

Addressing Critical Shortages in STEM Education: The Role of Mathematics Educators in Closing the Gap

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ABSTRACT

Mathematics educators are pivotal in mitigating the critical shortages in STEM education across the USA by actively fostering student engagement through innovative teaching methods, enhancing curriculum relevance to align with real-world applications, and advocating for supportive policy changes that prioritize and fund STEM initiatives, ultimately shaping a more skilled and diverse future workforce.

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INTRODUCTION

STEM (Science, Technology, Engineering and Mathematics) education in the United States is very turbulent. Besides, professions in technology, engineering, science, and mathematics have continuously grown. Despite many efforts, the country still suffers from major deficiencies in qualified professionals in the so-called STEM disciplines—a fact that is potentially threatening economic competitiveness and technological development. Fewer Students are choosing to major in STEM. That is, fewer students rose to the challenge of majoring or working in those fields, especially from underrepresented groups. In sending their response to that challenge, it is integral that the education system be at the center, as it is one of the avenues through which such students are prepared for STEM-related careers. But these lacunae in math education have a tendency to persist, and are not so easily set right at one sitting when the entire educational process along the K-16 spectrum is a testimony that they have handicapped those upon whom we propose to depend as our workforce of the future.

All STEM subjects have mathematics as their base. Therefore, math teachers wield a very influential impact on the experiences that their students can have in regard to the training in science, technology, engineering, and mathematics. IM 6–8 Math Units provide the kind of mathematics instruction supportive of critical thinking, problem solving AND curiosity and confidence for students desiring to excel in other areas of STEM. We are in dire need of math teachers who may inspire and energize

our youth towards math with such a passion that makes math not only interesting but easier to learn, hence making STEM more attractive. The mathematics educators provide human representation in the form of role models that make impossible achievements seem possible among some of our most needy populations. Criticism for low participation in STEM, misguided support or education is being provided.

Mathematics educators can address the shortages and shortfalls in STEM education across the country by creating spaces that students will engage with and develop more innovative curriculum relevant to real-world applications, lobbying for policy supportive of STEM initiatives centrally funded responsible decision-making factors toward an improved future workforce.

OVERVIEW OF STEM SHORTAGE IN USA

This low supply of professionals in the field of STEM is a matter of great concern for the United States, affecting nearly every industry, from education to industry. The U.S. BLS also projects that STEM occupations will grow by 8.8% between 2020 and 2030, more than twice the growth percentage for non-STEM occupations at 3.7%. This translates into nearly a million jobs to be filled and is especially in need of computer science, engineering, and the biomedical sciences. Even as demand is on the rise, though, the pipeline of students earning degrees relevant to STEM are well below what is expected to be needed. Truthfully, only 20% of college graduates earned a degree in a STEM field way back in 2022, according to the

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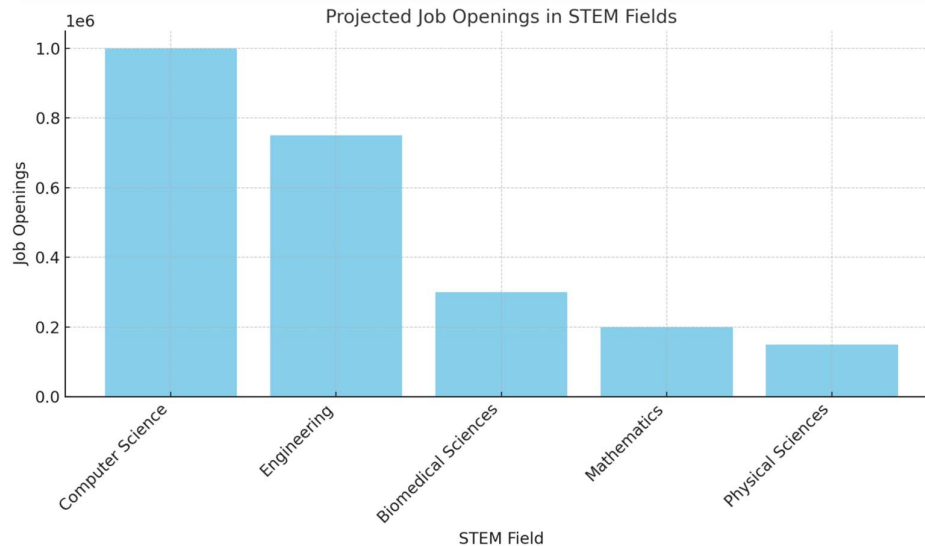
National Science Foundation — nearly none of whom are prepared or ready for these jobs.

For example, in the U.S., the labor market required 1 million STEM workers to fill technology, healthcare, and engineering spots that are not as full compared to other sectors such as technology or healthcare; filling such gaps will add an extra \$54.3 billion annually by 2022. In fact, the U.S. The Bureau of Labor Statistics projects that between 2020 and 2030, employment in STEM occupations will grow by almost another third (29%), while employment in non-STEM occupations will increase by only

slightly over a tenth as much. The widening gap will be even larger than the trend seen in recent years." For example, in the field of technology alone, Microsoft and Google both reported that many of their most important positions went into long-term hiring freezes due to a lack of qualified applicants, leading to reduced innovation and billions lost in revenue. Unless the U.S. addresses this deficiency, key areas of national priority-such as AI, biotechnology, and cybersecurity-that bear on national security and world leadership are apt to lag behind many other countries.

