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Examining the relationship between attitudes toward science and socioeconomic status among middle-class, midwestern middle school students

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Background: Previous research has uncovered disparities in children's attitudes toward science based on gender, income, parenting, geographical location, and school resources, among other factors. However, less is known about socioeconomic influences on science attitudes within the evolving rural middle class. The present study investigated the relationship between indicators of socioeconomic status on middle schoolers' attitudes toward science in a predominantly middle class, white, rural sample within the midwestern United States of America.

Methods: Parents were asked for demographic information and consent for their child participating in the study. Middle school children were invited to complete a short survey quantifying their attitudes toward science.

Results: Science attitudes did not vary based on gender. However, students with at least one parent that earned at least a bachelor's degree or from a household income exceeding $90,000 had more positive attitudes toward science than those whose parents did not obtain a college degree or whose household income was less than $90,000, respectively. Regression revealed that household income and parent's assessment of their child's interest in a scientific career significantly predicted a child's attitudes toward science, but gender and highest degree earned by a parent did not.

Conclusion: This study found differences in children's science attitudes within a rural, predominantly middle-class population. This finding contributes to the literature by revealing differences in science attitudes relating to higher levels of parental education (bachelor's degree) and income ($90,000) than previously identified. This highlights additional opportunities to support children's science growth and promote equitable science opportunities for everyone.

KEYWORDS

science attitudes, socioeconomic status, rural, parental education, middle class income, science career, middle school

1 Introduction

Science is foundational to modern medicine, technological advances, and tackling many of the world's problems including disease, famine, and climate change. Therefore, many scientists and educators seek to share their science knowledge and an enthusiasm for science with the general public through outreach activities and to inspire the next generation of science, technology, engineering, math, and medicine (STEMM) professionals. However, to do so effectively, one needs to know their audience.

For decades, research has shown that children's interest in science varies, and their attitudes toward science can be impacted by gender, their parents' careers, geographical location (urban versus rural), socioeconomic status (SES), and inequitable educational opportunities, among other factors (Gorard and See, 2009; Peterson et al., 2015; Betancur et al., 2018; Grimes et al., 2019; Archer et al., 2020; Gall et al., 2020; Liu and Schunn, 2020; Guo et al., 2022). Prior research has revealed that students from families of lower SES are more likely to have lower interest in science, science careers, and summer science experiences than students from higher SES families (Gorard and See, 2009; Liu and Schunn, 2020). Studying disparities in science opportunities and how to eliminate them for lower SES students remains an active and important research topic. However, there is a paucity of scholarship examining science attitudes within the evolving middle class in the United States. Indeed, parameters characterizing the middle class have changed. From 1970 to 2020, while middle class household incomes have increased, the middle class's share of aggregate income in the United States decreased from 62 to 42%, respectively (Kochhar and Sechopoulos, 2022). According to the Pew Research Center, the median household income of American middle-class families in 2020 rose to $90,131 (Kochhar and Sechopoulos, 2022). This number is substantially above the poverty line and threshold for free school lunches, which is often used as an indicator for studying students of lower SES in educational research. Although middle-class income has risen 50% over the past 50 years (Kochhar and Sechopoulos, 2022), inflation has resulted in higher expenses for many households. Indeed, many families earning a middle-income salary do not live a middle-class lifestyle due to increased spending on housing, healthcare, education, and other necessities (Haller et al., 2022). We hypothesized that socioeconomic variability within the middle class may correspond to differences in middle school children's attitudes toward science.

This study was envisioned through a socioeconomic theoretical framework, which posits that SES includes "not just income but also educational attainment" (APA, 2010). These factors can influence many areas of life, including students' education and career goals. A combination of current economic trends impacting the middle class, increased median middle-class income, variability in parental educational attainment, and a rural midwestern setting formed the conceptual framework. Specifically, the present study investigated the relationship between two indicators of socioeconomic status (household income and parent's education) and middle schoolers' attitudes toward science in a midwestern rural area that was predominantly middle class.

