Volume 4 (2024), pp. 1-14
American Journal of STEM Education: Issues and Perspectives

Enhancing STEM Engagement and Confidence: The Impact of the Verizon Innovative Learning STEM Achievers Program on Middle School Students' Attitudes and Perceptions

James Maiden
Uniformed Services University

Delarious O. Stewart
East Texas A&M University

Kali Holloway
Henry M. Jackson Foundation for the Advancement of Military Medicine, Inc.

ABSTRACT

The Verizon Innovative Learning STEM Achievers Program increases middle school students' interest, motivation, and confidence in STEM, focusing on underrepresented communities. Incorporating hands-on learning, mentorship, and emerging technologies like augmented reality, 3D design, and robotics, the program fosters early exposure to STEM disciplines. This study analyzes pre- and post-survey data from 121 participants using paired t-tests to measure changes in interest and attitudes. Results show significant improvements in enjoyment of STEM concepts, motivation in STEM classes, and confidence in STEM abilities. The findings underscore the importance of early STEM exposure, mentorship, and belonging in engaging underrepresented populations, contributing to efforts to reduce disparities and promote long-term interest in STEM fields.

Keywords: STEM Education, Confidence, Mentorship, Hands-On Learning, Student Engagement

INTRODUCTION

Science, technology, engineering, and mathematics (STEM) education has become increasingly important as the global economy relies heavily on technological innovation and scientific advancements (Yang et al., 2023). Despite the growing need for STEM professionals, many U.S. middle school students, particularly those from underrepresented communities, show declining interest in STEM subjects during this critical period of academic development (McGuire et al., 2023). The Verizon Innovative Learning STEM Achievers Program seeks to address this gap by providing a platform that inspires middle school students through hands-on learning, mentorship, and exposure to emerging technologies, such as augmented reality (AR), virtual reality (VR), 3D design, and robotics. This study examines the program's potential impact on increasing students' interest, motivation, and confidence in STEM fields.

The Role of Middle School in Shaping STEM Interests

Middle school represents a pivotal period for shaping students' interest in STEM as they develop ideas about their future academic and career aspirations (McGuire et al., 2023). Unfortunately, many students, particularly from marginalized communities, lose interest in STEM during this time due to limited access to resources, lack of exposure to role models, and insufficient educator encouragement. Research shows that students from underrepresented groups are more likely to disengage from STEM subjects without adequate support, perpetuating disparities in STEM participation (Archer et al., 2013). The Verizon STEM Achievers Program aims to counter these challenges by offering immersive and engaging learning experiences, particularly at a time when students are most impressionable. By creating opportunities for hands-on engagement, the program helps students see STEM as accessible, fun, and relevant to their lives.

Program Overview

The Verizon STEM Achievers Program is designed to empower middle school students by providing them with hands-on learning experiences, mentorship from STEM professionals, and exposure to cutting-edge technologies. Students engage in real-world problem-solving tasks, which provide technical knowledge and develop essential skills such as critical thinking, collaboration, and communication. The program is mainly focused on making STEM accessible to students from underrepresented communities in both rural and urban settings. By demystifying STEM fields and making learning interactive, the Verizon Innovative Learning (VIL) STEM Achievers Program aims to foster sustained interest in these fields throughout students' academic careers.

Impact on STEM Interest and Engagement

The Verizon STEM Achievers Program emphasizes a holistic approach integrating exposure to advanced technologies and personal development. One of the program's key strengths is its ability to introduce students to various STEM disciplines they may not typically encounter in traditional classroom settings. Students can see the practical applications of STEM concepts by engaging with cutting-edge technologies such as 3D printing, coding, and robotics. This exposure is vital in igniting curiosity and inspiring students to consider STEM a viable and rewarding career path, which is essential for sustained interest.

In addition to exposure, the program strongly emphasizes building students' confidence in their STEM abilities. Many students, particularly those from marginalized communities, often perceive STEM as too challenging or inaccessible. Through hands-on projects and guided mentorship, the program helps students overcome this perception by allowing them to experience success in STEM tasks. As students complete projects and solve complex challenges, they gain a sense of achievement that strengthens their belief in their ability to succeed in STEM, breaking down barriers to participation.