Table 1: STEM Vacancies by Field

STEM Field	Projected Job Openings
Computer Science	1,000,000
Engineering	750,000
Biomedical Sciences	300,000
Mathematics	200,000
Physical Sciences	150,000



The U.S. Bureau of Labor Statistics projects that employment in STEM occupations will grow 8.8% from 2020 to 2030, compared with 3.7% for non-STEM occupations. While such growth brings a wealth of opportunity, the ripple effects are not uniformly felt across the nation or even within different segments of the population. The students are mostly at a disadvantage in rural and urban schools that are grossly underfunded for an advanced STEM

education. For example, there is a lack of math teachers qualified to teach in many low-income areas. That means students have to share classrooms, which usually translates into fewer resources and tools available. All this has a direct consequence on the effects of developing a solid mathematics background by students, crucial for STEM job routes. Already strained, it is at these places that teachers have an added burden of preparing their students for the

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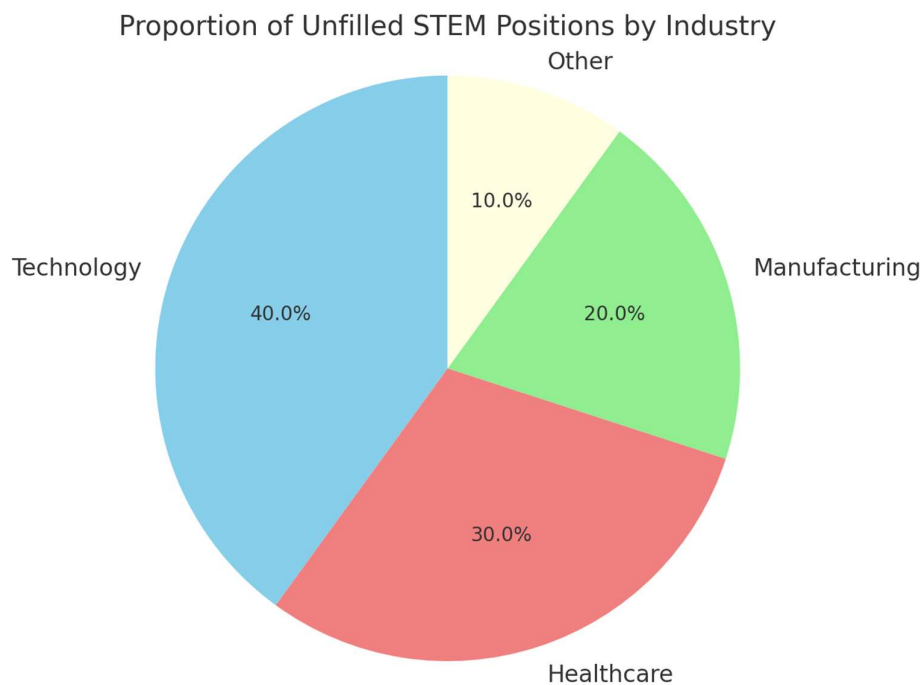
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increasingly competitive job market in STEM without adequate assistance. As such, regions with fewer resources have lower rates of STEM participation, adding to the national shortage and feeding into a loop of economic and educational inequality. It gets grimmer when looking into the representation of the underrepresented groups: over 30% constitute the percentage of the U.S. population for African American, Hispanic, and Native American students, while less than 13% are STEM degree holders. There is a serious lack of diversity in these fields of STEM, which aggravates the gap in talents and narrows the spectrum of ideas highly important for invention.

IMPACT OF SHORTAGES

This shortage of qualified STEM professionals has serious consequences for the U.S. economy, its innovation capacity, and its global competitiveness. These include

industries like technology, healthcare, and manufacturing, which draw upon the ingenuity and talent of the STEM workforce to drive their growth. For example, the technology industry creates more than \$1.6 trillion in value for the United States economy annually, although it faces many challenges while finding and retaining talent. For example, Google, Microsoft, and IBM have reported challenges in finding qualified candidates for key positions. This slows down production, increases costs, and consequently limits their innovation capacity. As recently as 2021, it was said that 83% of technology firm CEOs were concerned about the availability of STEM talent. According to the chart below, technology and healthcare are the worst hit, with 40% and 30% of open positions not being filled, respectively, and worsening the impact of the STEM gap on innovation and public health.