2 Materials and methods

2.1 Ethics and setting

This study was reviewed by the Institutional Review Board at Western Michigan University Homer Stryker M.D. School of Medicine, which determined that the study met the criteria for exempt status. The study was conducted in accordance with their guidelines. We partnered with the seventh and eighth grade classrooms at a middle school in a rural setting within Southwest Michigan in the United States. The school leadership agreed to the study being conducted within their school. The school district is in a small village that was surrounded by farmland. According to the United States Department of Agriculture Rural Development, the school is in a rural area.

Information about our science outreach program, a study consent form, and a demographics survey were sent home to the students' parents. When students were invited to complete an online survey, it began with an assent process. Only data from students who assented and whose parents consented were included in the study. All students in the seventh and eighth grade classes were welcomed to participate in science outreach sessions, regardless of whether or not they participated in the study. Surveys were collected in early 2020.

2.2 Surveys

Parents completed a survey that included demographic questions such as their educational attainment, household income bracket, and their student's gender, race, and ethnicity. Additionally, the survey asked whether or not their middle schooler was interested in a career in science. All questions were optional, and parents could skip any question that they did not want to answer. The categories for highest degree earned by a parent included: less than high school diploma, high school/GED, associate's degree, bachelor's degree, master's degree, doctorate, and prefer not to answer. The categories for annual household income included: less than $30,000, $30,000–$59,999, $60,000–$89,999, and $90,000 or greater.

Teachers distributed the student survey during class when the researchers were not present to reduce the possibility of their presence influencing student responses. After assenting to participating in the study, the middle schoolers completed an abbreviated Student Attitudes Toward STEM Survey–Middle and High School Students (Faber et al., 2013) survey that focused on science questions as previously described (Gall et al., 2020). A 5-point Likert-style scale was used ranging from strongly disagree to strongly agree for each question (Supplementary Table S1).

2.3 Data analysis

Parent and student forms were matched and de-identified by an honest broker. Participants' attitudes toward science scores were calculated by summing their responses to the survey questions (with one question that was phrased in the negative being reverse scored). The highest score that a student could receive on this scale was 45, and the lowest possible score was 9. To assess the internal consistency of

the abbreviated Student Attitudes Toward STEM Survey–Middle and High School Students used in this study (Supplementary Table S1), we conducted a Reliability Analysis in SPSS on our dataset; the Cronbach's alpha was 0.88. Planned contrasts (between-subjects *t*-tests) were used to compare attitudes toward science based on gender, interest in scientific career, household income, and parents' educational level. Based on the socioeconomic demographics of this participant pool and the median income of the middle class at the time (Kochhar and Sechopoulos, 2022), we placed the line for comparing attitudes toward science relative to income and education at $90,000 and a bachelor's degree, respectively. To test for normality, we ran Shapiro–Wilk tests and generated Q-Q plots. The data were normally distributed, so we used parametric *t*-tests.

To disentangle the contributions of income, education, gender, and science interest on students' attitudes toward science score, a linear regression was conducted. On both tail ends of parents' education, the sample size was low. Therefore, both to preserve participants' anonymity and to minimize the influence of a few participants on the analysis, the "less than high school diploma" and "high school diploma/GED" categories were combined, and the "master's degree" and "doctorate degree" categories were combined. For the same reasons, "less than $30,000" and "$30,000–$59,999" were combined.

The threshold for statistical significance was 0.05. Data were analyzed in GraphPad Prism and SPSS. Bar graphs were created using GraphPad Prism, and the area-proportional Venn diagram was created using BioVenn (Hulsen et al., 2008).

3 Results

We received 118 parental consent forms that included demographic information. Of the children granted permission by a parent to participate in the study, 105 middle schoolers completed the attitudes toward science scale. The combined enrollment of the seventh and eighth grade cohorts was approximately 150 students, indicating approximately 70% participation. The students ranged from 12 to 14 years old. Table 1 details the demographic information of the participants.

