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A Review of Efforts to Promote and Train Students for the STEM Workforce in The U.S.

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Abstract
America is facing keen competition from rivals like China in the quest for global science, engineering, and technology supremacy. The growth of Artificial Intelligence and the semiconductor industry demands a science, technology, engineering, and math (STEM) workforce capable of harnessing the immense opportunities by the strength of their numbers and the quality of their expertise. This review traces the origins of STEM and the efforts of governmental institutions to facilitate its growth. The role of educational institutions is also examined. The paper also highlights some of the partnerships and collaborations by corporate America in a bid to cultivate talent for the STEM industry. Amidst all these efforts, profound challenges remain, and this review highlights some of the solutions proffered to address these challenges and maximize a field critical to human existence.

Keywords: STEM, STEM Workforce, K-12, artificial intelligence

1. INTRODUCTION

It has become necessary to focus a lot of attention on human resources for the STEM industry as a result of the increase in demand for professionals with such training. According to the National Science Board's Vision 2030 document, the demand for science and engineering professionals will grow by 13% worldwide and 7% in the U.S. by 2026 (National Science Board, 2020). This development has highlighted the STEM promotion and training efforts by relevant stakeholders in the United States. With the U.S. prioritizing its global competitiveness in a world of fast-paced technological advancements, coupled with the dynamism of industry demands, it is important for the United States. to place a premium on developing and training professionals in STEM to stay current with emerging technological advancements and address challenges accompanying these new trends as well as other challenges that require the deployment of know-how in STEM (National Science Board, 2021).

Despite the critical role of STEM education in our world today, challenges still abound in terms of certain population segments' lack of access to STEM programs. These segments include women, racial and ethnic minorities, and individuals from economically challenged backgrounds (National Center for Science and Engineering Statistics, 2023).

1.1 A Historical Background of STEM

The development of Sputnik by the Soviet Union in 1957 led the U.S. to place more emphasis on and prioritize science and math education on a national scale. The motivations for this focus were national

security concerns, economic consolidation, and maintaining a competitive advantage over the Soviets (National Academies of Science, Engineering, and Medicine, 2024). STEM education in America has undergone a number of evolutions shaped by changes in national priorities, reforms in education, and important policy directives (National Science Foundation, 2023).

Over the years, policies, programs, and laws have been rolled out on national and state-level scales in a bid to ensure enhanced participation and promotion of STEM education in the U.S. The White House, Department of Education, state governments, and National Science Foundation (NSF) are among the institutions and agencies that have been at the forefront of efforts to train more professionals in STEM, provide solutions to issues of STEM education accessibility, and improve STEM literacy. These initiatives have been instrumental in forging a path for STEM education development and championing collaboration between teaching and learning institutions, the world of work, and governmental institutions (National Science Foundation, 2023).

What is the Workforce?

"The STEM workforce is comprised of workers in science and engineering (S&E), S&E-related, or STEM middle-skill occupations, regardless of their educational attainment or field of degree. The skilled technical workforce (STW or STW workers) is a subset of the STEM workforce and represents workers without a bachelor's degree who are employed in any of the identified STEM occupations (i.e., S&E, S&E-related, or STEM middle-skill occupations)" (National Science Board [NSB], 2024).

2. Federal Programs to Promote STEM Education

The NSF has provided funding for STEM research and teaching, and learning activities. Enhancing STEM teaching and learning, incorporating up-to-date technologies into education, and enhancing the teaching of STEM are the areas where the NSF's Education Directorate channels its attention (NSF, 2023). In a bid to promote inclusion and expand STEM education to different segments of the population, the NSF makes available financial aid to financially challenged students studying STEM programs. This is through a program called Scholarships in Science, Technology, Engineering, and Mathematics (S-STEM) program (National Research Council, 2011).

The Department of Education (DOE) has also been instrumental in the development of STEM education. Their Every Student Succeeds Act and Education Innovation and Research program advocated for the incorporation of STEM into K-12 instruction and provided improved financial support for STEM programs, respectively (Department of Education, 2015; 2022).

The STEM Education Act of 2015 was one of the initiatives aimed at supporting and expanding STEM education, specifically in engineering and computer science (Congressional Research Service, 2016).

In the recent past, the STEM Education Strategic Plan of 2018 to 2023 is one of the programs developed to enhance diversity in STEM, improve STEM literacy, and engender cooperation between policymakers (government), the STEM industrial sector, and institutions of learning (White House Office of Science and Technology Policy [OSTP], 2018).

In response to COVID-19, the American Rescue Plan Act of 2021 was passed to make financial assistance available to support after-school programs and the provision of technological resources for learning (U.S. Department of Education, 2021). The National Artificial Intelligence Initiative (NAII) was introduced by the Biden Administration to incorporate AI into K-12 and tertiary-level curricula (OSTP, 2022).

