why do female students enroll in high school elective STEM classes at Ogden High School?

Definition of Terms

For the purposes of this study, the following definitions will be used. The definitions are the work of the researcher, unless otherwise noted.

Gender Role Bias is showing preference to one gender over another -- in this case, males -- when considering STEM opportunities (Hand et al., 2017).

NGSS or *Next Generation Science Standards* are standards adopted by states where Earth Science, Biology and Physical science concepts are prioritized (Patterson & Johnson, 2017).

STEM an acronym used for science, technology, engineering, and mathematics, often used in when referring to classes and careers.

Literature Review

STEM classes and careers continue to be dominated by males as students and teachers continue to see STEM classes and careers through an outdated lens that favors males (Brown et al., 2017). In fact, females do not see themselves as having the tools/ability to be successful at STEM careers. This is a concern as the need for STEM workers continues to increase.

Females and Education

Females often perceive themselves as lacking the tools and abilities needed for success in STEM classes (Hand et al., 2017). There is little difference between academic achievements of males and females in STEM classes (Legewie & DiPrete, 2014). However, teachers still report that their students consider scientists to likely be males (Faller, 2019) and in a typical college, males outnumber females by at least 3:1 in STEM classes (Dasgupta & Stout, 2014).

The education system has been striving to increase females in STEM classes as evidenced by the adoption of new curriculum standards. Many states now use the Next Generation Science Standards (NGSS) when adopting curriculum and determining science

classes offered. This increases the diversity and amount of science classes required for graduation which leads to more science exposure for female students. The adoption of the NGSS added Earth Science as a requirement for all High school students resulting in Earth Science carrying the same importance as Biology and Chemistry at the high school level (Patterson & Johnson, 2017). Before the requirement of Earth Science, there was little exposure for females and less opportunity to build interest or determine success in this branch of science because Earth Science was last required at the middle school level (Patterson & Johnson, 2017). This left a gap of four years that many females were not engaged as consistently in Earth Science content as the required Biology or Chemistry content. With additional exposure and success, females may consider careers in Earth Science that they never would have experienced under different standards.

Females in the Workforce

Females make up half the world and hold more degrees than men but remain underrepresented in the STEM field (Kim et al., 2018). Females make up half of the labor force in our world but only 28% of the total scientific or technical workers (Thebaud & Charles, 2018). This presents a problem as more STEM jobs need to be filled each year. The history of females in the work force may play a role in the current situation. In the past, females have been brought into the labor force as a unit. Females were needed during wars when men were fighting overseas. They often were put into positions considered “women’s work” which did not include STEM opportunities (Thebaud & Charles, 2018). This history has dictated the type of jobs that females typically filled. They were often more interested in jobs that involve people and social interactions as well as intrinsic, altruistic and social rewards (Legewie & DiPrete, 2014). This

remains a concern as STEM jobs continue to grow at a much faster rate than other careers (Milgram, 2011) and females will be needed to fill this ever-growing field.

Females also need to be included in STEM careers because they bring a different perspective than their male counterparts. They see things differently and bring valuable perspective to the field which is currently absent. Females can determine how challenges will affect their gender and serve as ambassadors to other females through scientific trials and advancements (Milgram, 2011). Females will be the key to advancing our STEM sector at a faster rate than ever before and will be essential in providing innovation required for our future to improve economic competition, quality of life and national security (Dasgupta & Stout, 2014). Females remain an underutilized component of our workforce and a reason for that continues to be stereotypes.

Stereotypes

In a study conducted by Thebaud and Charles (2018), Western cultural stereotypes were examined in an attempt to identify the role stereotypes played in STEM opportunities. Western culture operates using two distinct genders and this plays a role in the way females view STEM opportunities. Individuals identify themselves as one of the two options presented. They also associate the typical characteristics matched to that gender. Thebaud and Charles (2018) found that males are seen as assertive, goal-oriented, ambitious, independent, competitive, and self-interested. These are all attributes that are connected to STEM fields. On the other hand, females are seen as warm, kind, nurturing, friendly, and polite (Thebaud & Charles, 2018). Many of these traits are not traditionally associated with STEM opportunities. STEM careers idealize workers with masculine characteristics and males receive more pressure and reward for

pursuing them. (Thebaud & Charles, 2018). Females, on the other hand, may find it hard to look past these stereotypes and see a future in STEM.

Teachers, however, can be very influential on females' perception of STEM. In an experiment conducted by Hand et al. (2017), teachers and students were given surveys to investigate stereotypes present regarding STEM. At the conclusion of the study, it was discovered that both teachers and students hold the perception that males performed better in STEM subjects while females exceled in humanities subjects. This perception may have a direct effect on the classes that students take and the careers that they choose. Hand et al. (2017) discovered that most teachers tend to show gender bias without realizing it. Curriculum and teaching methods can also play into stereotypes. Females reported that they had not learned about female mathematicians and both males and females report that they had not learned about female scientists (Hand et al., 2017). These stereotypes can determine how women see themselves and ultimately the education and career choices they make.

How Females See Themselves

The first step to creating change in the number of females taking advanced STEM classes may be to address how females see themselves and their place in STEM fields. Gender gap performance has been closing but how women perceive themselves in the field continues to underestimate and undervalue their abilities (Dasgupta & Stout, 2014). Change may need to occur during the middle school and high school years to see success. Adolescence is a period when identity is formed and by addressing stereotypes during this period in middle school and high school, more females may see identity potential in the STEM fields. Young females often do not see themselves aligning with the typical stereotypes of STEM identities (Kim et al., 2018). In a study conducted by Patterson and Johnson (2017), high achieving high school

females were studied to determine why they choose the classes taken in STEM fields. It was discovered that females see their peers as competition and this can play a role in classes taken (Patterson & Johnson, 2017). A female is less likely to take an advanced STEM class if none of their peers enroll as there is no one to compete with or measure themselves against. They seek classes that have additional females enrolled, in fact, females' class selection is more dependent on their peers than males (Dasgupta & Stout, 2014). This means that encouraging all women to take STEM classes is valuable so it becomes the norm.

Females also look ahead to their future education plans when choosing which classes to take. Patterson and Johnson (2017) discovered that grades have determined what classes are taken because students are more concerned with college admission and grades than content knowledge gained. Weber (2012) conducted a study where surveys were given to female middle school and high school students enrolled in STEM classes. Upon analysis, three factors were discovered that impact choice of STEM classes: engagement, capacity, and continuity. All three factors must be present to ensure success as they all work together to support females (Campbell et al., 2004). Females require engagement in the STEM field, the curriculum must include components that are of greater interest to them. Females will find engagement when STEM classes include awareness, interest and motivation (Campbell et al., 2004). Females find value in work that helps a community instead of the traditional tasks such as repairing things using technical and mechanical skills (Weber, 2012). They also must see that they have capacity or the ability to be successful. Females must be given the tools and skills they need to advance through STEM classes as they become more rigorous (Campbell et al., 2004). Kim et al., (2018) determined that STEM functions as an identity that females need to embrace if they are to clearly see their capacity. This identity allows females to view themselves as a member of the STEM

field and in turn, makes them feel as though they belong. Currently, they are consistently learning in environments suited to males that use male mathematicians as examples and exclude female examples in questions and projects (Hand et al., 2017). A sense of belonging is necessary to reach full capacity. Finally, to retain them in the field they must experience continuity. This includes opportunities and resources that give females the support they need for continued advancement in STEM fields (Campbell et al., 2004). This can include feedback from the adults in their lives; from parents to teachers and guidance counselors, encouragement is key. Males are more likely to report encouragement from these adults when it comes to STEM opportunities (Weber, 2012).

