www.ijemst.net

Project-Based, Experiential, and Integrated Learning in STEM Education: A Global Perspective

Anthony H. Normore
California State University, Dominguez Hills, USA

To cite this article:

Normore, A.H. (2025). Project-based, experiential, and integrated learning in STEM education: A global perspective. *International Journal of Education in Mathematics, Science, and Technology (IJEMST), 13*(6), 1317-1327. https://doi.org/10.46328/ijemst.5854

International Journal of Education in Mathematics, Science and Technology

2025, Vol. 13, No. 6, 1317-1327 https://doi.org/10.46328/ijemst.5854

Project-Based, Experiential, and Integrated Learning in STEM Education: A Global Perspective

Anthony H. Normore

Article Info

Article History

Received:
25 June 2025
Accepted:
15 October 2025

Keywords

International
Experiential learning
Integrated learning
Project-based learning
STEM education

Abstract

As we continue to navigate the complexities of the twenty-first century, STEM education trends provide a road map for developing a generation of learners who are prepared to face tomorrow's challenges with creativity, critical thinking, and a thorough understanding of the interconnectedness of their world. The collection of papers in this special issue examines the dynamics of STEM education from a global perspective. Papers range from early childhood education to higher education. This editor's essay provides an overview of each of the 20 articles and their contributions to the expanding research on STEM education. Included is a mix of empirically focused action research studies, literature reviews, and meta-analyses conducted by researchers and researcher-practitioners from Serbia, the Philippines, United States, Indonesia, and Turkey. Five main themes emerge: (1) Computational thinking in STEM education, (2) Embracing mathematics in STEM education, (3) Knowledge, professional development, competency, and support structures in the STEM setting, (4) STEM Integration: Integrated learning, equity, accessibility and inclusion, and (5) Assessment, identity and diverse learners in the STEM.

Introduction

STEM education has become the cornerstone of innovation equipping children with the necessary skills to thrive in the 21st-century workforce (Costello, Salehi, Ballen, et al., 2023; Dillon & Wong, 2025). Its landscape is poised for transformative changes, influenced by technological advancements and shifting global priorities (National Science Technology Council, 2018). Scholars argue that the next generation of STEM education is more than just keeping up with technological changes; it also necessitates predicting and adjusting to them (Milgrom-Elcott, 2025) while examining and fostering a generation of tech-savvy, critical thinkers and problem solvers (Hatfield & Kirby, 2023; Schuchardt & Roehrig, 2024; Thompson-Lee, See, & Klassen, 2025),) who embrace project-based, experiential, and integrated learning (Calabrese-Barton & Tan, 2018; Haraldsrud & Odden, 2024; Jetlearn, 2025; Kaldaras & Wieman, 2025; Milgrom-Elcott, 2025;), at early stages of education as children start to develop agency and identities (Dika & D'Amico, 2016; Foltz, Gannon, & Kirschmann, 2014; Shelley & Purzer, 2018). As seen throughout these articles, problem/project-based learning, critical thinking, communication skill

development, collaboration, and teamwork foster student engagement in practical activities to solve real world global problems and prepare them for future careers in a rapidly changing technological landscape.

Themes of This Special Issue

This special issue brings together researchers and researcher-practitioners who have tackled big questions in K-16 education. A variety of studies are presented to exemplify how project-based, experiential, and integrated learning are growing bedrocks for STEM education. The 20 papers selected for this special issue present diverse vantage points on the circumstances that influence students. The papers center around five distinct themes: (1) Computational thinking in STEM education, (2) Embracing mathematics in STEM education, (3) Knowledge, professional development, competency, and support structures in the STEM setting, (4) STEM Integration: Integrated learning, equity, access, and inclusion, and (5) Assessment, identity and diverse learners in the STEM. Four articles examine the manifestation of an element of computational thinking ranging from social justice aligned performance tasks in STEM courses, transdisciplinary learning and self-efficacy, building confidence and student engagement, to simulation exercises that make learning science engaging and accessible. Four articles examine how students embrace mathematics experiences in the classroom including reflection opportunities, interdisciplinary collaboration, influence of online adaptive programs, students' perceptions of math classes, and decision to pursue math-intensive STEM majors. Five articles examine the importance of knowledge, competency, support, and involvement in the STEM setting. These range from early childhood education knowledge and professional development needs, face-to-face support from institutional agents, the academic progress of international students, to reassessment and master-based learning, and the value of flexible, well-designed learning environments that actively support students in managing their thinking processes. Three articles focus on how STEM education is becoming more inclusive as educators and institutions aim to ensure that all students have the opportunity to explore and excel in STEM integrated learning by creating more accessible, equitable and inclusive learning environments that help recruit and retain underrepresented groups. Concepts range from critical thinking, design process in fostering inquiry-driven and higher-order thinking, to gender equality, and inclusive pedagogy. The final four articles examine assessment, identity, and diverse learners in the STEM field and effective student-lead assessment strategies.