Mentorship is another critical component of the Verizon STEM Achievers Program. The program connects students with STEM professionals who provide technical support and serve as role models. This connection is significant for underrepresented students, as seeing mentors from similar backgrounds helps them visualize their potential in STEM careers. The guidance and encouragement provided by these role models play a crucial role in overcoming cultural, gender, or socioeconomic barriers that might otherwise deter students from pursuing STEM pathways.

The program also fosters a strong sense of belonging in STEM, an essential factor in keeping students engaged. By creating a collaborative environment where students from diverse backgrounds work together on STEM projects, the program helps dismantle stereotypes and promotes inclusion. Research suggests that students who feel included and valued in STEM are likelier to continue pursuing these fields. The program's inclusive environment ensures that students from all backgrounds can see themselves as contributors to the future of STEM.

The Verizon STEM Achievers Program is designed to promote long-term engagement in STEM. Beyond the initial spark of interest, the program maintains mentorship relationships and offers continued opportunities for advancement, encouraging students to remain involved in STEM learning throughout their education. This sustained engagement is crucial in preparing students for high school STEM courses and careers in STEM fields. Through its comprehensive approach, the program is helping to cultivate the next generation of STEM professionals.

LITERATURE REVIEW

Middle school shapes students' long-term academic interests, particularly in STEM subjects. During this developmental stage, students form concrete ideas about which subjects they enjoy, and which align with their potential career aspirations (Tai et al., 2006). Research has shown that students' attitudes toward STEM in middle school significantly impact whether they pursue STEM-related courses and careers in high school and beyond. However, many middle school students, particularly those from underrepresented communities such as racial and ethnic minorities and low-income backgrounds, exhibit declining interest in STEM (Archer et al., 2013). This decline is often linked to limited resources, lack of access to engaging STEM experiences, and few role models in STEM fields (Wang & Degol, 2017). Programs like the Verizon STEM Achievers Program aim to address these barriers by providing immersive, hands-on experiences that can reignite students' interest in STEM.

Hands-On Learning and STEM Interest

The importance of hands-on, experiential learning in fostering interest in STEM has been well-documented. Inquiry-based learning, where students actively engage in problem-solving and experimentation, has been shown to significantly enhance students' interest and motivation in STEM subjects (Maltese & Tai, 2010). Beier et al. (2019) found that middle school students who participated in project-based STEM learning were likelier to develop a positive attitude toward STEM and consider STEM careers. The Verizon STEM Achievers Program's emphasis on interactive, project-based learning aligns with this research, offering students opportunities to explore coding, robotics, and augmented reality. These activities help students connect theoretical knowledge with real-world applications, which is critical for sustaining their long-term interest in STEM (Aschbacher et al., 2010). By offering engaging, practical projects, the program fosters an environment where students can see the relevance and excitement of STEM in their daily lives.

The Role of Mentorship in STEM Engagement

Mentorship is critical in fostering STEM interest and success, particularly for students from underrepresented backgrounds (Eagan et al., 2013). Students with access to role models and mentors in STEM fields are likelier to persist in STEM education and careers. Griffin et al. (2010) found that minority students, in particular, benefit from mentorship relationships where the mentor shares a similar background or experiences. Mentors provide academic guidance and emotional support, helping students navigate challenges and see themselves as capable of succeeding in STEM. The Verizon STEM Achievers Program connects students with STEM professionals who serve as mentors, offering guidance and encouragement throughout the program. This mentorship helps students overcome doubts about their abilities, especially those who may experience imposter

syndrome—feeling like they do not belong in STEM despite their capabilities (Walton & Cohen, 2011).