The Role of Adults

Adults can play a significant role encouraging females in STEM as well as breaking barriers and stereotypes that continue to live on. Parents play a large role in determining the attitudes young females have regarding STEM opportunities. In a study conducted by Rozek et al. (2015), it was determined that parents are a largely underutilized resource that could lead to more STEM engagement. Parents who placed a higher value on mathematics and science, two of the core STEM disciplines, had students that expressed more engagement and success. During middle and high school, a mother's support, more so than a father's support, are influential in predicting the motivation of females to engage in science and math (Dasgupta & Stout, 2014). Females look to the same sex parent for guidance as they consider what is possible for themselves. They know that gender differences exist and they use their mother as their role model. Therefore, mothers must make sure to encourage and expose their daughters to STEM opportunities during this identity forming time. Elementary and college-aged students report higher levels of parental support than high school children (Rice et al., 2013). A study

performed by Hall et al., (2011) surveyed high school students to determine what influences were present when considering career opportunities. Students reported their top four influences in the following order: personal interest, parental influence, earning potential, and teachers. Two out of the four influences involve adults that students interact with daily.

Females look beyond their parents to teachers, mentors, and other adults when determining their self-efficacy in STEM subjects (Hand et al., 2017). Teachers must make sure that they are encouraging all students. Teachers must work with school counselors to provide the encouragement that females are missing (Weber, 2012). A study conducted by Rice et al., (2013), found that students reported receiving the least amount of teacher support beginning in eighth grade and persisting throughout high school. They discovered that students reported high levels of support throughout elementary school and also in college. This means that high school females are not receiving the support or encouragement during these important years. This time period represents the time that females make important choices about the classes they take and the careers they will end up in.

Many counselors have little to no experience in STEM fields and often lack the experience to guide student through STEM opportunities (Hall et al., 2011). In an investigation carried out by Welsch and Winden (2019), it was discovered that " when forced to choose, female counselors are 13.6 percentage points less likely to recommend math to a female student relative to English" (p. 125). This may be a result of female counselors projecting their own strengths and weakness on their students. This can present a problem according to a study conducted by Hall et al., (2011) which discovered that many school personnel (both teachers and counselors) did not feel knowledgeable about career options in scientific or information technology fields. High school students reported that teachers have a direct influence on the

interests they have in STEM (Hall et al., 2011). This is a concern as parents and school personnel both play an influential role in the choices of students, but they admit that their knowledge of STEM is limited at best (Hall et al., 2011).

Females need exposure to mentors in the STEM fields that can serve as additional role models beyond their family and school. Mentoring programs can be valuable and provide role models that are already present in the STEM world (Kim et al., 2018). In a study conducted by Buschor et al. (2014) the lack of female role models in STEM careers was addressed. The lack of access to female role models left females with a vague idea of what working in science looks like. Mentors can show females that they can be successful. In research done by Stoeger et al. (2019), the outcome of mentoring programs on female participants was studied. They found that when a positive relationship is formed between a female student and a mentor, the students was more likely to see their STEM potential and show an increase in interest. This in turn lead to an increase in elective classes and STEM activity participation (Stoeger et al., 2019). The mentor relationship is most effective when it lasts for at least a year with regular communication (Stoeger et al., 2019).

Possible Solutions

There are numerous solutions that have been suggested to combat the gender discrepancy in STEM fields. Many changes can occur within our existing education system. Brown et al. (2017), suggested that teachers make simple changes in their current classrooms to promote females in STEM. The classroom environment can send unintended messages so teachers must make sure to include females in test questions, female examples in classroom décor and as guest speakers. Teachers can also remove barriers to success by using real world examples that help females make concrete connections to their own life experiences. All students preform better

when they can build upon previous knowledge. Giving students, especially females, choice and voice within projects can lead to positive results. This simple act shows that the perspective of females is valued and equally as important as their male counterparts. Faller (2019) also suggested that teachers should include an expansive view of scientists and get rid of the idea that science is for geniuses only because all students need to learn that resilience and struggles are normal. It is important to recognize their common occurrence and the ability all students have to overcome them.

A strong curriculum in math and science can give experiences to females that helps break stereotypes (Legewire & DiPrete, 2014). Teachers should also implement hands-on learning opportunities when applicable. All students are more likely to make connections and experience success when they are given concrete opportunities to learn. Hands-on learning often leads to increased collaboration in STEM classrooms. Females perform better and show more satisfaction when collaboration is present (Dasgupta & Stout, 2014). Increased collaboration while learning allows females to tap into their traits that are traditionally associated with their gender. Teachers need to incorporate real-life activities to engage both males and females in STEM classes in place of traditional technology activities or mechanical concepts (Weber, 2012). All students benefit from real-life activities as it relates to their lives and they can relate to the topics being taught.

Schools can make systemic changes as well to increase female participation in STEM fields. Expanding graduation requirements to include more STEM classes may combat stereotypes and increase exposure and success of females while reducing peer pressure in course selection (Thebaud & Charles, 2018). Schools can also look beyond their normal curriculum and walls to encourage females in STEM. Dasgupta and Stout (2014) suggested collaborations

between schools and science museum or colleges and universities. They also point out the value of informal STEM learning environments, after school activities, and summer camps.

Females will become more interested in STEM if they have parents that provide them with STEM opportunities, such as after school programs, materials at home and encouragement (Dasgupta & Stout, 2014). A study performed by Constan and Spicer (2015) evaluated the outcomes of students participating in the Physics of Atomic Nuclei (PAN) college outreach program that exposed students to careers and research in the nuclear sciences. The results showed that students who participated in the program claimed that PAN influenced their interest in STEM and played a role in their career plans. Students valued the relationships formed with faculty and graduate students facilitating the program and enjoyed participating in authentic research with them (Costan & Spicer, 2015). After school robotics programs also attempt to create interest in STEM fields. FIRST is a national organization that provides afterschool robotics programs targeted at students 6-18 years old. FIRST aims to engage students with mentors to create interest in science and technology and create self-confidence and leadership (Burack et al., 2019). Burack et al. (2019) studied the effects that FIRST had on STEM interest among students. They concluded that after-school programs including FIRST had a positive and long-term effect on students that encouraged them to continue their study of STEM in college. In a study performed by Sahin et al. (2014), students reported that they enjoyed after-school programs because there are task oriented instead of preparing for standardized tests. These programs allow students to engage in larger problems that are more relatable to their lives beyond the basic memorization needed for standardized testing.

