AN EXAMINATION OF MIDDLE SCHOOL STUDENTS' ATTITUDES TOWARD SCIENCE

Michelle L. Schpakow
Monmouth University
mschpako@monmouth.edu

Jillian L. Wendt
University of the District of Columbia
jillian.wendt@udc.edu

Kelly Paynter
Jacksonville State University
kpaynter@jsu.edu

https://doi.org/10.25891/r790-ty53

ABSTRACT
For more than 40 years, researchers have been studying the persistent underrepresentation of women in science. Today, the gender gap has narrowed in some, but not all, disciplines of science. To better understand the impetus of this continuing problem, the attitudes of middle school students toward science were examined using a causal-comparative design based on biological sex across four attitude constructs: attitudes toward school science, desire to become a scientist, value of science to society, and perceptions of scientists. A sample of 450 sixth-, seventh-, and eighth-grade science students located in suburban, central New Jersey responded to Likert-type items on the My Attitudes Toward Science (MATS) survey during their regularly scheduled science class periods. Data analysis was performed through a multivariate analysis of variance. The findings indicated no statistically significant differences in middle school students' attitudes toward school science, desire to become a scientist, value of science to society, and perceptions of scientists based on biological sex of the students. Implications for the findings are discussed.

KEYWORDS
science attitudes, middle school science, gender gap, biological sex

It is widely recognized that women historically have been underrepresented in science (National Science Foundation [NSF], 2019). Today, the problem persists within some disciplines of science, though female representation in other science careers, such as those in the health professions, veterinary medicine, and biology, has become more equitable (Jones et al., 2000; Wang & Degol, 2017). The unbalanced distribution of women in science, and blatant underrepresentation in some fields, is a two-fold problem: it has the potential to greatly impact the diversity, creativity, and productivity of the larger society (National Academies of Sciences, Engineering, and Medicine [NASEM], 2019; NSF, 2019), and it places women at a disadvantage by diminishing their earning potential in comparison to men (Beyer, 2014; Oh & Lewis, 2011; Xu, 2015).

To better understand and combat the problem of female inequities in science, educational researchers have been studying how male and female students participate in science for over 40 years (Buck et al., 2014; Bybee & McCrae, 2011; Naizer et al., 2014; Osborne et al., 2003). These studies have considered the problem through different lenses, such as disparities in science achievement based on biological sex or students' attitude toward or appreciation of science overall. Even with extensive study in this area, differences in engagement in science based on biological sex—referred to in the literature as the gender gap—continue to pervade the realm of science. Current research calls for continued investigation (Reilly et al., 2019; Wieselmann et al., 2020).

The research presented here investigated differences in science attitude constructs in middle school students based on biological sex. The aim of the research was to complement prior research that mainly focused on overall science attitudes or achievement differences based on sex or gender (e.g., Gokhale et al., 2015; Guzey et al., 2016; Quinn & Cooc, 2015) by examining the multidimensional nature of students' science attitudes. The study also used the My Attitudes Toward Science (MATS) instrument (Hillman et al., 2016), which has shown promise in examining the nuances of science attitudes.

Attitude Toward Science

Hillman et al. (2016) report that a child's attitude toward science can be broken into four main domains or constructs: attitude toward school science, desire to become a scientist, value of science to society, and perceptions of scientists. It is not enough then to measure only how positively or negatively a student views science as a whole. Instead, researchers need to determine on which specific attitude constructs male and female students differ to ultimately determine why fewer women historically participate in science across different fields.

Hillman et al. (2016) describe the attitudes toward school science construct as a student's feelings toward the behavior of participating in school science classes. A student's attitude can affect the way he or she engages with science coursework (Teodorescu et al., 2014). Male students traditionally have "a consistently more positive attitude [toward] school science than girls" (Chen & Howard, 2010, p. 138). Studies suggest that, overall, male students tend to appreciate the use of technology in school, show interest in learning by discovery, and are willing to take risks (Chen & Howard, 2010; Eagly & Wood, 2013; Incantalupo et al., 2014). In contrast, female students are often less confident in school science, which may cause them to dislike the subject in school, particularly in the middle grades (Smith et al., 2014).