Building a Sense of Belonging in STEM

A sense of belonging in classrooms and extracurricular programs is essential for maintaining students' interest (Maiden et al., 2021). This is especially significant in STEM fields. When students feel excluded or perceive that STEM is "not for people like them" (Good et al., 2012, p. 701), they are likelier to disengage, even if they have the ability and interest to succeed. This is particularly true for students from underrepresented groups, who often do not see many role models in STEM fields (Carlone & Johnson, 2007). The Verizon STEM Achievers Program intentionally creates an inclusive environment where students from diverse backgrounds can collaborate, share ideas, and learn from one another. Research supports the idea that culturally relevant, inclusive STEM learning experiences are crucial for engaging students from marginalized communities (Barton & Tan, 2010). By fostering a sense of belonging, the program helps students overcome feelings of alienation and see themselves as future STEM professionals.

Relevance of STEM to Personal Lives

Students are more likely to engage with STEM when they see how it connects to their experiences, interests, and communities (Aschbacher et al., 2010). Programs that make STEM relevant to students' lives are more successful in maintaining long-term interest in these subjects. The Verizon STEM Achievers Program leverages this by incorporating real-world STEM applications into its curriculum. Students work on projects that solve familiar problems, such as addressing environmental challenges or improving their communities through technology. By demonstrating the practical uses of STEM in everyday life, the program makes STEM more relatable and engaging for students. This connection between STEM learning and personal relevance sustains short-term interest and helps students see STEM as a meaningful part of their futures (Basu & Barton, 2007).

Sustained Engagement and Long-Term Benefits of STEM Programs

Long-term engagement in STEM is closely linked to educational and career success in these fields (Lent et al., 2018). For students to persist in STEM, they need consistent exposure to challenging yet supportive learning environments and ongoing mentorship. Programs that provide structured pathways for continuous STEM engagement, from middle school through high school and into college, are particularly effective in increasing retention rates among students from underrepresented communities (Kitchen et al., 2018). The Verizon STEM Achievers Program aims to provide this kind of sustained engagement by offering continuous mentorship and exposure to advanced STEM learning opportunities. The program plays a critical role in shaping the next generation of STEM

professionals by fostering a growth mindset and encouraging students to continue exploring STEM fields.

RESEARCH METHOD

Participants

The study involved 121 middle school students (44 females and 77 males) from grades 6 to 8 who participated in the Verizon STEM Achievers Program. The students were diverse in terms of race and ethnicity, with 42.1% identifying as African American, 20.7% as Hispanic/Latino/a, 12.4% as Caucasian, 12.4% as Mixed/Two or more races, 8.3% as Asian, and 4.1% as Pacific Islander.

Table 1. Participant Demographics by Grade, Gender, and Race/Ethnicity

Variable	n	%
Grade		
6th	35	28.9
7th	48	37.9
8th	36	29.8
Gender		
Female	44	36.4
Male	77	63.6
Race		
African American	51	42.1
Asian	10	8.3
Hispanic/Latino/a	25	20.7
Caucasian	15	12.4
Pacific Islander	5	4.1
Mixed/Two or more races	15	12.4

Hypothesis

The primary hypothesis guiding the study was:

> H_1: There is a significant increase in students' STEM interest (or confidence or any other measured variable) after participating in the Verizon STEM Achievers Program.

This hypothesis was tested using a paired sample t-test to compare pre-and post-survey results for the various measured variables.

Procedure

Participants completed a pre-survey before beginning the program and a post-survey after the intervention to measure changes in their attitudes and

perceptions toward STEM disciplines. The intervention consisted of hands-on STEM activities, including exposure to 3D printing, coding, and robotics and mentorship from STEM professionals. The program ran over one semester, with regular engagement in collaborative STEM projects to enhance practical understanding and personal development.

Measures

A survey was administered before and after the program to assess various dimensions of student attitudes toward STEM. The survey included measures of enjoyment of learning STEM, motivation to perform well in STEM, confidence in succeeding through hard work, perceived relevance of STEM to personal life, and the sense of feeling valued in STEM classes. The survey used a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree), and responses were converted to percentages for analysis.

Data Analysis

A paired sample t-test was used to analyze the pre- and post-survey data, comparing mean scores across several variables to assess the program's impact. Specifically, the analysis focused on determining whether there were statistically significant increases in enjoyment of STEM, motivation, confidence, perceived relevance of STEM, and students' sense of being valued in STEM classes. The t-test was conducted at a 0.05 significance level, and effect sizes were calculated to quantify the magnitude of any observed differences.