Attitudes toward science did not significantly differ between male and female students [Figure 1A; $t_{(102)} = 0.498$, $p = 0.620$]. However, students from households with incomes greater than $90,000 had significantly more positive attitudes toward science than students from households earning less than that amount annually [Figure 1B; $t_{(90)} = 2.318$, $p = 0.023$]. Similarly, middle schoolers who had a parent with a bachelor's degree or higher had higher attitudes toward science than those whose parents earned less than a bachelor's degree [Figure 1C; $t_{(101)} = 2.094$, $p = 0.039$].

Students whose parents indicated they thought that their student was interested in a science career had significantly higher attitudes toward science than students whose parents thought that their child was not interested in a science career [Figure 2A; $t_{(101)} = 4.927$, $p < 0.0001$]. Of the students whose parents provided socioeconomic demographic data and noted that they thought that their middle schooler was interested in a career in science, 44.4% were from households of less than $90,000 and/or whose parents did not earn a bachelor's degree (Figure 2B). Therefore, despite the role of socioeconomic factors on attitudes toward science, there was a meaningful proportion of students from households of less income or educational attainment who could be interested in pursuing a career in science.

TABLE 1 Demographics of study participants.

Category	Percent (number of participants)
Gender	
Female	50% (53)
Male	49% (51)
Transgender/Other	0% (0)
Prefer not to answer	1% (1)
Ethnicity	
Non-Hispanic	94.3% (99)
Hispanic	1.0% (1)
Prefer not to answer	4.8% (5)
Race	
White	94.3% (99)
Black or African American	1.0% (1)
Asian	1.9% (2)
Native Hawaiian or Other Pacific Islander	1.0% (1)
More than 1 race	2.9% (3)
Annual household income	
Less than $90,000	31.4% (33)
$90,000 or more	56.2% (59)
Prefer not to answer	12.4% (13)
Highest degree earned by a parent	
Less than a bachelor's degree	33.3% (35)
Bachelor's degree or higher	64.8% (68)
Prefer not to answer	1.9% (2)
Parental assessment of child's science career interest	
Yes	29.5% (31)
No	33.3% (35)
Prefer not to answer/unsure	36.2% (38)

Parents' self-reported demographic information of their middle schooler (gender, age, ethnicity, and race), socioeconomic factors (parental education and household income), and whether or not the parent thought that their middle schooler was interested in a career in science.

To further probe how the aforementioned factors predict science attitudes, we ran a multiple regression including the primary variables of interest: household income, highest degree earned by a parent, science career interest, and gender. In contrast to the bivariate analyses above, this test included more income and educational categories as ordinal variables (Table 2). Due to the nature of linear regression, this model only includes participants for whom we had data on all four variables as well as a science attitudes score ($n = 57$). The regression model was statistically significant [$F_{(4,52)} = 5.694$, $p < 0.001$, $R^2 = 0.305$] with household income and interest in a career in science, but not parent's education or gender, positively predicting a student's attitudes toward science score (Table 2).