A student's desire to become a scientist is broadly defined as his or her interest in pursuing any career in a scientific, medical, or technological field (Hillman et al., 2016). Ajzen and Fishbein (1977) explain that behavior is directed by attitude. Attitudes toward science can therefore influence students' choices to engage in science-related courses, potentially translating into improved academic achievement (Barnes et al., 2005; Leibham et al., 2013). It is then surmised that if one possesses a positive attitude toward science, then the resulting behavior would likely be engagement in or increased achievement in science (Singh et al., 2002). Male students in middle school have been found to express a desire for careers relating to technology, engineering, or mathematics at a significantly higher rate than middle school girls (Desy et al., 2011; Jenkins & Nelson, 2005; Stoet & Geary, 2018). Of the female students who do indicate a desire to become a scientist, the most popular career choices are veterinary medicine and healthcare professions (Desy et al., 2011; Jones et al., 2000)—so called "helping professions." Further, reports indicate that females are less likely to persist in science as a career broadly across disciplines (NSF, 2019). Thus, numerous efforts within the United States continue to focus on broadening participation of women in science, especially in "non-helping" fields (NSF, 2019).

Value of science, as defined by Hillman et al. (2016), is a student's awareness of how discoveries and technological advances aid society through STEM. Students become more interested in science when they see the practical significance of science as a contributor toward society (George, 2006). Differences in the perceived value of science to society based on biological sex are contradictory within the literature. Some studies have shown that female students recognize the value of science more readily than male students, though this perceived value does not necessarily correlate to an increased pursuit of STEM careers (Blanchard Kyte & Riegle-Crumb, 2017; Else-Quest et al., 2013), while Blanchard Kyte and Riegle-Crumb (2017) report that male students' choices for careers in science appear to be unaffected by their perception of science's societal value.

The stereotypical belief that scientists are male and that science is a masculine domain is referred to in the literature as the gender-science stereotype (Cai et al., 2016; Miller et al., 2015). It is a well-known phenomenon and has been shown to have a negative impact on female students interested in science (Hong & Lin, 2011; Quinn & Cooc, 2015; Reilly et al., 2019). Men working in STEM professions more readily endorse this stereotype, as their own actions serve as reinforcement of their perception that science is predominantly a male domain (Smyth & Nosek, 2015). Similarly, women who work outside of STEM professions continue to uphold this stereotype, whereas women working in STEM endorse the stereotype far less (Smyth & Nosek, 2015). The endorsement of the gender-science stereotype has led to fewer women participating in some fields of science such as computer sciences, engineering, and physics (NSF, 2019). The NSF (2017) has shown that female students are less likely than male students to pursue advanced science courses in high school and college, precluding women from entering science professions in an equitable manner when compared to men.

While the gender gap in science has been researched extensively, the gap still persists and many questions remain about the cause, continued perpetuation, and methods for closing the gap. If the goal of researchers is to identify disparities in science based on biological sex with the intention of drawing more women into all disciplines of the science-related workforce, it is important to understand how student attitudes differ based on sex at the critical middle school level. Attitudes, in fact, have been cited as one of the most important factors in determining females' participation in science (Else-Quest et al., 2013; Reilly et al., 2019; Smeding, 2012), yet they remain under-researched. As the pursuit of science-related careers is directly related to attitude, it becomes increasingly imperative to examine student attitudes across specific constructs rather than as a whole. These nuances may provide greater insight into student choices related to science than examining students' attitudes as a single domain, allowing educators and researchers to better provide interventions to keep female students interested in STEM.