Ethical Considerations

Informed consent was obtained from all participants and their guardians prior to participation in the study. The confidentiality of student responses was maintained, and participation in the survey was voluntary. The appropriate institutional review board (IRB) reviewed and approved the research protocol.

RESULTS

A comparison of the pre-and post-survey scores showed a statistically significant increase in the mean percentage of students who enjoyed learning new things in STEM ($t = -6.54$, $df = 120$, $p < 0.05$), with the mean rising from 58% ($SD = 12.5\%$) to 75% ($SD = 10.2\%$). Motivation to give their best effort in STEM also saw a significant increase ($t = -5.88$, $df = 120$, $p < 0.05$), as the mean percentage went from 49% ($SD = 14.1\%$) to 70% ($SD = 12.8\%$).

Confidence in succeeding through hard work improved significantly, with the mean increasing from 43% ($SD = 11.9\%$) to 65% ($SD = 11.3\%$) ($t = -4.25$, $df = 120$, $p < 0.05$). Similarly, the percentage of students who felt STEM connected to their personal lives rose significantly from 48% ($SD = 13.3\%$) to 68% ($SD = 12.5\%$) ($t = -3.92$, $df = 120$, $p < 0.05$).

Finally, the perception that students' opinions were valued in STEM classes also showed a significant increase, with the mean rising from 32% (SD = 14.6%) to 55% (SD = 12.9%), ($t = -3.18$, $df = 120$, $p < 0.05$). Each t-test result shows a statistically significant improvement in students' attitudes and perceptions toward STEM subjects after participating in the program. These results demonstrate that the Verizon Innovative Learning STEM Achievers Program positively influenced students' interest, motivation, and confidence in STEM education.

Table 2: Pre- and Post-Survey Mean Scores for STEM Attitudes

Variable	Pre-Survey M (SD)	Post-Survey M (SD)	t	df	p
Enjoy learning new things in STEM	58% (12.5)	75 % (10.2%)	-6.52	120	<0.05
Motivated to give best effort in STEM	49% (14.1%)	70% (12.8%)	-5.88	120	<0.05
Confidence in succeeding through hard work	43% (11.9%)	65% (11.3%)	-4.25	120	<0.05
STEM connects to personal life	48% (13.3%)	68% (12.5%)	-3.92	120	<0.05
Opinions valued in STEM classes	32% (14.6%)	55% (12.9%)	-3.18	120	<0.05

Note. M = Mean, SD = Standard Deviation. ($p < 0.05$)

DISCUSSION

The data highlights significant improvements in students' attitudes and perceptions toward STEM following the intervention, as indicated by the pre- and post-survey comparisons. One key finding was a notable increase in the percentage of students who reported enjoying learning new things in STEM, rising from 58% to 75%. This suggests that the intervention effectively enhanced student engagement and interest in STEM subjects (Nalipay et al., 2023). Additionally, students showed greater motivation to give their best effort in STEM classes, increasing from 49% to 70%. This finding indicates that the program successfully fostered a stronger work ethic and commitment to STEM learning (Wang & Degol, 2013).

Students' confidence in their ability to succeed through hard work also improved, with the mean percentage rising from 43% to 65%. This reflects a shift in their belief that success in STEM can be achieved through persistence, suggesting that the intervention contributed to the development of a growth mindset (Wang & Degol, 2013). Furthermore, the percentage of students who felt that STEM connected to their personal lives increased from 48% to 68%. This indicates that the program made STEM more relatable and relevant to the student's everyday experiences, which could foster long-term interest (Graham, 2013).

The perception that students' opinions were valued in STEM classes increased significantly, from 32% to 55%. This suggests that the intervention helped to create a more inclusive and supportive classroom environment where students felt their contributions were acknowledged and appreciated (O'Leary et al., 2020). These findings collectively demonstrate the positive impact of the intervention on students' attitudes toward STEM learning (Dost, 2024).