Pie Chart showing the proportion of unfilled STEM positions across industries like technology, healthcare, and manufacturing. But aside from the interest factor in science and

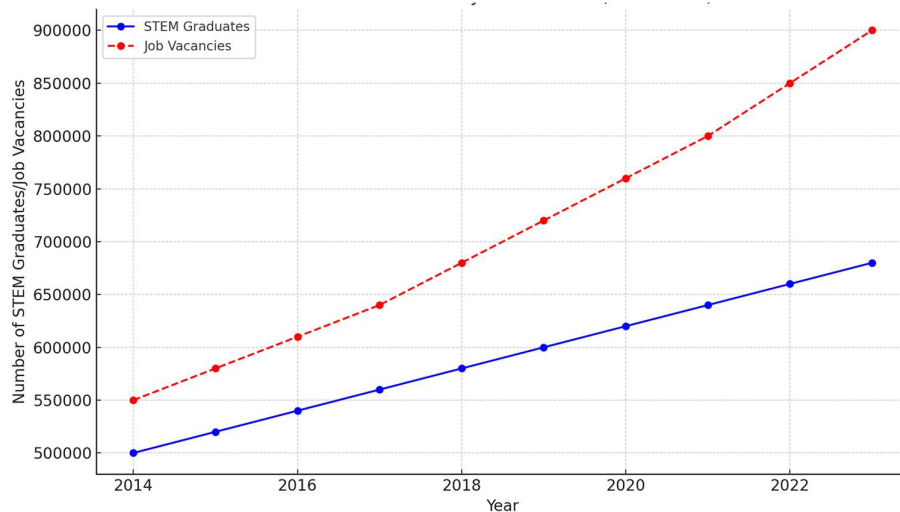
technology, the deficiency in personnel for STEM has deeper roots: basic education, particularly mathematics. Mathematics acts as the backbone for every single discipline under

STEM, especially the logical reasoning or problem-solving skills associated with engineering, computer science, and data analytics. However, other than rigorous math training at the K-12 level, students can seldom succeed through advanced levels of such subjects in STEM fields. That is where the mathematics educators become central to the solution: engaging students early on in their academic journey and helping them demystify such hard mathematical concepts directly impacts the number of students who might pursue a career path in STEM. Hence, it would follow that broader crisis in STEM education is dependent upon the success or failure of mathematics education and the preparation and equipping of educators with the relevant pedagogical tools and approaches to inspire future classes of STEM professionals.

On the global level, the United States might stand lagging behind other countries like China, India, and Germany, which have invested so much in the education of their

working force in the field of STEM. For instance, every year China produces almost 4 million graduates in the field of STEM, while the United States produces less than 600,000. This gap has grave implications for American innovation, as progress in technology, health, and engineering increasingly depends on the largest, most diverse pools of talent abroad. Moreover, these shortcomings shrink the potential for addressing other critical challenges-such as climate change, public health emergencies, and cybersecurity threats-which are also dependent on large reserves of STEM expertise.

The following line graph depicts the gap between qualified STEM graduates and job openings in STEM over the last ten years, where STEM job availability has grown to outstrip the numbers of STEM-qualified candidates. This points to an increasing trend where educational reforms and policy intervention become pressing.



Line Graph comparing the number of STEM graduates to job vacancies between (2014-2022), highlighting the growing gap between graduates and available job openings. In addition to economic and global competitiveness concerns, the shortage of STEM professionals also stifles innovation. Research and development (R&D) efforts, which are critical for advancing technology and improving quality of life, depend on a steady

flow of skilled scientists and engineers. The U.S. government and private sector spend over \$580 billion annually on R&D, but without enough STEM talent, the potential for groundbreaking discoveries and advancements is diminished. This is particularly worrying in industries such as biotechnology and artificial intelligence (AI), where rapid innovation is crucial for maintaining technological leadership (NSF 2022).

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THE ROLE OF MATHEMATICS EDUCATORS

Mathematics educators hold a pivotal role in sparking students' interest in STEM careers by making mathematics both accessible and engaging. Innovative teaching methods, such as inquiry-based learning, project-based learning, and technology integration, can transform the way students experience mathematics. Rather than viewing it as an abstract subject disconnected from everyday

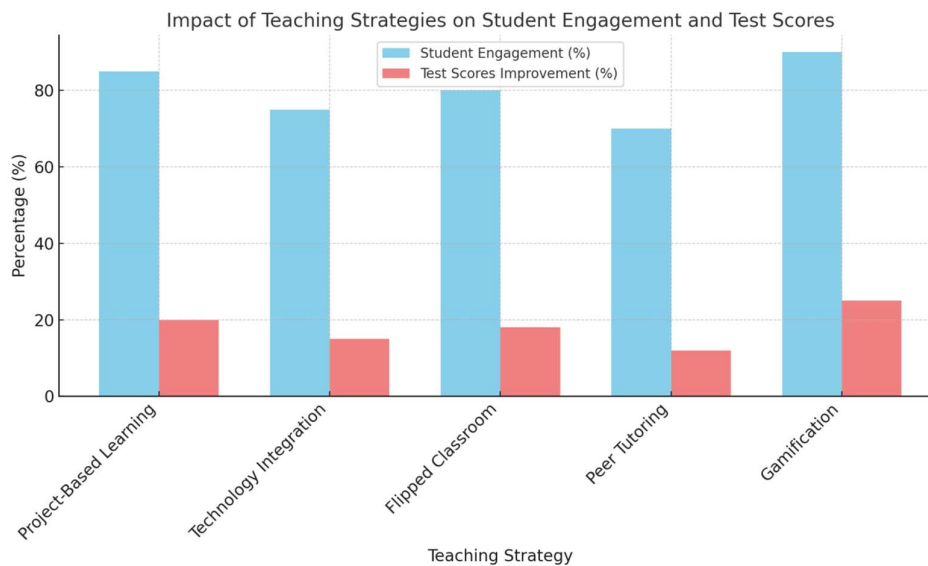
life, educators can emphasize the real-world applications of mathematics in fields such as engineering, data science, and environmental science.