Theories Related to Gender Stereotypes in Science

There are several theories that may provide insight into the observed STEM gender gap in terms of male and female students' interest in, attitudes towards, participation in, and persistence in science. Eagly's social role theory (1987), for instance, postulates that gender stereotypes may impact children's attitudes toward science. Social role theory suggests that children learn what social roles are acceptable and expected of them based on their observations of adults in their society (Eagly & Karau, 2002; Miller et al., 2015). Historically, men and women have performed different jobs within and outside of the household. These traditional gender roles are often observed by children and then perpetuated through subsequent generations (Eagly & Karau, 2002). Importantly, despite some shift in societal attitudes, these traditional gender roles persist today (Rennison & Bonomi, 2020). Research examining science identity aligns closely with social role theory in that individuals who do not have opportunities to see others that look like them participating in their selected field of study may not believe that they belong in the profession (Carlone & Johnson, 2007; Hill et al., 2010; Rockinson-Szapkiw et al., 2021). When this happens, the female students endorse and perpetuate stereotypes, allowing these beliefs to continue through to yet another generation. Though the perception increases in magnitude with age for both male and female students, Liu et al. (2010) found that it is stronger for female students than it is for male students in middle school.

Social role theory serves as a foundation to explain the historical disparities observed in STEM fields based on biological sex. As female representation in some science disciplines has improved, however, it is also important to consider how gender theories have evolved over time in response to social change and how changes to these theories may help to explain the inequities still observed in the other science disciplines. Gender identity theory, for example, reconsiders gender differences and isolates the term gender from biological sex (Vantieghem et al., 2014). Egan and Perry (2001) posit that individuals engage in gender as a multidimensional process rather than as a singular identity attribute, identifying these dimensions to include gender typicality, gender contentedness, pressure for gender conformity, and gender superiority. Individuals may express gender in typical or atypical ways for their biological sex or feel pressure to conform to expected gender roles (Egan & Perry, 2001; Lagaert et al., 2017; Vantieghem et al., 2014). Gender identity theory then realigns behaviors and attributes to the domains of masculinity and femininity rather than to each biological sex (Vantieghem et al., 2014). The dimensions of gender identity have been shown to serve as powerful mechanisms reinforcing the gender gap in non-STEM disciplines (Lagaert et al., 2017) and STEM disciplines alike (Sibley & Crane-Seeber, 2020). Given that gender governs interactions and self-perceptions in academic, occupational, recreational, and interpersonal aspects of an individual's life (Egan & Perry, 2001), it is likely that gender identity serves as a similar mechanism, reinforcing gender gaps in other disciplines, including STEM.

Negative Effect of Stereotypes in Science

The disproportionate abundance of men compared to women in STEM professions has led to a long-standing stereotype that science is mainly for men (Farland-Smith, 2009; Quinn & Cooc, 2015). Studies have shown that, when young students are asked to provide a depiction of what they believe a scientist looks like, scientists are typically believed to be White men (Farland-Smith, 2009; Farland-Smith et al., 2014; Miller et al., 2018). Recent analysis has indicated the frequency by which young female students draw depictions of scientists as male has decreased as compared to past decades (Miller et al., 2018). However, scientists are still overwhelmingly perceived as male by both young girls and young boys. Further, despite efforts to engage young girls in STEM, female elementary student participants still overwhelmingly believe that STEM is better suited for males (Wieselmann et al., 2020) and, importantly, view "mathematics as a gatekeeper for STEM participation" (p. 304).

In some cases, parents, teachers, and other role models may intentionally or unintentionally model gender stereotypes while encouraging male students to engage in science-related activities and encouraging female students to engage in more feminine activities (Farland-Smith, 2009; Venkataraman et al., 2019). The perceptions of such role models have been shown to influence students' views of whether or not they belong in science fields (Gokhale et al., 2015; McGuire et al., 2020; Ochsenfeld, 2016). Further, given the disparity in representation of females in science fields (NSF, 2019), female students may have fewer known female role models to alter the perspective that science is a masculine endeavor (McGuire et al., 2020; Stearns et al., 2016). Thus, there are fewer like others to view (Venkataraman et al., 2019; Wendt et al., 2019), which may influence students' identities and their ability to see themselves as belonging in science (Archer et al., 2013).