Methodology

Participants

The research participants were students currently enrolled in Earth Science at a rural central Iowa high school. This class was chosen because it is the final required science class that all students take before having more options to enroll in STEM elective classes. Earth Science is composed of 54 total students. The classes include all ability levels and is composed of 48% females and 52% males. There were 26 females and 26 males that participated in the survey. They represented 2 seniors, 31 juniors, and 19 sophomores. Permission to conduct the survey was given by the high school principal.

Materials

A survey was created to determine the beliefs held by students regarding STEM classes and careers as well as their perceived abilities in the STEM field. The survey focused on the following themes: stereotypes, females and education, and the role of adults and peers. The survey consisted of 21 total questions. Questions 1-4 collected basic data including grade, gender, classes taken and classes the student intends to take. Questions 5-6 addressed future plans and reasons for taking STEM classes. Questions 7-21 utilized the Likert scale while investigating the three major themes. Stereotypes were addressed in questions 7-10, females and education were addressed in questions 11-16, and the role if adults and peers were addressed in questions 17-21. The survey was created for this study and focused on the themes discovered in the literature review.

Research Design

The survey was created using Google Forms. The survey was sent to participating students currently enrolled in Earth Science through their school email. The form was emailed

on a Tuesday at the beginning of class and completed during Earth Science classes on that day. The survey remained open for two days for students who were absent or did not complete the survey during class. Students were reminded once in class on the following Wednesday to complete it. On Friday, at 3:30 the form was closed and submissions were no longer accepted. The data was compiled and analyzed to determine trends that influence why STEM classes are taken.

Results

The purpose of this study was to determine the reasons that female students enroll in advanced high school STEM classes. A survey was administered to measure how student perceptions, specifically females, determine the elective STEM classes taken during their high school years. The survey created focused on three distinct themes: stereotypes, females and education, and the role of adults and peers.

Stereotypes

Table 1

Survey Questions Relating to Stereotype Perceptions

Survey Questions Relating to Stereotype Perceptions
I have the skills to succeed in math classes.
I have the skills to succeed in science classes.
I can be successful in math careers.
I can be successful in science careers.

Table 1 presents the survey questions asked in relation to perceptions of stereotypes. A Likert-scale was used to measure participant perception of these statements. Participants were given the following options when completing the survey: 1 as “strongly agree,” 2 as “agree,” 3 as “neither

agree nor disagree," 4 as "disagree," 5 as "strongly disagree." The results were then divided into female and male responses. A mean was determined for each student based on their answers to each of the four statements.

Figure 1a

Mean Scores for Females Regarding Stereotype Perceptions

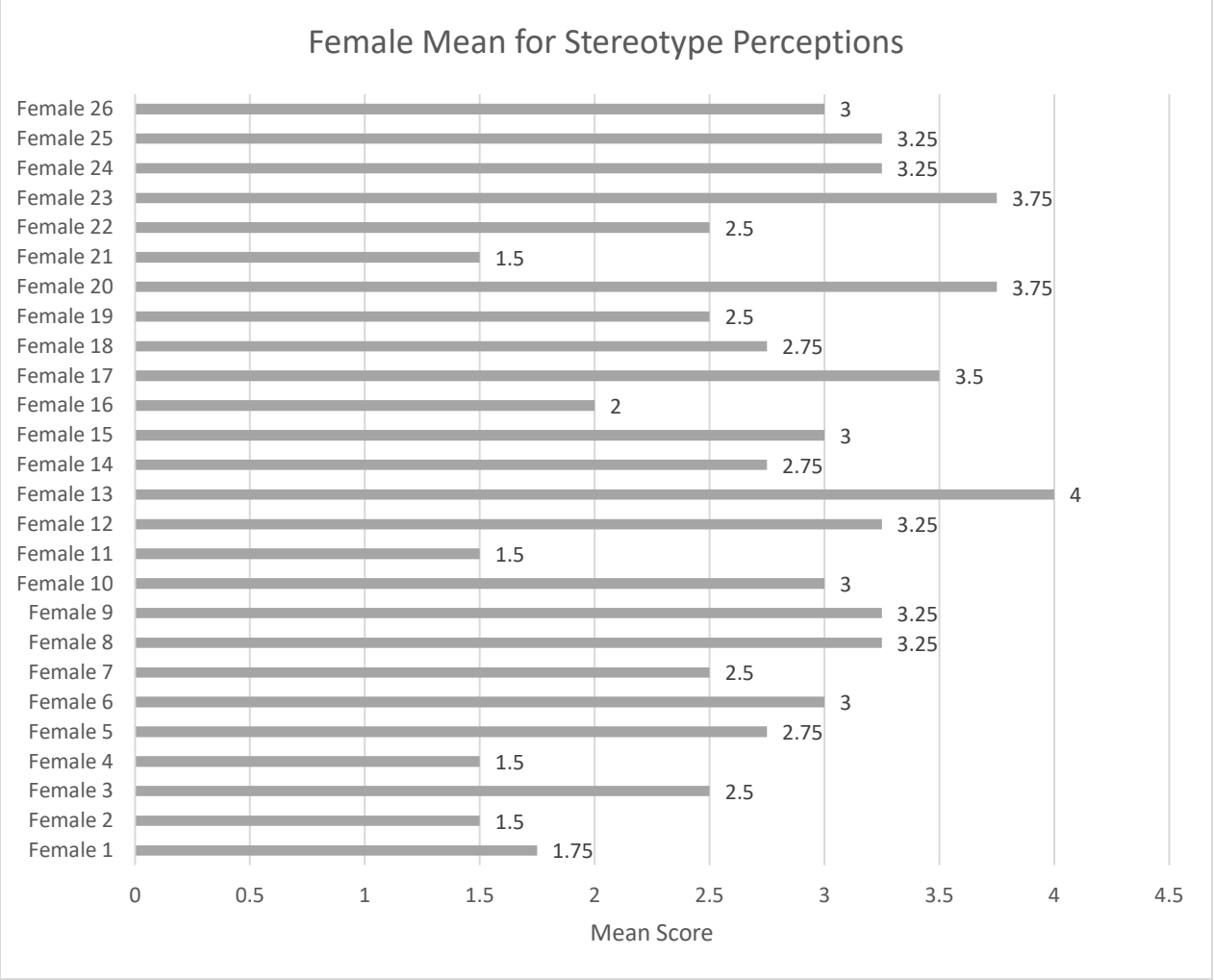

Figure 1a presents the calculated means for each female participant in response to stereotype perceptions. The mean scores range from 1.5 to 4.0 with a combined female mean of 2.74.