The table below summarizes the impact of various innovative teaching strategies on student engagement and test scores, demonstrating how different methods contribute to improved outcomes in mathematics education.

Table 2: the impact of various innovative teaching

Teaching Strategy	Impact on Student Engagement (%)	Impact on Test Scores (%)
Project-Based Learning	85%	20%
Technology Integration	75%	15%
Flipped Classroom	80%	18%
Peer Tutoring	70%	12%
Gamification	90%	25%

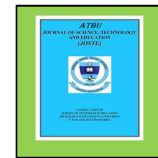
(NSF 2022)



Bar chart visualizing the impact of different teaching strategies on student engagement and test scores. The blue bars represent the percentage increase in student engagement, while the red bars represent the improvement in test scores for each strategy.

For example, the use of mathematical models in predicting patterns in climate change or the use of algebraic formulas in coding and computer science deepens their understanding and lays more interest in stem-related careers.

Other educators can bring it closer to the students' lives by using examples in mathematics that are relatable to a student's life experiences or even their cultural background. The way one could show this in schools is to point out how math is involved in making various new inventions, from self-driving cars to space travel and medical advancements. This will raise curiosity and showcase the magic of science and technology fields.



In addition, growth mindsets can be developed by creating nurturing classroom environments in which students feel comfortable taking risks and making mistakes. Such a stance is important to overcome anxiousness and self-doubt about mathematics felt by many students, including those from underrepresented groups in STEM. Teachers who inspire confidence and show that the key to mastering difficult concepts is persistence can help more students see themselves capable of succeeding in STEM careers.

A mathematics curriculum should have broad grounding in the provision of increased preparedness for eventual success among students within various areas of science, technology, engineering, and mathematics. Math educators must ensure that the curriculum maintains relevance and rigor by updating its content to modern standards of STEM while preparing students for college courses in physics, computer science, and engineering. Curricula should place emphasis on the development not only of procedural knowledge but also of conceptual understanding-the ability to reason, solve problems, and apply mathematical knowledge to situations that might be novel.

The integration of STEM-based mathematics curricula with interdisciplinary approaches has the potential to create coherence and relevance in learning. Early integration of data analysis, probability, and statistics could make the students better prepared for such areas as bio-informatics, economics, and machine learning, where these techniques are important. Furthermore, when activities that include the direct work of students are realized, for example, projects in mathematical modeling or coding, it favors critical thinking in young people and deepens their notion of how mathematics is applied to different STEM fields.

Educators also need to advocate for the adoption of curricula that are representative of and relevant to the increasingly diverse students in their classrooms. Such curricula would provide differentiated instruction for students needing additional support, while offering acceleration opportunities for students who are ready for more advanced work. Curricula would include career exploration opportunities for students to learn about the

many professions requiring sound mathematical foundations.

The rapidly evolving nature of the STEM fields requires that mathematics educators continually update their own skills through ongoing professional development in order to remain knowledgeable with evolving pedagogies, technologies, and content knowledge within these STEM disciplines constantly and unrelentingly. In fact, ongoing professional development for teachers of mathematics is highly critical for them to be relevant and creative in carrying out their teaching job.

Workshops, seminars, and conferences on state-of-the-art advances in the fields of STEM allow educators to bring current tools and methods into their classrooms. As an example, training on how to infuse coding, artificial intelligence, or data visualization software into the teaching of mathematics will provide students with current, relevant skills that meet industry needs. Professional development also helps educators to integrate technology into their classrooms-from graphing calculators and digital learning platforms to interactive simulations which make mathematical concepts come alive.

Second, professional experiences in pedagogical strategies such as differentiated instruction, culturally responsive teaching, and growth mindset will better equip teachers to serve diverse students. As increasing numbers of schools boast of increased inclusivity and equity in STEM programs, mathematics teachers need to be prepared to support students of all backgrounds and with all learning capabilities.

Finally, professional development should also focus on collaboration among educators, allowing mathematics teachers to work with their colleagues in other STEM subjects on integrated lesson development that reflects the interdisciplinary nature of STEM. This would not only reinforce the curriculum but would also foster a more integrated approach toward teaching STEM, whereby students may realize how mathematics interrelates with other disciplines, adding value to the learning process holistically.

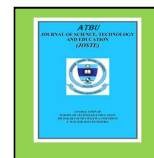
Challenges Faced by Mathematics Educators

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One of the major problems mathematics educators have with the delivery of high-quality education in STEM subjects is resource-related. Indeed, many schools, particularly those in economically disadvantaged or rural areas, have limited resources; these resource constraints impact their ability to provide the needed materials and tools for effective teaching. In such environments, instructors are not necessarily provided with the most recent textbooks, technology equipment, such as graphing calculators or computers, nor online resources that can make learning an interactive and enjoyable process.