Some fields of science, such as computer science, experience larger gender gaps than other science fields (Venkataraman et al., 2019) and may elicit additional stereotypes. Computer scientists, for example, are often stereotyped as "nerds, geeks, or hackers" who lack interpersonal skills (Beyer, 2014, p. 155). This stereotype is carried over to other scientific professions as many people perceive scientists to be individuals who work alone in laboratories filled with test tubes and scientific equipment (Farland-Smith et al., 2014). Women and girls may avoid these fields because they believe them to be isolating (Beyer, 2014; Venkataraman et al., 2019). Though the stereotype of science being only for men is untrue, the perception and feelings of not belonging may prevent women from choosing to pursue science as a career or remaining in a science career (Archer et al., 2013). Previous research reports that women also choose to leave science fields and careers due to external pressures, such as family responsibilities, a "chilly climate," and incongruence between personal values and job expectations (see Brue, 2019; Dawson et al., 2015; Fouad et al., 2016; Jensen & Deemer, 2019; Rockinson-Szapkiw et al., 2021).

Women who are impacted by gender stereotypes in science often find themselves at a disadvantage (McGuire et al., 2020). By not pursuing STEM careers, their earning potential is lowered in comparison to men (Beyer, 2014; Oh & Lewis, 2011; Xu, 2015). The potential loss of talent and the need for increasing the diversity of the STEM workforce are undeniable (NASEM, 2019).

Methods

This study used a causal-comparative research design with the students' self-reported biological sex as the independent variable and the students' attitudes toward school science, desire to become scientists, value of science to society, and perceptions of scientists as the dependent variables.

RQ: To what extent do attitudes toward school science, desire to become a scientist, value of science to society, and perceptions of scientists of male and female middle school students differ as measured by the MATS instrument?

Sample

A convenience sample of middle school students was selected from a suburban school district in central New Jersey in the United States during the 2017–2018 school year. Eighteen classes each from two middle schools were included in the sample for a total of 36 classes. Participants for this study were selected from general education science classes in the sixth, seventh, and eighth grades in each of the participating schools. The sample did not include advanced placement, honors, or resource level classes, but instead focused solely on general education track students. The resulting sample consisted of 198 male students and 252 female students for a total sample size of 450 participants. The ethnic breakdown of participant groups is shown in Table 1. All classes recruited used a spiral curriculum model, which shares instructional time among the major science disciplines—Earth, life, and physical—throughout the year at each grade level.

Table 1
Demographic Data of Middle School Students

Category	Gender	
Grade Level	Male	Female
6	22.7%	28.6%
7	42.9%	44.1%
8	34.3%	27.4%
Average Age	12.4 years	12.2 years
Self-Reported Ethnicity		
Caucasian	44.9%	45.6%
Asian	12.6%	20.2%
African American	8.7%	4.4%
Latino/Hispanic	8.3%	7.5%
Biracial	6.7%	11.1%
Other race(s)	9.5%	10.3%

Note: N = 450

Instrumentation

The MATS instrument, designed by Hillman et al. (2016), was developed to measure the multidimensional nature of a child's attitude towards science. This instrument measures a student's science attitude across the four specific attitude constructs: attitudes toward school science, desire to become a scientist, value of science to society, and perceptions of scientists.