Figure 1b

Mean Scores for Males Regarding Stereotype Perceptions

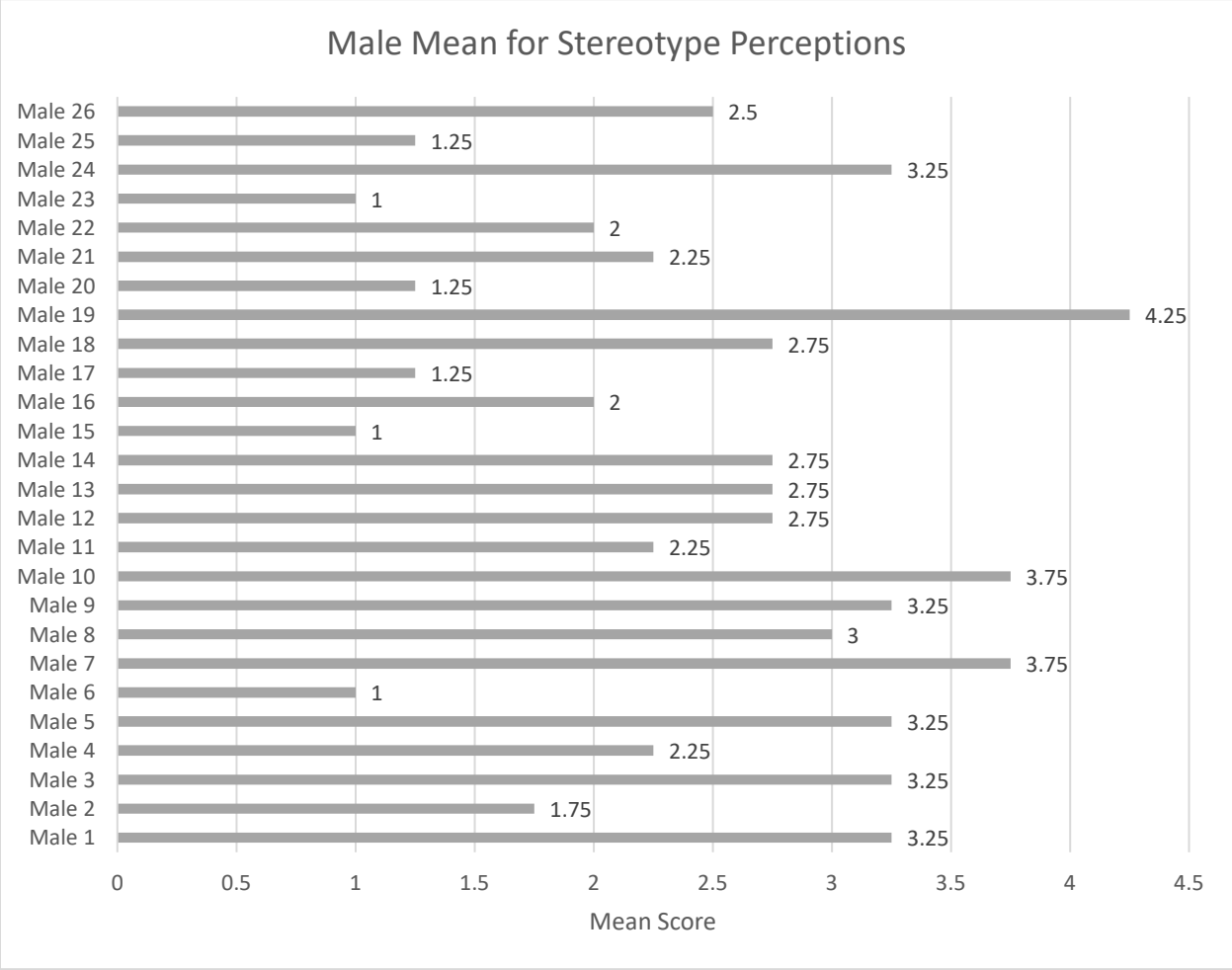

Figure 1b presents the means for each male participant in response to stereotype perceptions. The mean scores range from 1 to 4.25 with a combined male mean of 2.45.

Females and Education

Table 2

Survey Questions Relating to Education Perceptions

Survey Questions Relating to Education Perceptions
Math classes use lessons that engage me.
Science classes use lessons that engage me.
Math classes relate to my life.
Science classes relate to my life.
I am knowledgeable about math careers.
I am knowledgeable about science careers.

Table 2 presents the survey questions asked in relation to perceptions of education. A Likert-scale was used to measure participant perception of these statements. Participants were given the following options when completing the survey: 1 as “strongly agree,” 2 as “agree,” 3 as “neither agree nor disagree,” 4 as “disagree,” 5 as “strongly disagree.” The results were then divided into female and male responses. A mean was determined for each student based on their answers to each of the six statements.