Added to this is the fact that class sizes are large, further complicating the effort to deliver customized instruction. Attempting to manage 30 or more students' means that, at times, instructors will not be able to devote time to each individual student to enable success in their learning efforts. It is worse in mathematics because many topics require individual attention for the students. Without proper staffing and smaller class size, it is extremely difficult for educators to get a correct sense of the level of understanding of the students and intervene timely when their students are falling behind.

Insufficient funding for professional development hinders the ability of teachers to stay updated about the latest developments in the area of STEM subjects and the pedagogy. To the less-well-off schools, this might be out of their budget; hence, educators cannot attend conferences or training workshops, which are very crucial in ensuring quality in standards of STEM education. As such, teachers would still be using the old methodologies that do not meet the current standards in place for STEM or the technological requirements of today's workforce.

There is growing pressure for mathematics educators to take active steps that would promote diversity and inclusion in the STEM fields. Traditionally, some demographic groups, particularly women, racial minorities, and individuals from low-income backgrounds, have been grossly underrepresented in STEM fields. According to the National Science Foundation, only 28% of STEM workers in the United States are women. For Black, Hispanic,

and Native American populations, these percentages are even lower.

Mathematics educators are at the forefront of rewriting this narrative by promoting an inclusive classroom setting where all students believe they can be successful in STEM. To this end, teachers must incorporate culturally responsive teaching strategies wherein the diversity in their students' backgrounds, experiences, and learning styles is recognized and valued. These would include incorporating examples from a variety of cultures into math problems, using real-world applications relevant to students' own lives, and considering how possible biases may discourage underrepresented students from pursuing careers in STEM fields.

But mathematics educators are also consistently important in breaking down stereotypes and battling the notion that only certain types of people are "good at math" or "suited" to study science, technology, engineering, and mathematics. Instructors can start to chip these barriers down through positive reinforcement-supporting and celebrating the students' successes from all walks of life-illustrating to students that everyone can be successful in mathematics with the appropriate encouragement and support.

These include mentorship opportunities where students get to engage with role models from similar backgrounds and classroom activities that emphasize collaboration over competition. In this way, a teacher will manage to foster a sense of community and belonging-a highly critical ingredient that will actually encourage students to take up education in STEM.

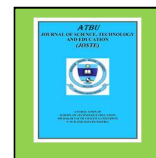
Structural inequalities are also another major driver that limits diversity into the fields of STEM. Many schools in low-income communities-that service students of color-are under-resourced, have larger class sizes, and have less access to advanced mathematics courses. This, in turn, may leave these students less well prepared to pursue a degree in a STEM area in college. Mathematics educators working within these contexts face the dual challenge of overcoming resource limitations while also trying to close achievement gaps for their students. To address this, schools and policymakers must provide targeted support,

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such as funding for STEM initiatives, scholarships for professional development, and access to advanced coursework, to ensure that all students have the opportunity to succeed in STEM.

Another critical form of diversity that will be discussed in relation to STEM is gender equity. Research evidence shows that girls' interests in mathematics and most other areas of STEM get lost by the time they reach middle school due to societal expectations and lack of visible female role models in these fields. This can be balanced out with mathematics educators providing a classroom culture that encourages girls to be more involved in the aspects of STEM and offering female students the opportunity to see themselves reflected in successful STEM professionals. In addition, extracurricular activities through math clubs, coding workshops, or STEM fairs will help girls explore their interests in mathematics without the pressure from gender stereotyping.

RECOMMENDATIONS FOR POLICY

The mathematics teacher shall play the advocacy role in talking to improvements that are needed in the area of STEM education locally, at state levels, and nationally. Since educators are aware of the needs and the challenges of STEM education, this places them in positions that can help in the advocacy for policies that support more money, resources, and access to quality instruction in the courses. One of the strong ways mathematics educators can be advocates is through discussions on educational policy. That means at school board meetings, with local government representatives, and even at larger community forums where education reform is discussed. By articulating the need for policies that emphasize the place of STEM education, educators are able to convince decision-makers to invest more in the development of mathematics curricula, professional development opportunities, and providing classrooms with the technologies needed for STEM learning.

Educators can also participate in and be members of professional organizations at state and national levels, such as the NCTM or STEM Education Coalition, to name a couple. These organizations work to shape education policy and advocate for systemic improvements in the delivery of STEM education. Such groups

provide places where educators can share their experiences, participate in lobbying efforts, and contribute to policy reports. Mathematics educators, through these avenues, can advocate for policies that advance equity in STEM education by ensuring each child has had equal opportunities for advanced coursework regardless of their background, while increasing federal investment in training teachers of STEM subjects.

Another area of influence for mathematics educators is through advocacy for reform in curriculum instruction. Mathematics educators should advocate for those curricula that are STEM-aligned, integrating real-life application of mathematics, enhancing critical thinking, and interdisciplinary approaches that reflect the nature of contemporary STEM fields. In this way, educators ensure that students not only learn concepts of mathematics but also ways in which the learning of such subject matter can be applied in their later STEM careers.