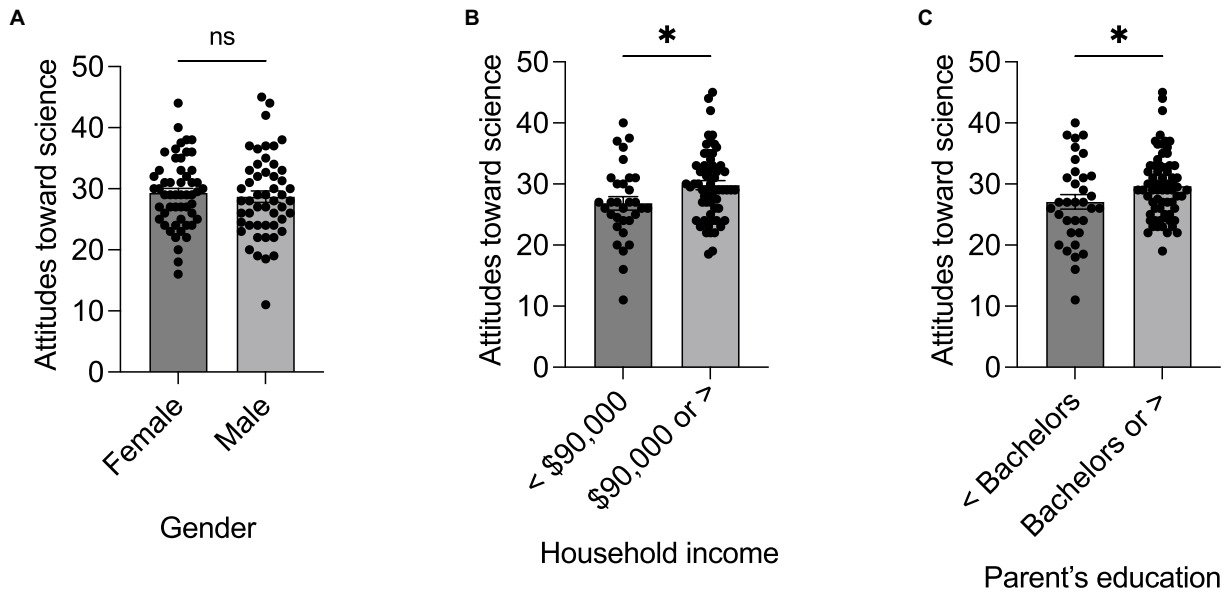

FIGURE 1
Middle schoolers' attitudes toward science. **(A)** No difference was detected between male and female middle school children. **(B,C)** Attitudes toward science were significantly higher for students from families earning more than $90,000 **(B)** and who had a parent with at least a bachelor's degree **(C)**. ns, not statistically different; *$p < 0.05$; bars = mean; error bar = SEM; $n = 92–104$.

4 Discussion

The present study examined the relationships among SES, gender, science career interest, and middle school students' attitudes toward science within a middle-class, rural, midwestern community. Consistent with our hypothesis, the present study found differences in these middle schoolers' attitudes toward science based on surveyed metrics of SES and parental assessment of their child's interest in a science career.

In contrast to prior research showing more positive attitudes and interest in science among boys (Mattern and Schau, 2002; Desy et al., 2011; Riegle-Crumb et al., 2011), we did not detect a statistical difference in science attitudes between girls and boys in this population (Figure 1A; Table 2). The lack of gender differences in science attitudes is encouraging for increasing the representation of girls in STEMM and might be attributed to female science teachers that can reduce stereotype threat or an increase in women role models in STEMM (Master et al., 2014; González-Pérez et al., 2020). Despite the lack of gender differences in this study's results, future research should continue to investigate potential sex or gender differences in science attitudes, because science attitudes can be multifaceted. For example, a prior study found that females have more positive attitudes toward the teacher and science's value to society, whereas males have more positive attitudes toward their own self-concept, enjoyment, and motivation in science (Weinburgh, 2000). Finally, there remains a gap in the literature examining transgender and non-binary students' attitudes toward science that future work could address.

SES can include multiple factors; we focused on family income and the highest level of education attained by a parent. Based on socioeconomic demographics of this participant pool and the median income of the middle class at the time (Kochhar and Sechopoulos, 2022), we first compared attitudes toward science relative to income and education at $90,000 and a bachelor's degree, respectively.

In our sample of rural, midwestern, primarily white, middle class middle schoolers, the children from families of higher income and education had more positive attitudes toward science than those of lower household income or parental education (Figures 1B,C). These results are consistent with the literature. Children of higher socioeconomic backgrounds often have parents with higher levels of education and resources. These parents may place a greater emphasis on their children's science education and have the resources to invest more in extracurricular activities and resources that support their children's exploration and development of scientific interests (Guo et al., 2022).