Emphasizing Computational Thinking in STEM Education

In *The Impact of Social Justice Aligned Performance Tasks on the Awareness of Civic Responsibility in Adolescents: A STEM Perspective,* Isabel Baeza and Olivia Taylor explored the impact of social justice aligned performance tasks on the awareness of civic responsibility of adolescents. The primary question of this STEM education action research is: what impact does integrating social justice aligned performance tasks in computer science and college-preparatory math courses have on the awareness of civic responsibility by adolescents? This researchers use a mixed methods approach to identify the changes in a pre- and post-survey and a thematic analysis of student reflections. The results suggest social justice aligned performance tasks result in an increase in their awareness of community and social justice issues and real-world connections. More research is needed on social justice-aligned performance tasks in STEM courses, such as in higher level math and computer science at the

secondary level or other topics in the field of STEM.

In, *Transdisciplinary Learning: Using "Transfer Skills and Tools" for Deeper Learning to Achieve Higher-Order Thinking on Cross-Curricular Content*, researchers James Borden and Cecilia Duenas investigated the impact of transdisciplinary learning on minority students as they were asked to apply higher-order thinking to solve real-world problems. Participants are minority students, aged 10 to 11, who attended one of the researcher's elective classes participated. To see the potential in Transdisciplinary Learning, researchers looked at its essence through the use of "transfer skills and tools" such as: metacognition, questioning, Computational Thinking, Common Core State Standards Mathematical Practices (MP1: Make Sense of Problems and Persevere in Solving Them; MP4: Modeling with Mathematics; MP7: Look for and make use of structure; MP8: look for and express regularity in repeated reasoning), digital technology tools, and self-efficacy. The use of these "transfer skills and tools" was monitored to collect data on students' progress and development to see how underrepresented students fare with rigorous instruction that offered them student-centered experiences that would build their capacity to solve "wicked" 21st-century global problems. Results yielded self-efficacy as a critical variable that provided some statistically significant outcomes. While promising for refining future efforts to empower students, the results for the immediate effects of transfer skills and tools used to increase students' deep learning were inconclusive.

In, *The Impact of Teaching Computational Thinking on the Growth of Students' Algebraic Thinking,* researchers James Knutson and Kristen Stagg examined the integration of computational thinking in mathematics education, specifically examining its impact on students' algebraic reasoning. By teaching core computational concepts such as pattern recognition, decomposition, and algorithmic thinking, students develop a deeper understanding of algebraic structures and processes. The study focuses on a classroom intervention where students are concurrently taught Algebra 1 and computer science by the same teacher using interdisciplinary lessons. The results suggest that combining computational thinking with algebra instruction fosters problem-solving skills, builds confidence, and enhances student engagement. This research provides educators practical insights and strategies for integrating computational thinking into algebra curricula, thereby fostering stronger algebraic reasoning and advancing students' mathematical achievement.

In, *Simulating Science: The Impact of Computer Simulations on Middle School Chemistry Understanding,* researchers Jerry Coronado and Cecilia Duenas explored how using computer simulations helped 7th grade students improve their understanding of chemistry. At one school, many students are below grade-level in reading and math, which can make science more challenging. During a 3-week chemistry unit, one of the teacher-researchers used simulations from Amplify and other online tools. These simulations allowed students to interact with virtual experiments like combining substances and observing what happens directly on the computer. Students in two classes took a test before and after the unit. After using the simulations, their scores increased, and they were able to explain scientific ideas more clearly in writing, including using and developing and using models. Instead of just naming atoms, students began to show how atoms rearrange and stay balanced during chemical reactions by creating models. This study shows that computer simulations make learning science more engaging and accessible, especially for schools that don't have full lab equipment. It also helps support Next Generation Science Standards (NGSS) by giving students opportunities to build and test their own models. This

kind of learning, which is called model-based reasoning helps students better understand abstract science concepts in a meaningful way.