Prior to the current study, the instrument was subjected to several rigorous field tests to demonstrate its reliability and validity. Expert review was conducted by teachers, researchers, and graduate students (Hillman et al., 2016). Cronbach's alpha coefficients showed internal consistency for each of the subscales across elementary, middle, and high school grade levels. The Cronbach's alpha coefficients for the attitude toward school science, desire to become a scientist, and value of science to society subscales were 0.866, 0.700, and 0.794 respectively for all grade levels (Hillman et al., 2016). The same subscales revealed coefficients of 0.841, 0.658, and 0.780 at the middle school (grades six–eight) level. In a previous study, the perception of scientists subscale showed a lower coefficient (0.539 total and 0.495 at the middle school level), indicating students' perceptions were not homogenous (Hillman et al., 2016). Cronbach's alpha for the current study is reported in the Results section below.

The MATS instrument consists of 40 items representing the four subscales of students' attitudes using 5-point, Likert-type responses. The attitude toward school science subscale contains 14 items, allowing each student's score to total between 14 points, indicating the most negative attitude toward school science, and 70 points, indicating the most positive attitude toward school science. The desire to become a scientist subscale only contains two items so that each student's score could fall between 2 and 10 points. The value of science to society subscale has 12 items allowing potential scores to fall between 12 and 60 points. These three subscales are comprised of an equal number of positively phrased and negatively phrased statements. For the perceptions of scientists subscale, a higher score represents a more stereotypical ideation of scientists, where 60 is the highest possible score and 12 is the lowest possible score (Hillman et al., 2016). No composite score was calculated, as the instrument is designed and used to interpret multiple components of a student's attitude rather than an overall positive or negative attitude. The subscales of the instrument allow its findings to be interpreted to the extent that researchers can identify the specific attitude constructs on which students differ based on biological sex.

Procedures

After receiving ethics approval and obtaining consent and assent forms, students electing to participate in the study were asked to complete the MATS instrument during their normal science class periods. After obtaining the completed instruments, the researchers combined data from all classes, entered them into an Excel spreadsheet, and analyzed the data with the use of IBM SPSS software. Because the first three subscales included positively and negatively worded statements, reverse coding was necessary for the negative statements before data analysis could take place.

A one-way MANOVA at the 95% confidence level was conducted to determine if there was a difference in attitudes towards school science, desire to become a scientist, value of science to society, and perceptions of scientists of male and female middle school students. Prior to conducting the MANOVA, data screening was performed. Several outliers were identified and removed from the study. A Kolmogorov-Smirnov test and generation of histograms indicated that the assumption of normality was violated, a problem inherent in the use of Likert-type surveys. Thus, QQ plots were created and subsequently showed normal distribution patterns. Additionally, "even when the data are not multivariate normal, the multivariate normal may serve as useful approximation" (Rencher, 1995, p. 94). The central limit theorem permits normality violation with large enough sample sizes, as those seen in the present study, to the extent that analysis could be continued (Rencher, 1995). Therefore, with a sample size of 450 students, the assumption of normality was deemed tenable. The Box's *M* test was used to test the equality of covariance matrices. The assumption of covariance matrices was met ($p = 0.467$).

Results

The results indicated that male students' attitudes toward school science ($M = 56.07$, $SD = 9.70$) were not statistically significantly different from female students' attitudes toward school science ($M = 54.04$, $SD = 10.84$). Male students' desire to become scientists ($M = 5.49$, $SD = 2.28$) was also found to be no different, statistically, than that of female students ($M = 5.17$, $SD = 2.34$). Similarly, no statistically significant differences were found in male students' ($M = 48.15$, $SD = 7.28$) and female students' ($M = 48.52$, $SD = 6.65$) perceived values of science to society. When examining the descriptive statistics, male ($M = 27.56$, $SD = 5.16$) and female ($M = 27.47$, $SD = 4.86$) students' perceptions of scientists were nearly the same.

A Wilks' Lambda statistic was used to measure the proportion of variance in the functions of student attitudes that is not associated with group membership (Warner, 2013). The result of the MANOVA was not statistically significant at an alpha level of 0.05, where $F(4, 445) = 1.96$, $p = 0.10$, partial $\eta^2 = 0.02$, which suggests there were no statistically significant differences in male and female middle school students' attitudes toward school science, desire to become a scientist, value of science to society, and perceptions of scientists. The effect size, as measured by partial eta squared, was small (Warner, 2013).