IMPLICATIONS

The findings from this study carry significant implications for STEM education, particularly in how targeted interventions can positively influence students' attitudes, motivation, and engagement in STEM subjects. The significant increase in students' enjoyment of learning new things in STEM, from 58% to 75%, suggests that incorporating engaging and interactive teaching methods can foster greater interest and excitement toward STEM fields (Sáinz et al., 2022). This highlights the need for educators to prioritize innovative instructional strategies that make STEM more engaging, potentially leading to higher student participation and long-term interest in these fields (Sáinz et al., 2022).

The increase in students' motivation to give their best effort in STEM classes (from 49% to 70%) implies that interventions designed to build intrinsic motivation can effectively enhance students' academic persistence and commitment. Schools and educators may benefit from integrating similar programs that reinforce the importance of effort and dedication to academic success. This could be particularly useful in underserved communities where students may not always receive consistent encouragement to pursue STEM disciplines.

The increase in students' confidence in succeeding through hard work (43% to 65%) underscores the importance of promoting a growth mindset within STEM education. By helping students believe in their capacity to succeed through effort, educators can foster resilience and perseverance, both essential skills for success in STEM fields. The success of this intervention suggests that schools should embed growth mindset principles into their STEM curricula to cultivate a culture of persistence and self-efficacy.

The finding that more students perceived STEM as connected to their personal lives (rising from 48% to 68%) emphasizes the importance of

contextualizing STEM content in a way that relates to students' everyday experiences. STEM programs highlighting real-world applications of scientific and mathematical concepts can make these subjects feel more relevant and accessible to students, potentially leading to sustained engagement and interest in STEM careers. This insight suggests that curriculum developers and educators should emphasize practical and relatable applications of STEM content.

The significant increase in students feeling that their opinions were valued in STEM classes (32% to 55%) points to the importance of creating inclusive classroom environments where students feel heard and supported. This finding suggests that students are more likely to engage and participate actively in learning when they perceive their voices as valued. Educators should focus on fostering a classroom culture that encourages open dialogue, collaboration, and respect for diverse perspectives in STEM learning.

The data indicates that targeted interventions in STEM education can significantly enhance students' engagement, motivation, and confidence, with long-term implications for their academic success and interest in STEM careers. These findings suggest that schools and educators should prioritize approaches that make STEM learning engaging, relatable, and inclusive while fostering a growth mindset to equip students for future success in STEM fields.

The role of mentorship emerged as a critical factor in the program's success. The presence of STEM professionals who served as mentors provided technical guidance and acted as role models, particularly for students from underrepresented communities. This supports the findings of Griffin et al. (2010) and Eagan et al. (2013), who highlighted the importance of mentorship in influencing minority students' persistence in STEM fields. The mentors in the program likely contributed to students feeling more confident in their abilities and more connected to the STEM community.

However, some limitations must be acknowledged. The study relied on self-reported data, which can be subject to social desirability bias. Students may have provided responses they believed were expected rather than reflecting their true feelings. Additionally, the lack of a control group limits the ability to attribute changes solely to the program. External factors, such as other educational interventions or personal experiences during the study period, may have influenced the results. Future research should consider including a control group and employing qualitative methods like interviews or focus groups to gain deeper insights into students' experiences.

CONCLUSION

This study demonstrates the positive impact of a targeted intervention on students' attitudes and perceptions toward STEM education. The significant improvements in student engagement, motivation, confidence, and the perceived relevance of STEM subjects highlight the effectiveness of programs emphasizing

interactive, inclusive, and relatable learning experiences. By enhancing students' enjoyment of STEM and fostering a stronger connection between their academic efforts and personal success, these interventions contribute to developing essential skills like persistence and resilience, which are crucial for long-term achievement in STEM fields.

The findings suggest that fostering a growth mindset and creating supportive classroom environments where students feel their contributions are valued can lead to more positive academic outcomes. As STEM education continues to be a critical focus for preparing students for the demands of the modern workforce, this study provides valuable insights for educators, administrators, and policymakers aiming to improve student outcomes in STEM-related disciplines.