Although income and education are often correlated, previous work has shown that they can independently impact children's science achievement (Betancur et al., 2018). Therefore, we next ran a multiple regression to tease apart the specific contributions of the variables of interest on science attitudes. Similarly to the results of the *t*-tests (Figures 1, 2), household income and parental assessment of their child's interest in a science career had positive, statistically significant linear relationships with middle schoolers' science attitudes scores (Table 2). However, whereas children with a parent who earned a bachelor's degree had more positive attitudes toward science than children without a parent who earned at least a bachelor's degree (Figure 1C), the effect of education was not significant in the regression which included more educational brackets (Table 2). Indeed, descriptive statistics within these educational brackets show that science attitudes are highest within children who have a parent with a bachelor's degree, but scores for children whose parents earned a master's degree or higher are similar to those whose parents did not earn a bachelor's degree. This may indicate a non-linear relationship between parental education and a child's attitudes toward science, at least in this sample. However, we caution over-interpretation of this result for a few reasons. First, as previously mentioned, the sample sizes for categories on both ends of the

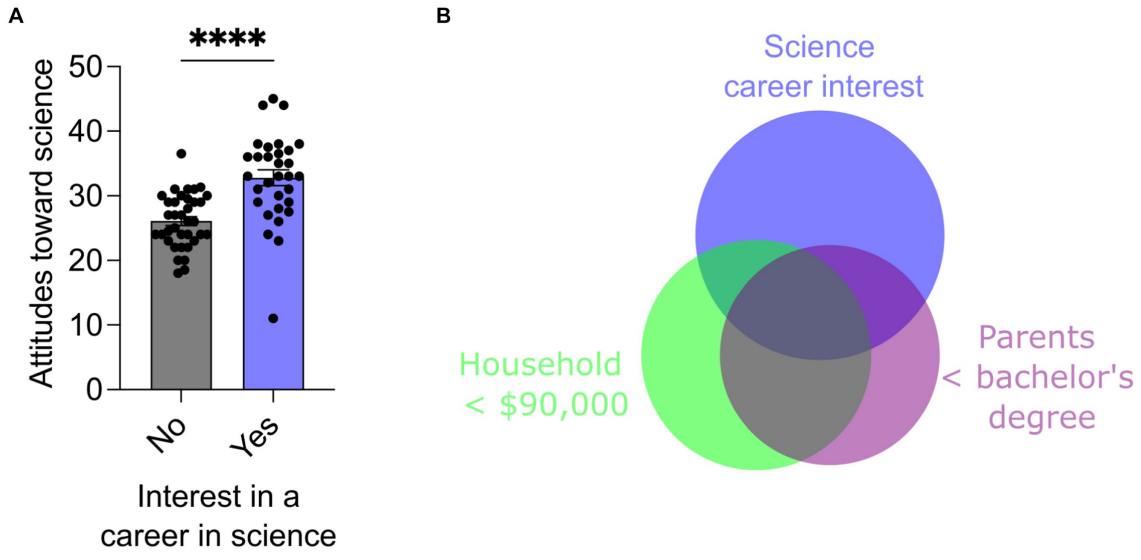

FIGURE 2
Science career interest. **(A)** Students whose parents noted that they thought their student was interested in a career in science had significantly higher attitudes toward science than students thought not to be interested in a science career. ****$p < 0.0001$; $n = 67$. **(B)** Of the students whose parents provided socioeconomic demographic data and indicated that their middle schooler was interested in a science career ($n = 27$), there was meaningful overlap with the lower bracket of socioeconomic status (parental income and education) in this study. This area proportional Venn diagram was produced using BioVenn.

TABLE 2 Linear regression results and attitudes toward science scores by demographic brackets.

Category	Percent (number of participants)	Average science attitudes score (*SD*)	Beta estimate (95% CI)	*p*-value
Annual household income			2.623 (0.245–5.000)	0.031*
Less than $60,000	10.5% (6)	22.1 (6.8)		
$60,000–$89,999	26.3% (15)	28.6 (5.1)		
$90,000 or more	63.2% (36)	30.1 (6.1)		
Highest degree earned by a parent			0.028 (−0.850–0.795)	0.946
High school diploma/GED or less	17.5% (10)	27.0 (8.7)		
Associate's degree	17.5% (10)	26.1 (5.2)		
Bachelor's degree	45.6% (26)	30.9 (5.7)		
Master's degree or higher (including doctorate)	19.2% (11)	27.5 (5.2)		
Parental assessment of child's science career interest			2.625 (1.132–4.119)	<0.001*
Yes	43.9% (25)	32.2 (7.1)		
No	56.1% (32)	26.3 (4.1)		
Gender			0.442 (−1.075–1.959)	0.562
Female	59.6% (34)	29.6 (5.4)		
Male	40.4% (23)	27.8 (7.4)		