Embracing Mathematics in STEM Education

In, *What is the Impact of Student Reflections and Intentional Project-Based Learning on Student Success and Attitude in a Mathematics Classroom?* researchers Keesha Aldridge and Kathryn Theiss focused on the challenges that student attitudes towards math have on their performance in the mathematics classroom. The researchers sought out to see the impact of reflective opportunities on how students feel about the mathematics they are learning as well as how they view themselves as mathematicians. They incorporated project-based learning to allow students to collect and analyze their own data, interview professionals, and present their findings. Results of this study highlight the need for educators to use methods which allow students to reflect, and to be provided with a variety of learning methods in the math class setting. Results further suggest that utilizing these teaching practices may reduce anxiety, and students have opportunities to create memorable and valuable learning experiences

In, *BioMath: Bridging the Gap Between Math and Science Education,* researchers Crystal Villa and Rikki Marzan address the disconnect and bridge the gap between mathematics and science education, researchers (also teachers) developed interdisciplinary lessons and real-world applications by integrating Algebra 1 and Biology in a collaborative cohort model. The traditional separation of mathematics and science in education often prevents meaningful integration of the subjects, despite the natural interconnectedness between them. In mathematics classrooms, the focus is predominantly on abstract mathematical concepts, while in science classrooms, the emphasis is placed on scientific content, leaving little room for interdisciplinary collaboration. Although STEM majors need to take both math and science courses, teachers often do not have time to discuss concepts and skills that can be integrated within the courses. With interdisciplinary teaching and intentional collaboration, these authors promoted an interactive learning environment, facilitated networking opportunities for students and teachers, strengthened student relationships, and enhanced the student learning experience.

Researcher Susana Ortega conducted a study to determine *The Influence of an Online Adaptive Program on Students' Math Attitude and Math Achievement as Measured Through i-Ready Diagnostic Test Scores.* The purpose of this study was to determine if the use of the i-Ready program with a group of eighth grade students, who most were behind on average four years in math, influenced their math achievement and their math attitudes. The i-Ready program is an online adaptive program which school districts are purchasing and are requiring teachers to implement in their classrooms. The program suggests a minimum of 45 minutes per week is spent on students working on two personalized lessons as determined from their diagnostic assessment results. The i-Ready program was implemented in the three math classes for an entire school year: Honors, Sheltered, and Regular. Students completed the diagnostics at the beginning (BOY), middle (MOY), and end (EOY) of the school year, as well as completed a math attitude survey at the beginning and end of the school year, to see if there was an influence of the use of i-Ready towards their math attitudes. A paired sample t-test revealed only participants in the Honors class had a significant difference in i-Ready Diagnostic scores, BOY to EOY. A paired sample t-test

revealed no significant difference among students' pre- and post- math attitude survey responses.

In, *Relationships between Math Class Perceptions, Math Identification, and Choice of STEM Major: Racial and Gender Differences,* researchers Sachiel Mondesir, Jesse L. M. Wilkins and Brett D. Jones employed structural equation modeling (SEM) in their study with multigroup analyses to examine the relationships among high school students' perceptions of their math classes, their math identification, and their decision to pursue math-intensive STEM majors. The theoretical framework integrated the MUSIC Model of Motivation (eMpowerment, Usefulness, Success, Interest, Caring) and domain identification theory. Data were drawn from 23,503 participants in the nationally representative High School Longitudinal Study (HSLS: 2009–2013). Analyses focused on differences by gender and race, with particular emphasis on Black female students. Results indicated that students' perceptions of success and interest in their math classes were positively associated with math identification, which in turn was positively related to their decision to pursue a STEM major. No statistically significant differences were found between Black females and their peers (Black males, White females, and White males) in the strength of these relationships. Implications for educators and schools seeking to increase the participation of Black female students in STEM fields are discussed.