Figure 2a

Mean Scores for Females Regarding Education Perceptions

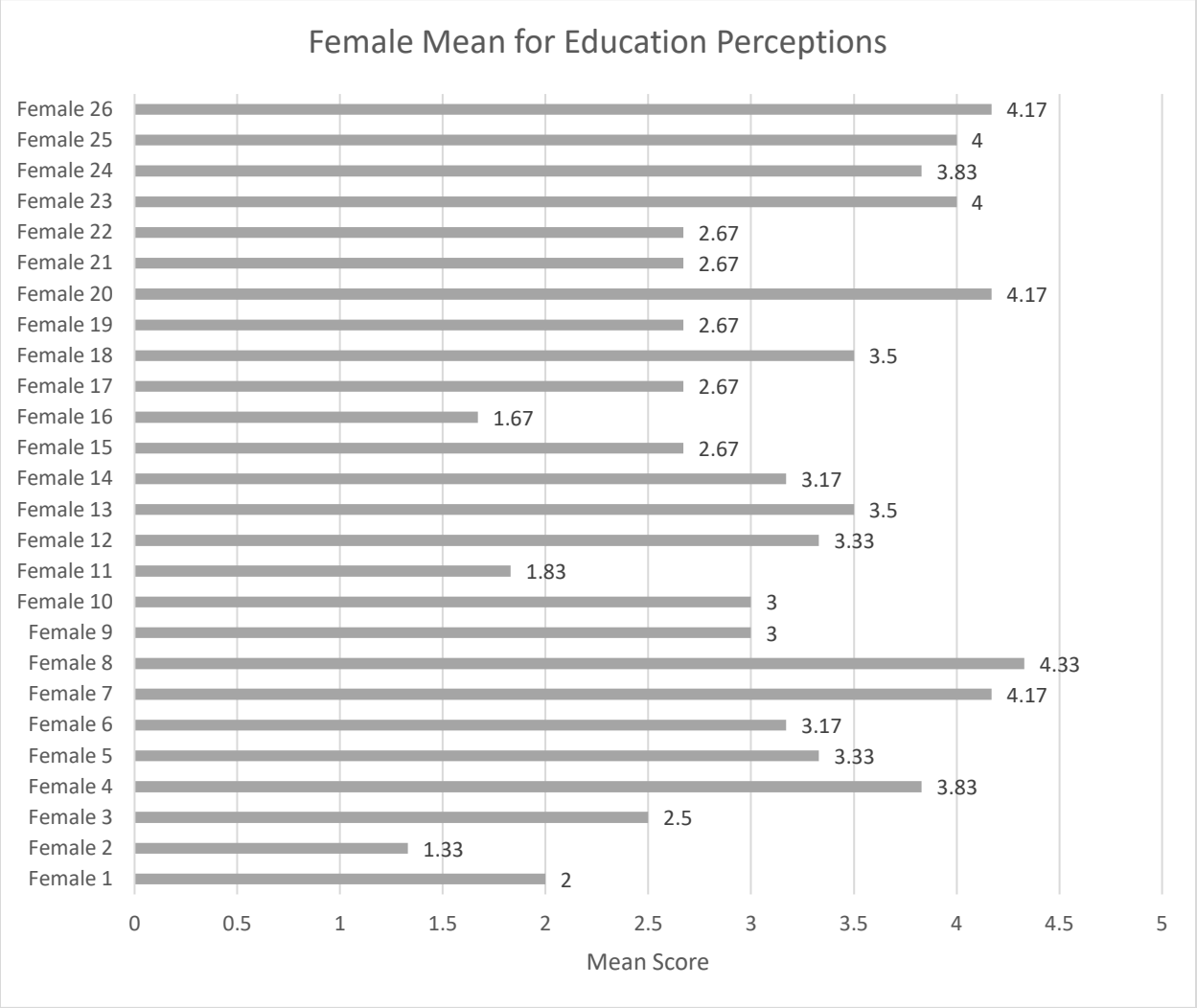

Figure 2a presents the calculated means for each female participant in response to education perceptions. The mean scores range from 1.33 to 4.33 with a combined female mean of 3.12.

Figure 2b

Mean Scores for Males Regarding Education Perceptions

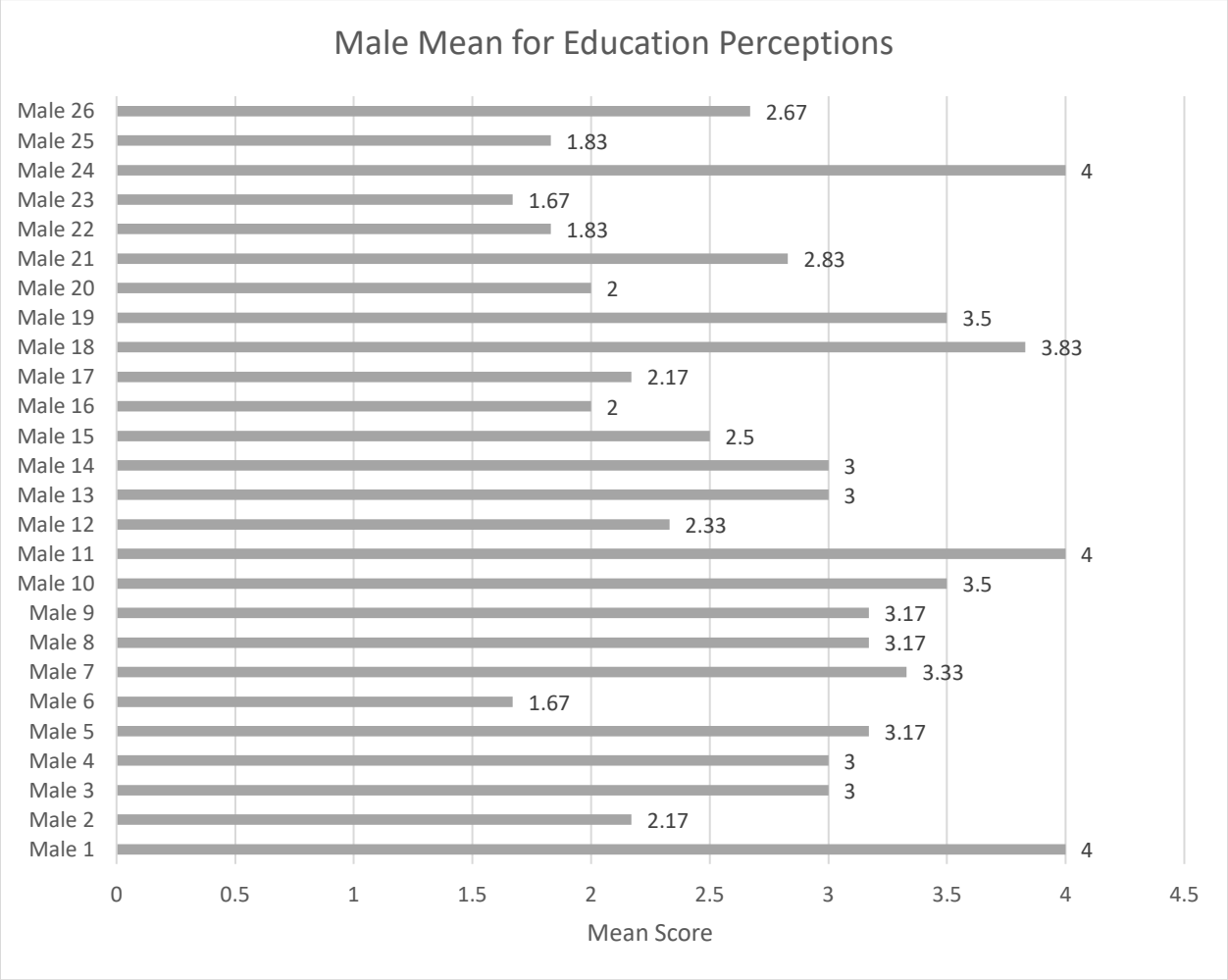

Figure 2b presents the calculated means for each male participant in response to education perceptions. The mean scores range from 1.67 to 4.0 with a combined male mean of 2.82.

Role of Adults and Peers

Table 3

Survey Questions Relating to the Role of Adults and Peers Perceptions

Survey Questions Relating to the Role of Adults and Peers Perceptions
My peers influence the courses I take.
My parents influence my academic choices.
My parents play a role in my academic success.
My counselor can assist me with class selections.
My counselor can assist me with career options.

Table 3 presents the survey questions asked in relation to perceptions of the role of adults and peers. A Likert-scale was used to measure participant perception of these statements. Participants were given the following options when completing the survey: 1 as "strongly agree," 2 as "agree," 3 as "neither agree nor disagree," 4 as "disagree," 5 as "strongly disagree." The results were then divided into female and male responses. A mean was determined for each student based on their answers to each of the five statements.