This analysis includes the participants for which no data points were missing ($n = 57$). SD, standard deviation; CI, confidence interval. *$p < 0.05$.

educational spectrum were small, prompting combining neighboring categories (less than high school and high school/GED; master's and doctorate) to preserve participants' anonymity and minimize undue influence of a couple data points on the linear regression. Second, we do not know the fields of study for the parents who had earned advanced degrees; they might not be related to science.

Consistent with the present finding on the significant relationship between household income and children's science attitudes (Figure 1B; Table 2), previous scholarship has shown that income can directly influence the learning resources available for families and students; those from wealthier households may be able to purchase more learning resources to use at home, hire tutors to help their

children succeed, or pay for after school or summer activities (Liu and Schunn, 2020). Additionally, economic effects on students' science outcomes may begin at a more basic level: previous research found that the effects of parents' income on students' science achievement was mediated significantly through reading and math abilities (Betancur et al., 2018). Although the aforementioned study examined science achievements rather than attitudes, it is possible that foundational skills such as mathematics and reading may also mediate science learning experiences and thus science attitudes.

Although the present study did not observe a stepwise linear relationship between a parent's educational attainment and their child's attitudes toward science (Table 2), it did find that students with a parent who earned a bachelor's degree had generally more positive science attitudes than children whose parents had not earned a bachelor's degree (Figure 1C). Previous work has shown that parents' level of education can influence children's achievements even more so than income (Erola et al., 2016). Higher levels of parental education can yield increased human, cultural, and social capital; these resources and influences on parenting in turn can impact their child's science learning experiences (Betancur et al., 2018). Parents with higher education may be more aware of the career options available in the sciences. Also, due to their own educational experiences, these parents can converse with their children about science and provide in-home educational experiences relating to STEMM (Betancur et al., 2018). Finally, parents with greater formal education might set higher academic and science expectations for their children. Research suggests that parental expectations can influence a child's self-evaluation and goal-setting in science learning, ultimately affecting their attitude toward the subject (Bandura et al., 1996; Guo et al., 2022).

The present study also found more positive attitudes toward science in students whose parents indicated that they thought their middle schooler was interested in a science career. This result held true in both analyses (Figure 2A; Table 2). This finding demonstrates alignment between parents' perceptions of their children's science interest and their children's science attitudes and is consistent with previous literature showing that more positive attitudes toward science are closely related to persistence in school science and interest in pursuing science as a future career (Iwuanyanwu, 2022). Many factors influence career decisions, and middle schoolers have time for career interests to change; however, children's career aspirations are more stable than expected (Archer et al., 2020). Previous work has shown that SES correlates to students' motivation for science, with children as young as kindergarten reporting less motivation to learn science compared to their higher SES peers (Liu and Schunn, 2020). Interestingly, previous research also has found that parents' education was the largest predictor of children's eventual occupational achievement, more so than income (Erola et al., 2016). Although students in the present study interested in a science career tended to come from families of higher parental education and/or household income, there was a meaningful proportion of children interested in a science career from families of lower middle-class income and parental educational attainment (Figure 2B). This finding highlights an opportunity for educators and STEMM professionals to teach and mentor children interested in science that may not have as much science support from home. It also adds to the literature by extending previous SES differences to a middle class, rural, midwestern community. Additionally, interventions may benefit from encouraging children to think of science as action, instead of identity defining; for example, the wording of who can "do science" versus who can "be a scientist" can be a powerful shift to encourage children to think of a broader range of people involved with science (Lei et al., 2019). Indeed, many children value science and are interested in doing science but do not strive to become a scientist (Archer et al., 2020).