Future efforts should build on these results by further integrating engaging, student-centered approaches in STEM curricula and ensuring that students from diverse backgrounds see the relevance of STEM in their personal lives. These strategies help create a more inclusive and equitable pathway to success in STEM for all students.

The findings of this study demonstrate that the Verizon Innovative Learning STEM Achievers Program effectively enhances middle school students' interest, motivation, and confidence in STEM subjects. By integrating hands-on, project-based learning with mentorship from STEM professionals, the program addresses critical factors identified in the literature as essential for engaging underrepresented students in STEM. The significant improvements observed in students' attitudes toward STEM suggest that such programs can play a vital role in diversifying the STEM pipeline and addressing the underrepresentation of minority groups in these fields.

The study's results have important implications for educators, policymakers, and organizations seeking to promote STEM education among underrepresented populations. They highlight the need for educational interventions that are content-rich, culturally responsive, and inclusive. Programs should prioritize creating learning environments that foster a sense of belonging, provide relevant and engaging learning experiences, and offer mentorship opportunities with diverse role models.

To build upon the successes of the Verizon STEM Achievers Program, future initiatives should consider incorporating strategies to sustain students' interest over the long term. This could include follow-up programs, continued mentorship opportunities, and pathways that guide students from middle school through high school and into higher education. Additionally, addressing the study's limitations by including control groups and utilizing mixed-methods approaches would strengthen the evidence base and provide deeper insights into the mechanisms driving the program's effectiveness.

REFERENCES

Archer, L., Dewitt, J., Osborne, J., Dillon, J., Willis, B., & Wong, B. (2013). "Not girly, not sexy, not glamorous": Primary school girls' and parents' constructions of science aspirations. *Pedagogy, Culture & Society, 21*(1), 171–194. https://doi.org/10.1080/14681366.2012.748676

Aschbacher, P. R., Li, E., & Roth, E. J. (2010). Is science me? High school students' identities, participation, and aspirations in science, engineering, and medicine. *Journal of Research in Science Teaching, 47*(5), 564–582. https://doi.org/10.1002/tea.20353

Basu, S. J., & Barton, A. C. (2007). Developing a sustained interest in science among urban minority youth. *Journal of Research in Science Teaching, 44*(3), 466–489. https://doi.org/10.1002/tea.20143

Beier, M. E., Kim, M. H., Saterbak, A., Leautaud, V., Bishnoi, S., & Gilberto, J. M. (2019). The effect of authentic project-based learning on attitudes and career aspirations in STEM. *Journal of Research in Science Teaching, 56*(1), 3–23. https://doi.org/10.1002/tea.21465

Barton, A. C., & Tan, E. (2010). We be burnin'! Agency, identity, and science learning. *The Journal of the Learning Sciences, 19*(2), 187–229. https://doi.org/10.1080/10508400903530044

Carlone, H. B., & Johnson, A. (2007). Understanding the science experiences of Successful women of color: Science identity as an analytic lens. *Journal of Research in Science Teaching, 44*(8), 1187–1218. https://doi.org/10.1002/tea.20237

Dost, G. (2024). Students' perspectives on the 'STEM belonging' concept at A-level, undergraduate, and postgraduate levels: An examination of gender and ethnicity in student descriptions. *International Journal of STEM Education, pp. 11*, 12. https://doi.org/10.1186/s40594-024-00472-9

Eagan, M. K., Hurtado, S., Chang, M. J., Garcia, G. A., Herrera, F. A., & Garibay, J. C. (2013). Making a difference in science education: The impact of undergraduate research programs. *American Educational Research Journal, 50*(4), 683–713. https://doi.org/10.3102/0002831213482038

Good, C., Rattan, A., & Dweck, C. S. (2012). Why do women opt out? Sense of belonging and women's representation in mathematics. *Journal of Personality and Social Psychology, 102*(4), 700–717. https://doi.org/10.1037/a0026659