In order to ensure internal consistency and report on the instrument used in the study, Cronbach's alpha coefficients were calculated for each subscale: attitude toward school science ($\alpha = 0.893$), desire to become a scientist ($\alpha = 0.774$), value of science to society ($\alpha = 0.781$), and perception of scientists ($\alpha = 0.534$). The attitude toward school science, desire to become a scientist, and value of science to society subscales demonstrated high reliability (Rovai et al., 2013). The perception of scientists subscale, however, demonstrated only moderate reliability (Rovai et al., 2013), aligning with previous findings of the instrument developers (Hillman et al., 2016).

Discussion

This study aimed to examine the differences, if any, that exist among middle school students' attitudes toward science from a multidimensional perspective based on students' biological sex. The results of this study indicated that male and female students' attitudes toward science are not statistically different at the middle school level among the sample population. A comparison across each attitude construct measured by the MATS instrument based on descriptive statistics revealed similar scores for male and female students. When considering the subscales, the attitudes toward school science of male and female middle school students was positive. The students' desire to become scientists was almost neutral for both males and females. Students of both biological sexes also shared positive views of the value of science to society and indicated a low ideation of scientist stereotypes. This finding aligns with previous research, albeit limited, that indicates a shift in attitudes toward science around middle school, with girls demonstrating more equitable attitudes than boys (Desy et al., 2011; McGuire et al., 2020). However, causation for this shift in attitudes still remains undetermined (McGuire et al.,

2020) and is an important component of understanding how efforts to broaden female participation across all science disciplines may be made effective.

Though attitudes toward school science, value of science to society, and perceptions of scientists remained positive for students of both biological sexes, male (M = 5.49, SD = 2.28) and female (M = 5.17, SD = 2.34) students only indicated a neutral desire for careers in science. In this case, the students indicate that they enjoy science in school, believe it has value in society, and no longer endorse science stereotypes, yet neither male nor female students showed a great desire to become scientists themselves. It appears that the belief that science is a male domain could be waning, but the draw of new students into STEM professions is not keeping pace with current and projected economic needs (Huderson & Huderson, 2019). While recent NSF (2019) reports indicate that women hold the majority of degrees in psychology, biology, and social sciences, they continue to be underrepresented in computer science, engineering, mathematics, and physical sciences. Thus, efforts should be focused on determining how attitudes may impact women's choices to pursue specific science fields over others.

Because there are persistent gender gaps within STEM fields, it would be logical to expect statistically different results in the science attitudes male and female students express. No significant differences, however, were shown in the data from this study. Social role theory, and even gender schema, may not be enough to explain the differences observed in men and women in the STEM workforce. Gender identity may be a greater factor in the results observed in this study. Prior research has shown that more women are drawn to biological, psychological, and health professions than to physical science, technology, or engineering (Jones et al., 2000; Wang & Degol, 2017). These professions are dubbed "helping professions" because the work associated with these professions often translates to caring for or helping others. Differences in attitudes may not be perceived as based on biological sex alone. Instead, it will be important for future studies to examine any differences that may exist based on students' gender identities.