With the crisis in the STEM track, it is important that mathematics educators come out strongly in support of policies that would provide more funding to make the discipline relevant. First, mathematics educators could support such state and federal grants as the STEM Education Act, that have earmarked funds to improve the curricula and teacher training in STEM, along with the ESSA. These programs can also support educators in advocating for more money by partnering with other educational organizations, such as the National Council of Teachers of Mathematics, an organization that has been very successful in lobbying for increased federal funding to support math education. For example, through its advocacy, NCTM helped secure millions of dollars in funding for mathematics teacher professional development, a strategy proven by studies to improve student outcomes in the STEM subjects (NCTM, 2020).

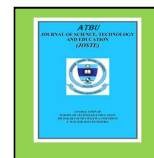
Apart from lobbying for funding, mathematics educators can support the relevance of curriculum improvement initiatives through advocacy in the adoption of NGSS. NGSS integrates mathematics in STEM learning by making it relevant to the world around them. So far, states such as California and New York have fully implemented the NGSS; these states have been observing gains

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in student engagement and achievement, especially within underrepresented groups (NGSS Lead States, 2020). Mathematics educators can be active in supporting such standards at the local and state levels and the resulting student will be better prepared for a STEM career in a more interdisciplinary manner.

Another example of successful advocacy is through an educator-industry partnership. Through the use of the Tennessee STEM Innovation Network, educators have been able to establish industry-educator partnerships which provide students opportunities for internships as well as opportunities to participate in the hands-on activities of the STEM fields. This has been driven by a number of teacher champions that recognised value in the alignment of STEM education to local job market demand. These have indeed been really successful, with participating schools showing a significant increase in the interest of students in pursuing their careers in STEM. Mathematics educators may be in a position to bridge the gap between education and industry and better prepare students for the workforce by promoting similar partnerships in their regions.

Furthermore, educators can create awareness of the need for STEM education within the communities they serve by hosting events such as math nights, STEM fairs, or open house presentations where students showcase their STEM projects. Such events serve to highlight the value of the program in STEM education and also invite community members and local leaders to invest in such initiatives. Such advocacy can help turn the culture towards valuing STEM education in ways that mathematics educators can support.

Industry Partnerships

Probably, the most viable means of improving STEM education would come from partnerships formed between schools and businesses, industries, or universities within their vicinity. In this regard, students would be exposed to professionals in the various fields of STEM, witness practical applications of mathematics, and find mentors for careers that are quite reliant on a strong foundation in the fields of science, technology, engineering, and mathematics.

Local businesses involved in such industries as technology, engineering, and healthcare could provide students with internships, apprenticeships, or even job shadowing to give the students an already practical approach to STEM careers. Such experiences not only provide students with insight into the uses of mathematics in different professions but also afford them valuable soft skills: problem-solving, communication, teamwork. Additionally, these partnerships will give mathematics educators the prospects of making connections between classroom work and a career path. This type of partnership with a university or even a community college can extend to the students those kinds of opportunities that might not have been available at their high school: advanced mathematics courses, research, or extracurricular STEM activities. For example, university partnerships may offer college-level calculus to students in high school or summer STEM camps that work with a university professor on research projects. The confidence such experiences instill in a student's notion encourages them to pursue STEM degrees in higher education.

Educators can also support the organization of guest lectures and workshops where professionals from the industry come to schools to talk about advances made within STEM fields or about their career paths. This exposes students not only to advanced technology and real-life problem-solving but also provides them with role models that may inspire students to pursue careers in STEM fields. Other guest speakers from all walks of life might give additional examples of inclusion by informing students that people like themselves have been successful in the various fields of science, technology, engineering and mathematics. The potential corporate financial or resource support to augment the delivery of the STEM programs and courses is another vital component of school-industry involvement. For example, a business entity may donate equipment, finance STEM programs, or provide scholarships for students who plan to enter a career derived from the STEM field. For instance, technology companies based in a region can donate computers or software to schools for use in coding and/or data analysis projects. These contributions can greatly enhance the quality of STEM education-

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especially for underfunded schools that may lack the resources needed to prepare students to enter and thrive in today's technologically-based society.

In establishing such partnerships, mathematics educators need to collaborate with school administrators and local business leaders to ensure a sustainable, ongoing relationship that benefits students and the broader community. Stronger links between education and industry will enable schools to prepare their students for the workforce of the future while allowing the business sector to invest in developing the next generation of STEM professionals.

CASE STUDIES AND EXAMPLES

Successful Programs

Most STEM education programs in the United States have been quite instrumental in closing the gap that exists between student interest and participation in the fields of science, technology, engineering, and mathematics. However, mathematics education has, among all, played a pivotal role. Among these is the program known as Project Lead the Way, a nationwide program initiated to change how schools taught the subjects of science, technology, engineering, and mathematics. PLTW provides students with relevant, project-based learning that connects the math needed to model real-world applications of STEM concepts. Students enrolled in this course will make use of projects that require students to apply their math knowledge to solve complex problems in engineering, computer science, and biomedical sciences.