The present study has several caveats. First, like most studies in this domain, the findings are correlational; we cannot randomly assign participants to families of specific educational or income levels. Second, the sample size was modest. We included as many participants as possible in each analysis; however, because parents could choose not to answer any demographic question, the missing data points (especially for annual household income and parental assessment of their child's science career interest) further shrunk the sample size for certain analyses. To promote transparency, sample size for each group is reported in the tables and figure legends. The participant population was predominantly white, non-Hispanic, and with parents of higher educational attainment and income than average within the United States (Bureau, 2022). Because we did not ask about the highest degree from each parent (only the highest degree achieved by either parent), it is possible that the average is more similar to the national average if one parent had earned a bachelor's degree but the other did not. Regardless, even though the present sample does not represent the entire United States, there are many other rural and suburban communities with analogous demographics. Furthermore, the focus on a rural, midwestern, middle class community adds to the literature. While previous research has observed disparities in science attitudes and career aspirations among racial and ethnic minorities and those of low SES (Weinburgh, 2000; Riegle-Crumb et al., 2011; Lei et al., 2019; Gall et al., 2020; Kaya, 2022), the present study reveals differences in science attitudes within the middle class relating to parents' level of education and income at higher levels than previously reported. Of course, the need to support students in families of lower SES and to create pathways to support their education and STEMM opportunities remains. The present study reveals additional opportunities for supporting another segment of students that may be interested in science but do not come from upper middle-class families of higher educational attainment or income (Figure 2B). Additionally, it highlights the value of STEMM outreach in all communities.

To further understand the impact of socioeconomic status on attitudes toward science, future studies should expand to other regions of the country and seek broader diversity of participants. To begin elucidating the impact of specific socioeconomic descriptors on middle schoolers' attitudes toward science, we ran a multivariate regression in addition to the *t*-tests. Overall, the results were very similar except for the effect of parental education on students' science attitude scores. Sharing the results of both types of analyses provides a more complete picture on the relationships among these factors and allows for the inclusion of more participants rather than reducing the reported analyses only to participants without any missing demographic data points. Future work should continue to compare and contrast the impacts of multiple socioeconomic indicators and mediators on science attitudes. Although the present study was not powered for more complex analyses, the study being conducted within one school minimizes otherwise confounding variables such as school resources and geographical location. Finally, although the SES data are now a few years old, they were not influenced by the significant income and

occupational changes that impacted many families during COVID-19, as surveys were serendipitously collected right before COVID-19-related restrictions began. Future studies should continue to investigate science attitudes and STEMM career aspirations in these communities, especially because recent research reveals an increasing urban–rural divide, with rural residents having less positive attitudes toward scientists than urban residents, even when controlling for income and education (Okada and Shen, 2023). Even when STEMM attitudes are positive (Japashov et al., 2022), barriers persist for many children in rural communities to pursue STEMM careers. For example, colleges may be geographically distant, students may have knowledge gaps and resource limitations impacting their ability to pursue a STEMM career, or they may face pressure to stay within their community or financially assist their family members through work (Peterson et al., 2015; Grimes et al., 2019). Increased political polarization between urban and rural areas, with rural areas less trusting of scientists, can also be a barrier for rural students to pursue STEMM careers (Okada and Shen, 2023). Science outreach in schools can be an effective way to reach rural students (Hendrickson et al., 2020; Lewis et al., 2020), and mentoring can support rural students seeking to pursue STEMM careers (Oshiro et al., 2023).

In conclusion, the present study expands upon the literature of SES impacts on science attitudes by revealing differences corresponding to parental education and household income in science attitudes among predominantly white, middle class, rural, midwestern middle schoolers. The gap in science performance between high and low SES students is narrowing (Broer et al., 2019), demonstrating progress. However, much work remains to fully close this gap and increase STEMM opportunities for all students.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by Western Michigan University Homer Stryker M.D. School of Medicine Institutional Review Board. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

Author contributions

KP-S: Writing – original draft, Visualization, Formal analysis, Data curation, Conceptualization. WY: Writing – original draft. PV: Writing – review & editing, Formal analysis, Data curation, Conceptualization.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/feduc.2024.1403039/full#supplementary-material

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