It should also be noted that the MATS instrument is relatively new and has not yet been used extensively. Thus, more extensive use of the instrument may lead to its further refinement based on current and subsequent findings. For example, the desire to become a scientist subscale only has two items stating "I would like a job as a scientist" and "I don't want a job as a scientist, because I have no interest in it." As previously discussed, many of the differences based on biological sex currently found in STEM professions are related to the specific fields of science. Additionally, some careers requiring STEM skills, such as nursing, may not be considered STEM professions by students (Stoet & Geary, 2018). Because this subscale does not enumerate the various professions students may choose within the sciences, students in the present study considering careers that they would not label with the term "scientist" may not have answered these survey items to reflect their true career plans. The neutral findings on this particular subscale may be due to a lack of agreement on what it means to have a career as a scientist. Students surveyed did not show strong preferences for or against scientific careers, and no statistically significant difference was found based on biological sex. If the instrument had listed specific careers within science such as veterinarian, computer scientist, astronomer, or botanist rather than simply using the term "scientist," students may have been better able to envision themselves within the larger STEM professional community. This type of change to the instrument could allow for a better overall comparison of students' desire to enter STEM professions based on biological sex as well as demonstrating how biological sex affects students' choice of career fields within STEM.

Similarly, the perception of scientists subscale demonstrated only moderate reliability in a previous study (Hillman et al., 2016), as well as in the current study. This finding indicates that additional refinement of the perception of scientists subscale may be needed. The low Cronbach's alpha coefficient calculated for this subscale in both studies may indicate a shift in students' views of the stereotypical traits that scientists possess; however, it is also likely that the subscale lacks internal consistency as it attempts to measure many stereotypical perceptions within a single subscale. Some of the statements, for example, apply to the masculine domain of science while other statements are made regarding scientists' presumed lack of social skills or the stereotype that all scientists work in laboratories (Hillman et al., 2016). Students may endorse some, but not all, of these stereotypes, leading to the low internal consistency score. Separating the specific stereotypes out into their own subscales, or onto a separate instrument completely, could improve the reliability and validity of this instrument.

Limitations and Recommendations for Future Research

The sample used in this study was drawn from middle schools residing within the same suburban school district, which could limit the generalizability of the results. The study could be replicated in other geographical locations to ascertain the climate of students' attitudes at a national or international scale. Additionally, the numbers of male and female students used in the study were not equivalent, nor were the numbers of students in each of the three grade levels. Using a sample that is more equivalent in representation of biological sex, as well as a larger sample, could yield different results.

The MATS instrument itself also represents a limitation. It is a relatively new instrument, and it yielded a low Cronbach's alpha for the perceptions of scientists subscale during its field testing. A similarly low Cronbach's alpha was calculated for the perceptions of scientists subscale during the present study ($\alpha = 0.53$). Thus, the development of a more robust measurement of perceptions of scientists could be beneficial in future studies. Future measurement should also account for the multitude of careers that relate to science.

Studying students' attitudes at one point in time may not provide the same depth of knowledge as studying how students' attitudes change over time. Therefore, a longitudinal study allowing researchers to compare students' attitudes toward school science, desire to become a scientist, value of science to society, and perceptions of scientists could yield different results measuring how these attitude constructs change over time. Increasing the diversity of the STEM workforce should not end with attracting more women to the different fields of science. Future studies should also be performed measuring students' attitudes across the four constructs based on race and ethnicity to further inform curricular reform that may diversify science professions.

Further, the authors recognize that sex and gender are complex characteristics. While the current study has limited the examination of attitude constructs to comparisons among biological sex, future study should examine variations of sex and gender, including gender identities, to further add to the research literature. Research that focuses on those with diverse gender identities remains sparse (Sibley & Crane-Seeber, 2020).

Conclusion

While this study demonstrated that no statistically significant differences among middle school students' attitudes toward science existed among the sample population studied, the findings contribute to the body of knowledge by supporting and upholding previous studies (Desy et al., 2011; McGuire et al., 2020). The findings indicate that a shift in attitudes may have occurred in recent years, resulting in more equitable attitudes toward science among male and female students. However, future research should consider what factors impact students' attitudes toward science, whether attitudes remain consistent as students matriculate into high school and beyond, and whether findings are generalizable among populations who have diverse gender identities. The findings, regardless, indicate an encouraging trend within the field of education in supporting the construction of attitudes that embrace science, breaking from traditional gender roles, identities, and expectations.

Disclosure Statement

The authors reported no potential conflict of interest.

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