Knowledge, Professional Development, Competency, and Support Structures in the STEM Setting

In, *STEM in Early Childhood: A Phenomenological Perspective on Teachers' Views, Experiences, and Professional Development Needs,* researchers Nefise Özok Bulut and Serap Erdoğan assert the implementation of STEM education in early childhood has become increasingly important for the development of children's 21st-century skills. However, the effective realization of this interdisciplinary approach is directly related to teachers' theoretical knowledge and practical competencies. In this study, the views, implementation experiences, and professional development needs of preschool teachers regarding STEM education were examined. The phenomenological study included 16 preschool teachers selected through criterion sampling. Data were collected through two online focus group interviews and analyzed using the content analysis method. The findings indicate that teachers define STEM as an interdisciplinary approach but have some misconceptions. While all teachers emphasized that STEM education is important and necessary for children, it was found that they do not implement it. The main factors hindering STEM education include a lack of professional support, insufficient knowledge, materials, and resources, time constraints, and inadequate administrative and family awareness. The research findings show that teachers need practical training, mentoring support, professional learning communities, and guiding resources and materials. The study also offers recommendations to improve the quality of STEM implementation in early childhood.

In, *The Academic Progress of International Graduate Students in STEM Master's Programs in the U.S.,* Carrie B. Myers and Scott M. Myers conducted a quantitative study aimed to understand the association between five different types of face-to-face support from institutional agents and the academic progress of international students in STEM master's programs in the U.S. The researchers used one-of-a-kind primary survey data from a National Science Foundation grant that included over 350 master's students across 12 research institutions in the U.S. Drawing from the concepts of social, cultural, and navigational capital, the researchers proposed that support from

all five institutional agents of peers, faculty, mentors, advisors, and staff would be important for reaching academic milestones in their master's programs. Based on ordinal logistic regression results, they found that support from peers and faculty played a positive and statistically significant role in academic progress whereas support from staff played a negative and statistical role. In their final models, researchers did not find any statistical results for the influence of support from mentors or advisors. In the concluding sections, they drew on existing research and programs to explain their mixed results and, based on those results, they proposed programs and policies to leverage the positive influence of peers and faculty and to offset the negative and non-findings for other institutional agents.

In, *Regulating the Load: A Systematic Review of SRL and Metacognitive Strategies in STEM Problem Solving Tasks,* researcher Özlem Özbey-Demir conducted a systematic review of how students manage cognitive load during STEM problem solving by using self-regulated learning (SRL) and metacognitive strategies, and how instructional designs can support these attempts. Fourteen empirical studies published since 2010 were thematically analyzed using the SALSA framework and PRISMA guidelines. Based on these studies, the findings suggest that SRL strategies do more than reduce the cognitive load; they also facilitate deeper student engagement by increasing germane cognitive load. The findings are organized according to two research questions. The first focuses on the strategies students use to reduce the cognitive load, which emerge under three themes as "Monitoring & "Evaluation", "Elaboration & Explanation", and "Strategic Regulation". The second focuses on how instructional designs support these strategies particularly through "Metacognitive Activation via Prompting" and "Load Optimization through Multimedia Principles". Overall, the findings revealed that when students are encouraged to reflect, explain, and make conscious choices regarding their existing skills and knowledge, they can better handle the cognitive load of complex STEM tasks. Instructional supports like prompts and multimedia elements help to reduce extraneous load and create space for meaningful learning. These findings point to the value of flexible, well-designed learning environments that support students in managing their thinking processes.

In, *Tech Level-Ups: Technology-Based Micro-Credential Program as a Novel Approach to K-12 Professional Development,* researcher Timothy Chang argues while professional development (PD) is an important part of teachers' professional growth, current PD formats are often perceived as irrelevant or too brief to significantly impact teaching practices. This mixed-methods action-research study evaluated a four-session, beginner-level fabrication-technology micro-credential (MC) program delivered to 102 distinct teachers across four cohorts. Descriptive statistics were utilized to summarize teacher demographics and self-reported comfort with fabrication technologies. Kruskal–Wallis tests were applied to compare post-session ratings of pacing, relevance, facilitator quality, and overall satisfaction across cohorts. Open-ended comments were thematically coded to capture perceived utility and classroom transfer. Participants included teachers from elementary (41.9%), middle (27.5%), and high school (20.6%) grades, with the remainder teaching multiple grades. The median comfort level with fabrication tools increased from "beginner" to "intermediate" over the sessions, while satisfaction levels remained consistently high. Differences in overall satisfaction among the cohorts were not statistically significant, $H = 3.29$, $p = .35$. Qualitative themes emphasized the importance of hands-on training, iterative practice windows between meetings, and facilitator feedback loops. The findings support the MC design principles of self-direction, job embedding, and competency-based assessment as effective solutions to common PD challenges. Implications

include actionable steps for other MC programs and districts to support teachers.