Figure 3a

Mean Scores for Females Regarding the Role of Adults and Peers Perceptions

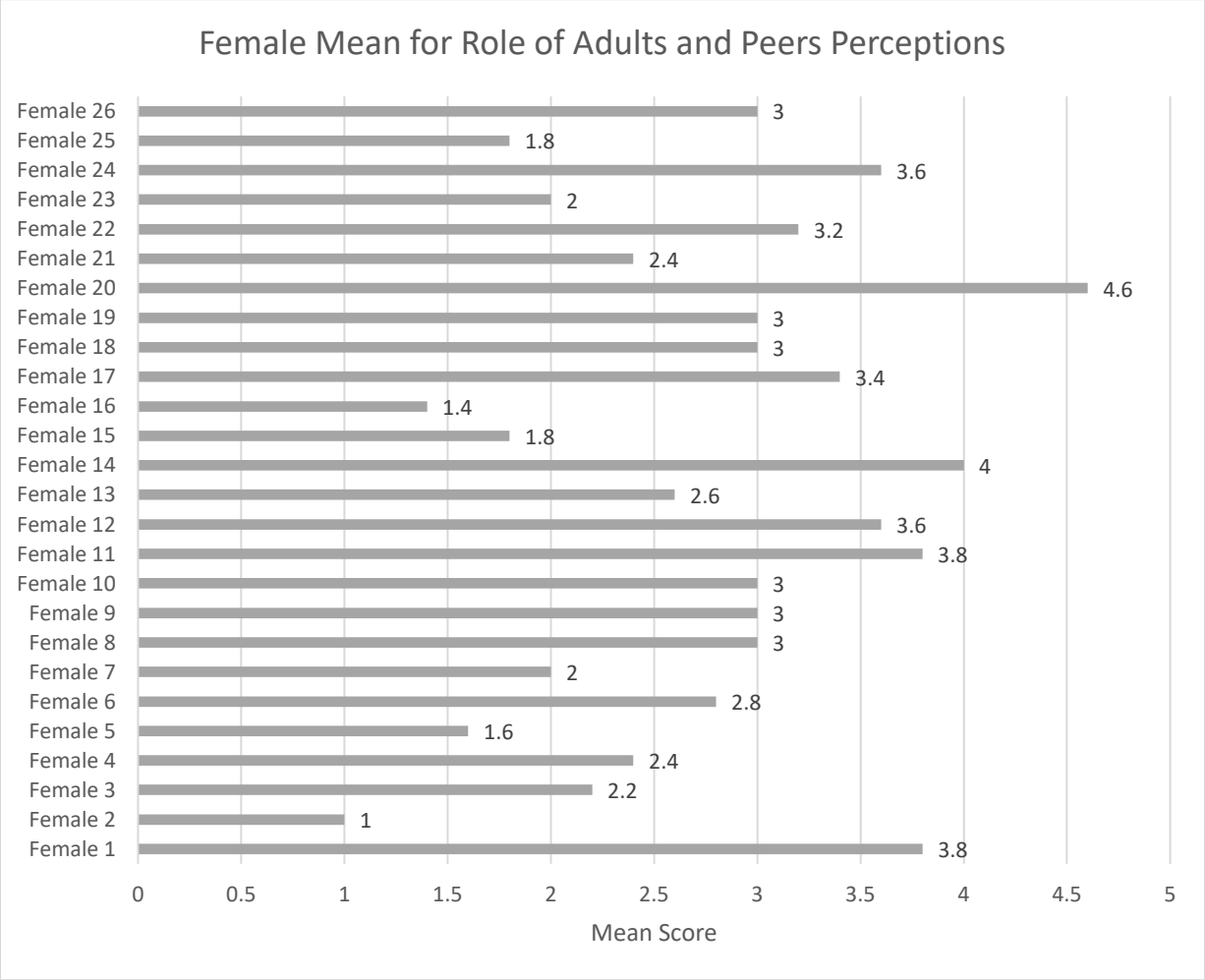

Figure 3a presents the calculated means for each female participant in response to the role of adults and peers' perceptions. The mean scores range from 1.0 to 4.6 with a combined female mean of 2.80.

Figure 3b

Mean Scores for Males Regarding the Role of Adults and Peers Perceptions

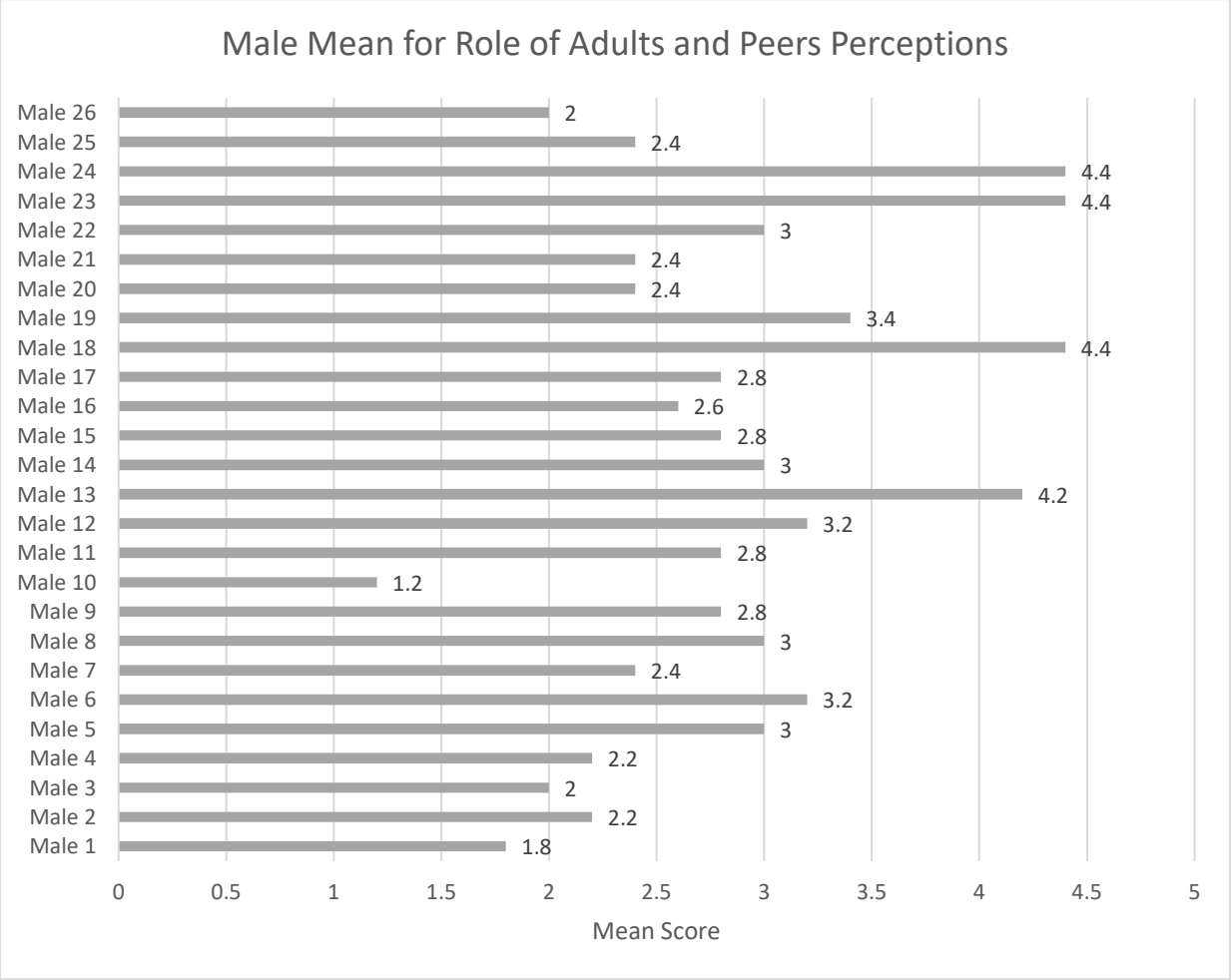

Figure 3b presents the calculated means for each male participant in response to the role of adults and peers' perceptions. The mean scores range from 1.2 to 4.4 with a combined male mean of 2.85.