Graham, M. J., Frederick, J., Byars-Winston, A., Hunter, A. B., & Handelsman, J. (2013). Science education. Increasing persistence of college students in STEM. *Science (New York, N.Y.)*, *341*(6153), 1455–1456. https://doi.org/10.1126/science.1240487

Griffin, K. A., Pérez, D., Holmes, A. P., & Mayo, C. E. (2010). Investing in the future: The importance of faculty mentoring in the development of students of color in STEM. *Research in Higher Education, 51*(7), 611–634. https://doi.org/10.1007/s11162-010-9165-7

Kitchen, J. A., Sonnert, G., & Sadler, P. M. (2018). The impact of college- and university-run high school summer programs on students' end of high school STEM career aspirations. *Science Education, 102*(3), 529–547. https://doi.org/10.1002/sce.21332

Lent, R. W., Brown, S. D., & Hackett, G. (2018). Contextual supports and barriers to career choice: A social cognitive analysis. *Journal of Counseling Psychology, 55*(3), 274–283. https://doi.org/10.1037/0022-0167.55.3.274

Maiden, J. L., Stewart, D. O., Mizelle, N., & Thorne, D. (2021). Examining factors that promote doctoral degree attainment for African American males in counselor education programs. *Journal of African American Males in Education*, *12*(1), 35–48.

Maltese, A. V., & Tai, R. H. (2010). Pipeline persistence: Examining the association of educational experiences with earned degrees in STEM among U.S. students. *Science Education, 94*(5), 877–907. https://doi.org/10.1002/sce.20359

McGuire, L., Mulvey, K. L., Goff, E., Irvin, M. J., Winterbottom, M., Fields, G. E., Hartstone-Rose, A., & Rutland, A. (2020). STEM gender stereotypes from early childhood through adolescence at informal science centers. *Journal of Applied Developmental Psychology*, p. *67*, 101109. https://doi.org/10.1016/j.appdev.2020.101109

Nalipay, M. J. N., Huang, B., & Jong, M. S. Y. (2024). Promoting STEM learning perseverance through recognizing communal goals: Understanding the impact of empathy and citizenship. *International Journal of STEM Education, 11*, 17.

O'Leary, E. S., Shapiro, C., Toma, S., Sayson, H. W., Levis-Fitzgerald, M., Johnson, T., & Sork, V. L. (2020). Creating inclusive classrooms by engaging STEM faculty in culturally responsive teaching workshops. *International journal of STEM education*, *7*(1), 32. https://doi.org/10.1186/s40594-020-00230-7

Sáinz, M., Fàbregues, S., Romano, M. J., & López, B. S. (2022). Interventions to increase young people's interest in STEM. A scoping review. *Frontiers in Psychology*, *13*, 954996. https://doi.org/10.3389/fpsyg.2022.954996

Walton, G. M., & Cohen, G. L. (2011). A brief social-belonging intervention improves academic and health outcomes of minority students. *Science, 331*(6023), 1447–1451. https://doi.org/10.1126/science.1198364

Wang, M. T., & Degol, J. (2013). Motivational pathways to STEM career

choices: Using expectancy-value perspective to understand individual and gender differences in STEM fields. *Developmental Review, 33*(4), 304–340. https://doi.org/10.1016/j.dr.2013.08.001

Yang, D., Wu, X., Liu, J., & Zhou, J. (2023). CiteSpace-based global science, technology, engineering, and mathematics education knowledge mapping analysis. *Frontiers in Psychology*, *13*, 1094959. https://doi.org/10.3389/fpsyg.2022.1094959

Disclosure: The opinions and assertions expressed herein are those of the authors and do not reflect the official policy or position of the Uniformed Services University of the Health Sciences or the Department of Defense.

Disclaimer USU and HJF: The contents of this manuscript are the sole responsibility of the author(s) and do not necessarily reflect the views, opinions or policies of Uniformed Services University of the Health Sciences (USUHS), The Henry M. Jackson Foundation for the Advancement of Military Medicine, Inc., the Department of Defense (DoD) or the Departments of the Army, Navy, or Air Force. Mention of trade names, commercial products, or organizations does not imply endorsement by the U.S. Government.