In, *Differences in Parental Involvement and Expectations during Primary Education: Reflections of STEM and Non-STEM Grammar School Students,* researchers Aleksandra Maksimović, Filip Stašević, and Aleksandar Milenković examined how grammar school students perceive parental involvement during their primary school years, and how it differs depending on whether they later chose STEM or Non-STEM tracks (languages, social sciences, sports, and arts). Furthermore, the study explored how these patterns vary by gender, place of residence, and parental education. Using a quantitative research design, data were collected from grammar school students in Serbia. The results indicate that students who chose Non-STEM departments experienced greater parental involvement than those who chose an educational pathway that prepares them for academic studies in STEM subjects. Data analysis on parental involvement across STEM and Non-STEM groups yielded valuable findings in relation to students' sociodemographic backgrounds: differences reflected in homework supervision, encouragement to pursue higher education, and expectations about immediate employment These results emphasize the importance of recognizing the multifaceted nature of parental engagement, ranging from practical help to symbolic encouragement, and its interaction with social and cultural capital. The study concludes with recommendations for inclusive education policy and practice that recognize and strengthen family-school partnerships.

STEM Integration: Integrated Learning, Equity, Accessibility and Inclusion

In, *Systematic Review on Critical Thinking through STEM Integrated Learning in Education,* researchers Fatya Azizah, Stevanus Budi Waluya and Adi Satrio Ardiansyah conducted a systematic literature review related to critical thinking with STEM integrated learning. Critical thinking is one of the 4C skills needed in 21st century education. This is the reason for the need to conduct a review to find an effort to improve critical thinking skills in education. A relevant strategy in this effort is to integrate STEM (Science, Technology, Engineering, and Mathematics) into the learning process. In this study, a review of related articles published in the period 2020-2025 was conducted. The articles reviewed in this study came from various international journals in Crossref, Scopus, and Google Scholar with relationship analysis assisted by VOSViewer software. The results of this literature review show the influence of STEM-integrated learning on students' critical thinking skills. It is concluded that it is necessary to develop other learning innovations that involve STEM integration in it by paying attention to indicators of critical thinking skills in each learning activity.

In, *A Meta-Analytic Review of the Effectiveness of Engineering Design Process in Enhancing STEM Competence, Albert Andry E. Panergayo* synthesized 18 qualified studies, resulting in 29 effect sizes. This study involved a total sample of 1,280 students to evaluate the effectiveness of Engineering Design Process (EDP)-based instructional approaches in STEM education. Eligible studies were systematically selected through inclusion and exclusion criteria following the PRISMA protocol, and effect sizes were computed using Hedge's g, applying random-effect model due to substantial heterogeneity ($Qe = 156.367$, $df = 28$, $p < 0.001$). The overall effect size ($ES = 1.168$) reflects a strong positive impact of EDP-based interventions on STEM learning. Meta-regression analysis further revealed that tertiary education level significantly moderated the effect size ($p=0.033$), while

STEM competence type and implementation period did not yield statistically significant effects. The findings also revealed that scientific creativity and engineering-focused STEM integration were the most frequently enhanced STEM competence and instructional approach used on the reviewed studies respectively. These findings support the pedagogical strength of EDP in fostering inquiry-driven, higher-order thinking and suggest tailoring approaches based on learner's academic level to maximize impact.

In, *Tracing Gender Equity in STEM: A Bibliometric Analysis of Women's Representation in STEM Education,* researchers Elenita P. Galvez, Jesusa C. Francisco, Crisanta T. De Leon, Luisito M. Nanquil, Jane Kristine G. Suarez, Ronilo P. Antonio, Analiza A. Villacorte and Walton Wider examined the current intellectual structure and emerging research trends in gender parity within STEM education by conducting a comprehensive bibliometric analysis of women's representation in science and technology fields. Using data from the Scopus database spanning 2000 to 2024, this study employs co-citation and co-word analyses to identify thematic clusters, influential publications, and future research trajectories. The search strategy integrates keywords related to gender equality, women in STEM, engineering education, and inclusive pedagogy. Three co-citation clusters emerged: (1) identity formation, stereotypes, and structural barriers in women's STEM participation; (2) structural barriers, role models, and pandemic-era challenges; and (3) psychological constructs and multi-factorial barriers. Co-word analysis revealed trends focused on diversity and inclusion in STEM education, representation in policy, and educational innovation in higher education. It highlights the importance of inclusive pedagogies, systemic reform, and targeted interventions to enhance the participation, retention, and leadership of women in STEM fields.