Summary of Results

Table 4

Summary of Findings for All Themes and Statistical Analysis

	Stereotypes	Education	Role Models and Peers
Female Mean	2.74	3.12	2.80
Male Mean	2.45	2.82	2.85
Overall Mean	2.60	2.97	2.82
p-Value	0.2249	0.1762	0.8442

Table 4 summarizes the overall findings of the survey. The mean was determined for all 26 females for each theme studied. The mean was also determined for all 26 males for each theme studied. A combined mean was also calculated that included responses from all participants. The means for the females were compared to the means for the males using a two-proportion categorical test. The goal was to determine if there was a significant difference between the perceptions of males and females for each of the three themes. The means for every participant were entered into the two-proportion applet (Rossman & Chance n.d) to determine the p-Value. A p-Value determines the likelihood that the two groups, male and female are equal. A p-Value of less than 0.05 is considered significant, meaning the two groups are not equal. None of the three themes showed a significant difference as the p-Values were found to be 0.2249, 0.1762, and 0.8442.

Table 5

Reasons for Taking STEM Classes Past and Future

Why have you chosen to take these classes?	Female Percentage	Male Percentage	Total Percentage
I am interested in the topics these classes cover.	50%	42.3%	46.2%
I am preparing for college by taking these classes.	57.7%	57.7%	57.7%
I plan on working in these fields after school.	34.6%	42.3%	38.5%
My parents expect me to take these classes.	11.5%	11.5%	11.5%
My friends are taking these classes	3.8%	23.1%	13.5%
Other	19.2%	15.4%	17.3%

Table 5 presents the responses of all participants when asked "Why have you chosen to take these classes?" This question referred to advanced STEM classes and included all disciplines currently offered at this school. Participants checked all responses that pertained to them both past and future. The percentage of participants who agreed with the statements are indicated by percentage. Female and male percentages are separated and a combined total percentage is also included.

Discussion

Overview of the Study

In this rural Iowa school, a pattern has emerged of fewer females enrolling in STEM classes, especially advanced STEM classes. Over the past 5 years, females make up 40.4% of students taking advanced STEM classes while males comprise 59.6%. The purpose of this study was to determine the reasons that females enroll in these classes. A survey was given to 26

females and 26 males, students currently enrolled in an earth science class. The survey set out to measure perceptions surrounding three themes: stereotypes, females (and males) in education, and the role of adults and peers when considering whether or not to take advanced STEM classes. The results of the survey were analyzed to determine why female students enroll in advanced STEM classes at this rural Iowa high school.

Summary of the Findings

The survey was given to 26 males and 26 females currently enrolled in an earth science class to gauge their perceptions on three major themes discussed in the literature review: stereotypes, females in education, and the role of adults and peers. As presented in Table 4 using p-Values, there was no significant difference when comparing the mean scores between females and males for each of the three themes. The stereotype theme reported a p-Value of 0.2249, the females and education theme reported a p-Value of 0.1762, and the role of adults and peers theme reported a p-Value of 0.8442. As none of these p-Values are lower than 0.05, no significant difference between females and males surveyed was observed. This is encouraging, showing there is no significant difference between males and females and the abilities they perceive in themselves.

Stereotypes

As seen in Table 4, the results for this theme show females with a mean of 2.74 and males with a mean of 2.45. When considered as a whole, all students present a combined mean of 2.60. These numbers suggest that most students, male and female do not believe the traditional stereotypes commonly held in reference to the STEM fields. As reported by Hand et al., (2017) female students believe they lack the tools and abilities to be successful in STEM classes. A mean of 2.74 reported by female participants showed that this is not the case in this

rural Iowa high school. Females reported that they have the skills needed to be successful in STEM classes and careers. In an additional study carried out by Thebaud and Charles (2018), masculine traits are often associated with STEM careers, making it difficult for females to see themselves being successful. The results from Table 4 do not agree with this stereotype. All students in this study believe that they possess the skills to be successful in STEM classes and in STEM careers.

The lack of a significant difference between male and female perceptions of stereotypes might have been predicted. This result could be explained by the continued implementation of the Next Generation Science Standards (NGSS). The survey was given to students in an earth science class, a class that was only added three years ago. Earth Science was created as a recent requirement at this rural high school due to these new standards. As noted by Patterson and Johnson (2017), the addition of NGSS has increased the exposure to earth science curriculum beyond middle school classes. More students, both male and female are getting exposure to earth science, a science strand which previously ended at the middle school level. This may explain participants reporting increased skills in STEM. This district also added an agriculture program three years ago to fill a void in the career and technical program. This has allowed numerous students to explore the agriculture field and take classes previously unavailable to them. In a study completed by Thebaud and Charles (2018), Western cultural stereotypes were studied comparing the traditional roles of females and males. Many females continue to follow these traditional roles when choosing careers. The addition of an agriculture program has increased female exposure to a field that is traditionally filled by males. This exposure and increased familiarity may have decreased stereotypes that were commonly held in the past by high school students in regard to the agriculture field. These changes in availability and variety

of STEM classes allow all students the opportunity to succeed in more advanced STEM classes and build the skills needed for these fields.

Females in Education

As seen in Table 4, the results for this theme report females with a mean of 3.12 and males with a mean of 2.82. When considered as a whole, all students present a combined mean of 2.97. These numbers suggest that most students, male and female do not have strong perceptions when evaluating their education in the STEM fields. The results indicate that both male and female students do not have strong opinions about classes being engaging or relating to their lives. They also stay neutral when ranking knowledge of careers in STEM fields. The literature on STEM education suggests that females do not often find STEM classes engaging and cannot see themselves continuing in the field (Hand et al., 2017). The results from this survey, as well as the research presented in the literature review, indicates that there is a need to reduce this obstacle for both males and females. With the addition of new standards in the NGSS, the science department has implemented an inquiry-based curriculum to keep all students, both males and females engaged. The math department continues to evaluate curriculum to move toward a more engaging curriculum. The advanced STEM classes that fall into the career and technical department also by nature are more hands-on. More effort needs to be focused on making sure that curriculum is relevant to students' lives to promote continued engagement. As Campbell et al., (2004) found females report engagement in STEM classes when they relate to a students' life by including awareness, interest and motivation.