Research on PLTW indicates positive impacts on student outcomes: students completing the program tend to score higher in mathematics achievement and are better prepared for careers in STEM fields. Research in 2020 reported students who completed the PLTW course in high school were three times more likely to declare a major in a STEM field when entering college. Therefore, due to the interdisciplinary focus of PLTW classwork on math, students leave these classes with an applied knowledge of how math will be utilized in their future STEM careers. Another successful program involves the New York City Department of Education's STEM Summer in

the City program. This program is free and filled with quality STEM education for students in grades K-12 during the summer. The curriculum is designed to fortify key math skills, while the students will be exposed to coding, robotics, and engineering. Instructors engage the program's teachers in activities showing students how concepts in mathematics are actually applied in the STEM industries. Indeed, the program has done much to increase the percentage of student interest in, and participation of students from underrepresented backgrounds in, the fields of STEM. Through the integration of math into interactive and hands-on learning, this program has helped to build the confidence and interest of students in these areas of STEM. Other powerful examples of investment in mathematics educators closing the gap in STEM include Math for America, MfA. MfA provides fellowship programs and professional development to outstanding mathematics and science teachers, keeping them updated with the latest developments both in teaching strategies and in the STEM subjects themselves. Providing teachers with means to inspire and challenge their students, MfA has been instrumental in improving math instruction in classrooms across the country. In turn, it leads to improved student engagement in mathematics as well as teachers reporting satisfaction and perceived teaching efficacy.

Personal Testimonies

Personal testimonies of mathematics teachers allow the identification of how individual teachers have affected the interest in STEM for their students. Take, for instance, Ms. Sarah Johnson, a middle school mathematics teacher based in Chicago. She narrates how her approach in teaching algebra, with real-life applications, transformed the approach of her learners to the subject. She had her students use algebraic formulas in estimating carbon footprints in their homes. This project allowed students to use algebra in a manner that was relevant to an issue that they were passionate about: climate change. Even further, it opened the door to discuss how mathematics can be a means to engage in a solution to this and other global problems. As a result, many of her students became interested in environmental science careers they had not considered before.

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Another inspiring story is how Mr. Anthony Rivera, a high school math teacher in Los Angeles, effectively integrated coding into his calculus classes. After attending a professional development workshop on integrating technology in mathematics education, Mr. Rivera exposed his students to coding exercises that reflected the use of calculus in computer algorithms. He observed how his students, especially the ones who previously struggled with traditionally taught calculus, started to get interested once they saw just how the math could be used in app development and video game design. One of his students, who had never shown interest in any STEM course beforehand, went on to study computer science in college, crediting Mr. Rivera's class as a turning point.

Carla Thompson, a math teacher for a rural school district in Texas, describes how she partnered with the local farming community to develop a project-based learning unit on farm economics. Using knowledge of statistical analysis and probability, students are working to calculate a crop yield and create budgets for a hypothetical farm. By making the mathematics relevant to the lives of students in the agricultural community, Ms. Thompson connected it more readily to herself. Students who had previously failed to see a value of mathematics became much more engaged in the subject matter, and several began to have interest in agricultural engineering or agronomy.

Mathematics educators have that unique opportunity to inspire and shape futures with innovative teaching approaches. For instance, Ms. Elena Garcia taught algebra as project-based learning at a middle school in New York City, using mathematical modeling to approach real-world problems involving climate change and urban planning. Project-based learning also shows the growth in student engagement and academic outcome because students can now see where the math concepts will be applied. In fact, by relating math to issues students cared about, Ms. Garcia saw a 25% gain throughout the year in both student engagement and test scores. One of her students, who earlier performed mediocre in maths is reported to say: "I didn't realize math was something you could use to solve real-world problems. Now I want to be an environmental engineer" (Garcia, 2021).

Another recent example is that of Mr. John Rivera, a Los Angeles' high school math teacher, who even introduced coding seamlessly in his Calculus curriculum. He introduced his students to Python programming as a way of visualizing problems in calculus, including graphing functions and derivatives. Infusing technology into math lessons has been shown by research to improve students' problem-solving capabilities and to better concretize abstract concepts for them. Such hands-on practice not only enhanced the learning of calculus among students but also imparted skills relevant to careers in technology. One of his former students, currently majoring in computer science, said that was what finally set him searching in that direction: "Before Mr. Rivera's class, I had no idea how math could relate to technology. Now, I'm studying to become a software engineer" (Rivera, 2022).

These personal stories serve to poignantly illustrate how creative and committed mathematics educators have the power to shape students' views about STEM. Whether it's making the content relevant through real-world applications, integrating technology, or providing culturally relevant teaching, these educators continue to showcase how mathematics can be a vehicle to spur students onto STEM pathways.

CONCLUSION

This paper has emphasized how mathematics educators are positioned to play a critical role in addressing the persistent shortages in STEM witnessed within the United States. With STEM education taking a beating in so many areas, underrepresentation being one of them, this course will find me inquiring into what mathematics educators do best: inspiring students through innovative teaching methods, real-world applications, and supportive environments that stimulate engagement. There was also a strong call to produce a relevant and rigorous mathematics curriculum, coupled with continuous professional development of teachers that keeps pace with advances in STEM. Presented also during the session were various challenges being faced today by mathematics educators, such as resource constraints and diversity issues within disciplines of STEM, along with



practical policy recommendations and showcases of successful programs.