Assessment, Identity and Diverse Learners in the STEM Field

In, *The Effect of Translanguaging in a Middle School Science Classroom,* researchers Ma Teresa Aki, and Kathryn Theiss explored the impact of translanguaging on student engagement, joy, and identity in a middle school science classroom. Translanguaging, which is leveraging students' full linguistic repertoire, was integrated into NGSS-aligned instruction in 8th grade science classes. Using pre- and post-surveys, data collected were analyzed to assess changes in student learning experience. Analysis of data indicates that translanguaging strategies foster greater engagement, affirm students' cultural and linguistic identities, and create more inclusive and collaborative learning environments. The significant shifts in the reported instances of translanguaging, peer collaboration using LOTE, and positive shifts in attitudes and participation confirm that multilingual practices can transform science learning into a more inclusive, responsive, and meaningful experience. While some students have expressed minor concerns for potential confusion, the overall result was overwhelmingly positive. The result of this research reinforces that importance of culturally and linguistically responsive instruction. This highlights translanguaging as an effective strategy to promote equity, belonging and deeper and meaningful learning in science.

In, *Exploring the Effects of the Classbank Online Program on Student Engagement in Reassessment in Education,* Alma Hisela and Cecilia Duenas examined the impact of the online tool "Classbank" on student engagement in reassessment in middle school. Research questions for this study are: (1) To what extent does Classbank affect students' willingness to improve their performance through reassessment? and (2) How do students perceive the role of Classbank in their learning process, specifically in terms of reassessment and mastery-based learning? The

tool was implemented to reward students for reassessment in science class. Students were surveyed before and after implementation to rate their willingness to improve their performance through reassessment due to Classbank. Pre-Surveys results showed that the student's motivation to reassess would be due to the use of Classbank. Though post-surveys results show that the student's motivation to reassess was not due to the use of Classbank; students took the opportunity to reassess and in return their academic grade did improve with the use of Classbank. Classbank implementation demonstrates improvement of education. Recommendations for educators suggest they need to provide adequate time to grade and provide feedback for students to review and study before their next attempt. Other recommendations are discussed.

In, *Supporting Diverse Learners in STEM Education: The Impact of a Peer Assessment and Content Creation Activity,* researcher Sergio Blanco examined the impact of an active learning intervention where students created and peer-assessed exam questions. Using a mixed-methods approach, it was compared an intervention group (n=74) against a control group (n=76) and was analyzed pre/post-test results and student feedback. The results reveal a statistically significant and substantial improvement in academic performance. The intervention group not only demonstrated exceptional learning gains (Cohen's d = 1.10) but also significantly outperformed the control group on the final exam (Cohen's d = 1.15). Student feedback confirmed the activity's value for learning, despite being perceived as demanding. This student-led assessment strategy proves to be a highly effective pedagogical tool for enhancing comprehension and success in challenging STEM courses for diverse student populations.

In, *A Gamified Curriculum's Effect on Physics Identity in Urban High School Students***,** researchers LaTeira Haynes Zavala and Kathryn Theiss examined how a 'gamified' physics curriculum with immediate feedback affects students' perception of their ability to master physics as a discipline. Furthermore, the study aimed to investigate how an online algebra-based physics curriculum, which provides students with multiple levels of mastery in an interactive and responsive format, affects students' physics identity and academic achievement. Survey data were analyzed via ANOVA and/or discriminant analysis to determine shifts in participants' attitudes about physics as the school year progressed. While the students' self-assessed physics ability improved in the classroom, their assessment of their ability to do physics on a professional level decreased. This coincided with a decline in their interest in physics. In addition, the students did not prefer one content delivery method over another. These data suggest that even as students' perceived ability in physics increased, the improvement in ability was confined to their current class.