Role of Adults and Peers

As seen in Table 4, the results for this theme showed females with a mean of 2.80 and males with a mean of 2.85. When considered as a whole, all students present a combined mean

of 2.82. These numbers suggest that most students, male and female have adults, both in the school and at home that play a role in their education. The scores remain around the neutral option of the Likert-scale which allows room for improvement in the area of adult roles. Table 5 reports that only 11.5% of both males and females take advanced STEM classes because their parents expect them to. This result shows that students have created an intrinsic value for STEM classes as they continue to choose them without heavy parental influence. Rice et al., (2013) found that elementary and college aged students report a higher level of parental support than high school students. These results indicate that parents play a larger role at a younger age, but less so once high school age is reached. Therefore, students are motivated by different factors when choosing advanced STEM classes to take. In a study performed by Hall et al. (2011), high school students reported that personal interest is their top influence when considering classes to take. Fostering the intrinsic value for STEM classes may lead to an increase in advanced STEM class enrollment in the future.

Table 5 also reports that peers seem to play a minimal role as only 3.8% of females and 23.1% of males take classes because their peers do. This contradicts a study where Dasgupta and Stout (2014) found that class selection for females is more dependent of their peers than males. The findings presented in Table 5 indicate that this is not the case at this rural Iowa high school. There may be a different relationship present. Patterson and Johnson (2017) reported that females see their peers as competition and this may influence classes taken including elective STEM classes suggesting that competition for success may play a larger role than taking the same classes as their peers. The results found in Table 5 indicate that school personnel including teachers and counselors likely play the largest role in encouraging advanced STEM class enrollment. At our rural school, every STEM department has both male and female teachers

who engage students in learning. In a study conducted by Rice et al., (2013) students reported receiving the least amount of teacher support during their high school years. This rural school should explore teacher support and utilize both male and female teachers to allow more students to envision STEM possibilities for themselves. Teachers must make sure that they are encouraging all students and they must work with school counselors to provide the encouragement for STEM students (Weber, 2012). Students already have direct connections with valued male and female adults who can guide them and help them become successful in STEM fields. While the ranking of this theme remains neutral, adults do play a role in student perceptions.

Recommendations

Moving forward this rural Iowa school must strive to increase the number of all students that take advanced STEM classes, not just female students. As reported in Table 4, both males and females had a higher mean in questions pertaining to their perceptions of education. In addition, Table 5 reports that 50% of females and 42.3% of males report an interest in STEM classes. The challenge that remains is encouraging students to continue to enroll in these advanced STEM classes. These classes need to continue to move toward engaging lessons that relate directly to students' lives. By doing this, students will continue to achieve success in STEM classes and continue enrollment throughout their high school career. Classes will become applicable to their lives and promote engagement throughout their entire high school career and hopefully beyond.

Also reported in Table 5 is the percentage of students who enroll in STEM classes as preparation for college: 57.7% of both males and females. This data indicates that students intend to go to college and are aware that STEM classes are recommended to be successful.

Teachers and counselors need to present an increased amount of STEM career information to students. This could be achieved utilizing career nights, communications with parents, and can easily be incorporated into class curriculum. Presenting this information to students in multiple formats has the potential to increase interest in pursuing jobs and degrees in this field. Currently when asked about working in the STEM fields, Table 4b show that only 34.6% for females and 42.3% for males had plans to do so.

As presented in Table 4, the second lowest mean corresponded with the theme of the role of adults and peers. By addressing this theme as well, an increase in enrollment of females and males in STEM classes could potentially be observed. The counselors need to continue to educate students about college opportunities and careers in STEM. This study showed that school personnel have the biggest influence on students so they must remain educated and up to date on the current opportunities. A partnership needs to be cultivated that educates parents about STEM possibilities for their children as most parents are not well-versed in the everchanging field. A partnership with counselors and teachers could create a beneficial team that encourages enrollment in STEM classes and careers. A mentoring program should be explored to foster students' interest in STEM fields. This school is located near a state university that specializes in science and technology. A mentoring program between professionals at this university and interested students has the potential to create relationships the encourage students to pursue their interest in all parts of STEM not just those offered at our local high school.

Limitations

This study was conducted using only one class, Earth Science, with a total of 52 participants. They are all from the same school and were not randomly selected. Participants share common educational experiences that may be unique to a rural Iowa setting. All

participants currently have the investigator as an instructor and this may have altered how they filled out their surveys. They may have put answers that they think the instructor wanted to see instead of being completely forthright. These limitations could have impacts on the data acquired from the survey. A larger group, containing more classes and more grade levels may have shown a different trend.

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Appendix A: Survey

Section 1: This will provide basic demographic information of survey participants.

1. Grade

2. Gender

3. Classes taken including this year. (Check all that apply)

   Anatomy and Physiology
   Chemistry
   Physics
   Advanced Chemistry
   Calculus
   Statistics
   Precalculus
   Intro to Ag
   Ag Entrepreneurship
   Plant Science Horticulture
   Agronomy
   Ag Mechanics
   Vet Science
   Animal Science
   Ag Business
   Ag Welding
   DMACC Applied Math
   CAD/3D Printing
   Accounting

4. Classes you plan on taking. (Check all that apply)

   Anatomy and Physiology
   Chemistry
   Physics
   Advanced Chemistry
   Calculus
   Statistics
   Precalculus
   Intro to Ag
   Ag Entrepreneurship
   Plant Science Horticulture
   Agronomy
   Ag Mechanics
   Vet Science
   Animal Science

Ag Business
Ag Welding
DMACC Applied Math
CAD/3D Printing
Accounting

5. Why have you chosen to take these classes? (Check all that apply)

   I am interested in the topics these classes cover.
   I am preparing for college by taking these classes.
   I plan on working in these fields after school.
   My parents expect me to take these classes.
   My friends are taking these classes.

6. What are your future plans?

   Attend community college.
   Attend a four year college.
   Attend a trade school.
   Enter the workforce.
   Join the military.
   I'm not sure yet.
   Other…

Section 2: Questions about stereotypes/how females see themselves. This will be rated on a five-point Likert type scale ranging from 1 (strongly agree), 2 (agree), 3 (neither agree nor disagree), 4 (disagree) to 5 (strongly disagree).

7. I have the skills to succeed in math classes.

8. I have the skills to succeed in science classes.

9. I can be successful in math careers.

10. I can be successful in science careers.

Section 3: Questions about females and education. This will be rated on a five-point Likert type scale ranging from 1 (strongly agree), 2 (agree), 3 (neither agree nor disagree), 4 (disagree) to 5 (strongly disagree).

11. Math classes use lessons that engage me.

12. Science classes use lessons that engage me.

13. Math classes relate to my life.

14. Science classes relate to my life.

15. I am knowledgeable about science careers.

16. I am knowledgeable about math careers.

Section 4: Questions about the role of adults/peers. This will be rated on a five-point Likert type scale ranging from 1 (strongly agree), 2 (agree), 3 (neither agree nor disagree), 4 (disagree) to 5 (strongly disagree).

17. My parents play a role in my academic success.

18. My parents influence my academic choices.

19. My counselor can assist me with class selections.

20. My counselor can help me select careers.

21. My peers have an influence on the courses I take.