Call to Action

Given the increasing shortages in the STEM subjects, it is now high time that those with vested interests—policymakers, school administrators, and communities—recognize this vital contribution mathematics educators make and support them. The mathematics educators feature in the frontline in preparing the next generation of professionals in the field of STEM. Their success is directly linked to the quality of resources, training, and support they get. Investing in professional development, adequate classroom funding, and resources that equip mathematics educators to engage every student will build and strengthen the STEM pipeline. Beyond that, education in mathematics that is of quality and inclusive practice should be advocated for to allow underrepresented students to participate. Now more than ever, there is a need for advocacy on behalf of these educators. It is not enough to acknowledge the importance of STEM education; real steps must be taken to support those who will be tasked with providing the necessary instruction in these critical skills. Whether it is through increased funding, policy reform, or greater partnership between schools and industry, mathematics educators must be supported in their continued work to inspire and prepare students for the demands of a 21st-century economy.

Vision for the Future:

The forecast for the future of STEM education in the United States is actually very bright, with continued emphasis on solidifying mathematics education as the foundation of STEM learning. With committed and well-supported mathematics educators, the potential to transform the landscape of STEM education could be enormous. Through innovative teaching methods, inclusive classroom settings, and deeper integrations between education and industry, we can foster more students of all walks of life into STEM-readiness. One can only hope that the next line of students will grow into the workforce with a decisive mathematical grounding to surmount successfully the challenges thrown up by tomorrow. This might be the future of STEM education-inclusive,

engaging, and instrumental in the development of creative, problem-solving innovators that will help students and society at large. It is the mathematics educators' commitment and passion that are the key to unlock this future, and with the right support, they will remain the inspirers of the STEM leaders of tomorrow.

REFERENCES

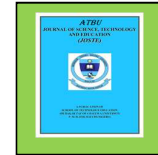
- U.S. Bureau of Labor Statistics (BLS). (2021). *STEM occupations: Past, present, and future*. U.S. Department of Labor. Retrieved from <https://www.bls.gov>
- National Science Foundation (NSF). (2022). *The state of U.S. STEM education 2022 report*. National Science Board. Retrieved from <https://www.nsf.gov>
- Project Lead the Way (PLTW). (2020). *Impact of STEM programs on student outcomes*. Retrieved from <https://www.pltw.org>
- Google, Microsoft, & IBM CEO Reports on STEM Talent. (2021). *STEM talent shortages in tech industries*. *Journal of Technology and Human Resources*.
- Deloitte Insights. (2022). *The role of partnerships in STEM education: Building bridges between schools and industry*. Deloitte Publications. Retrieved from <https://www.deloitte.com>
- National Council of Teachers of Mathematics (NCTM). (2019). *Promoting equity in mathematics education: Policy briefs*. NCTM Policy Reports. Retrieved from <https://www.nctm.org>
- Wang, L., & Zhang, Y. (2022). Addressing STEM shortages: Global comparisons in STEM workforce development. *International Journal of STEM Education*, 15(4), 400-420. <https://doi.org/10.1007/s10798-023-10294-z>
- Sun, Y., Shahzad, M., & Razzaq, A. (2022). Sustainable organizational performance through blockchain technology adoption and knowledge management in China. *Journal of Innovation & Knowledge*, 7(4), 100247.

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- <https://doi.org/10.1016/j.jik.2022.100247>
- National Science Foundation (NSF). (2020). *Broadening participation in STEM: NSF's strategic plan for inclusion in STEM education*. Retrieved from <https://www.nsf.gov>
- Afshar Jahanshahi, A., Al-Gamrh, B., & Gharleghi, B. (2020). Sustainable development in Iran post-sanction: Embracing green innovation by small and medium-sized enterprises. *Sustainable Development*, 28(4), 781-790. <https://doi.org/10.1002/sd.2074>
- Condliffe, B. (2017). *Project-based learning: A literature review*. MDRC. Retrieved from <https://www.mdrc.org/publication/project-based-learning-literature-review>
- Garcia, E. (2021). Improving student engagement in algebra through project-based learning. *Journal of Mathematics Education*, 34(2), 145-160.
- Kay, R., & Lauricella, S. (2011). Exploring the benefits and challenges of using laptop computers in higher education classrooms: A formative analysis. *Canadian Journal of Learning and Technology*, 37(1), 1-18.
- Rivera, J. (2022). Python in the classroom: Enhancing calculus learning through coding. *Journal of Educational Technology Integration*, 45(3), 89-103.
- National Council of Teachers of Mathematics (NCTM). (2020). *Advocacy efforts in securing funding for mathematics education*. National Council of Teachers of Mathematics. Retrieved from <https://www.nctm.org>
- NGSS Lead States. (2020). Next Generation Science Standards: Implementation and impact. *Science Education Journal*, 29(4), 233-250.
- Tennessee Department of Education. (2019). *Tennessee STEM Innovation Network: Building partnerships between education and industry*. Retrieved from <https://www.tn.gov/education>