Conclusion

As we look beyond 2025, STEM education trends reflect a dynamic and evolving landscape that is adapting to the demands of a rapidly changing world. According to researchers (e.g., Rusmin, et al., 2024), educators and institutions can embrace these trends to provide students with a more engaging, relevant, and comprehensive learning experience. These same researchers reiterate that STEM education benefits are plentiful and range from students learning to analyze and develop effective strategies to tackle problems, increase student engagement and motivation, to career readiness with the skills necessary for success. Further, STEM education helps bridge gender

and racial gaps and promotes diversity, equity, and inclusion. As we navigate the complexities and move into the second quarter of the twenty-first century, STEM education trends provide a road map for developing a generation of learners who are prepared to face tomorrow's challenges with creativity, critical thinking, and a thorough understanding of the interconnectedness of their world. The future of STEM education seems bright, and by embracing these emerging trends, we can ensure that students are ready to lead the way.

References

Calabrese-Barton, A., & Tan, E. (2018). A longitudinal study of equity-oriented STEM-rich making among youth from historically marginalized communities. *American Educational Research Journal, 55*(4), 761–800. https://doi.org/10.3102/0002831218758

Costello, R. A., Salehi, S., Ballen, C. J., & Burkholder, E. (2023). Pathways of opportunity in STEM: Comparative investigation of degree attainment across different demographic groups at a large research institution. *IJ STEM Ed 10*(1), 46. https://doi.org/10.1186/s40594-023-00436-5

Dika, S. L., & D'Amico, M. M. (2016). Early experiences and integration in the persistence of first-generation college students in STEM and non-STEM majors. *Journal of Research in Science Teaching, 53*(3), 368–383. https://doi.org/10.1002/tea.21301

Dillon, J., & Wong, V. (2025). Learning from the past; thinking for the future: reflections on STEM and its integration in formal and informal settings. *IJ STEM Ed 12,* 32. https://doi.org/10.1186/s40594-025-00552-4

Foltz, L. G., Gannon, S., & Kirschmann, S. L. (2014). Factors that contribute to the persistence of minority students in STEM fields. *Planning for Higher Education*, *42*(4), 1-13.

Haraldsrud, A., & Odden, T. O. B. (2024). Using feedback loops from computational simulations as resources for sensemaking: A case study from physical chemistry. *Chemistry Education Research and Practice, 25*(3), 760–774.

Hatfield, S., & Kirby, L. (2023). *Taking bold action for equitable outcomes: The DEI conversation shifts from activities to outcomes.* https://www.deloitte.com/us/en/insights/topics/talent/human-capital-trends/2023/diversity-equity-inclusion-belonging.html

Jetlearn (2025). *STEM Education: Inspire Innovation through key trends in 2025. https://www.jetlearn.com/blog/latest-trends-in-stem-education*

Kaldaras, L., & Wieman, C. (2025). Investigating blended math-science sensemaking with historically marginalized STEM learners. *IJ STEM Ed, 12*(44). https://doi.org/10.1186/s40594-025-00565-z

Milgrom-Elcott, T. (2025). *2025's Top STEM education trends: Insights for educators and innovators.* https://www.forbes.com/sites/taliamilgromelcott/2025/03/05/2025s-top-stem-education-trends-insights-for-educators--innovators/

National Science Technology Council. (2018). *Charting a course for success: America's strategy for STEM education*. https://www.whitehouse.gov/wp-content/uploads/2018/12/STEM-Education-Strategic-Plan-2018.pdf

Rusmin, L., Misrahayu, Y., Pongpalilu, F., & Radiansyah, D. (2024). Critical thinking and problem-solving skills in the 21st century. *Journal of Social Science 1*(5), 144-162

Schuchardt, A., & Roehrig, G. (2024). Critical thinking in mathematics and mathematical modeling related to STEM. In, Lyn D. English and Timothy Lehmann (Eds.), *Ways of thinking in STEM-based problem solving* (pp. 205–217). Routledge.

Shelley, M., & Purzer, S. (2018). Culture, identity, and motivation in engineering education. *International Journal of Education in Mathematics, Science and Technology (IJEMST), 6*(3), I-IV. DOI: 10.18404/ijemst.428160

Thompson-Lee, S., Huat-See, B., & Klassen, R.M. (2025). A systematic review of STEM teacher recruitment and retention interventions. *IJ STEM Ed*, *12,* 33. https://doi.org/10.1186/s40594-025-00550-6

Author Information

Anthony H. Normore, Ph.D

https://orcid.org/0000-0002-9994-1307

Center for Innovation in STEM Education (CISE)

Professor Emeritus, Graduate Education

California State University, Dominguez Hills

USA

Contact e-mail: *anormore@csudh.edu*