The High School Apprenticeship Program was an intensive STEM initiative in collaboration with tertiary-level researchers to provide high school learners with research experience in science and engineering

(Department of Defense, 2019).

The Department of Defense (DOD) and NASA implemented their initiatives to promote STEM among students (Congressional Research Service, 2021).

The STEM workforce development and education outreach initiatives aimed to reach students through over 1,000 public and private community colleges throughout the United States. The Department of Energy (DOE) has a multitude of programs to offer, the leading one being their Community College Internships (CCI) program. This 10-week paid internship, which is highly competitive, gives community college students the chance to gain experience at one of the 16 participating DOE national laboratories. Interns engage in state-of-the-art technologies, instrumentation projects, and research facilities while being mentored by lab technicians and researchers in the context of the DOE's mission. Beyond the research experience itself, host laboratories offer professional development functions, such as workshops, laboratory tours, and scientific lectures. The internship program takes place three times annually, providing high school students opportunities during the spring, summer, and fall sessions to diversify their skills and build foundational knowledge indispensable in any industry (U.S. Department of Energy, 2021).

The Biden-Harris Administration identified five key areas that needed attention in its vision for the United States' science, technology, engineering, math, and medicine (STEMM) ecosystem. In the White House Office of Science and Technology Policy's (OSTP) *Equity and Excellence: A Vision to Transform and Enhance the U.S. STEMM Ecosystem,* enhancing support services to tackle issues of access, remove barriers, and provide support to marginalized and socio-economically disadvantaged people was the first key issue discussed in this policy document. The second key area was to address the issues of inadequately trained STEMM teachers. The OSTP also identified funding challenges as another key area to be addressed. In addition to these areas that the OSTP set out to act on, issues of bias, harassment, and discrimination, especially in recruitment and promotion, the provision of conducive working environments, effective avenues to address discrimination and accountability issues as well as the provision of more funding for minority business owners in STEMM was another priority area. The final issue that the OSTP set out to act on was to enhance accountability measures in the area of information gathering. This was to influence policy-making and serve as a measurement of implementation performance against set targets (White House Office of Science and Technology Policy [OSTP], 2022).

The Federal Strategic Plan for Advancing STEM Education and Cultivating STEM Talent of 2024 is anchored on three main pillars. The policy document talks about the establishment of a federal STEM workforce, a national STEM workforce well-equipped to meet the current demands of industry and attract STEM professionals from around the world while building the capacity and competency of American STEM workers to maintain the global competitiveness of the United States (National Science and Technology Council, Committee on Science, Technology, Engineering, and Mathematics, 2024).

2.1 State-Level Programs to Promote STEM

States have designed programs and policy initiatives to address specific professional needs of their immediate local industries.

The Texas STEM initiative pays more attention to computer science training and providing instructor training opportunities as strategies for making their populace ready for STEM industry jobs (Texas Education Agency).

California instituted the Math and Science Partnership (CaMSP), which focuses on financial assistance to upgrade the capacity of teachers at the K-12 level and promote collaboration with universities (California Department of Education, 2021).

According to the Illinois Board of Higher Education, its Illinois Workforce and Education Alignment Project (WEAP) gives students hands-on training and apprenticeships to prepare them to meet the needs of a real-world STEM work environment (Illinois Board of Higher Education, 2022). Similar to the project in Illinois, the Florida STEM Career Pathways Program also provides practical training for students interested in STEM professions by collaborating with businesses within the state to provide this training (Florida Department of Education, 2023). Ohio is implementing laws that allow you to verify that a student is knowledgeable in STEM. This is done through the awarding of a diploma or certificate, which serves as proof of these skills. The Ohio STEM Learning Network has partnered with the state's tertiary institutions to provide students with these certifications before they join the labor force (Ohio Department of Higher Education, 2023).

The North Carolina Department of Public Instruction's programs to support Computer Science Education among K-12 students involved a collaboration between the department and private institutions. These institutions included the North Carolina Technology Students Association (NCTSA), Microsoft and Prodigy Learning (MPL), Expanding Education Pathways (EACP) Alliance, and Code.org. These programs were geared towards providing K-12 students in the state with the relevant Computer Science and Information Technology education, and also provide the requisite training to teachers who provide instruction in these fields (North Carolina Department of Public Instruction, n.d.).

3. The Role of Educational Institutions in STEM Workforce Training

K-12, community-based tertiary institutions, and universities drive the cultivation of STEM talent for the future. These institutions equip students with expertise to enable them to function in an increasingly STEM-driven world. They are also at the center of America's goal to be a STEM powerhouse and maintain its competitive edge over its global peers.

STEM skills are no longer just industry-specific requirements. For young people to tackle emerging challenges and become solution providers, STEM skills have become essential for all spheres of life. There is therefore a need to look out for gifted STEM learners and equip them with all the tools and resources they need to realize their full potential in the industry (Wu, Pease, & Maker, 2019).

The Education Development Center (EDC) works to improve STEM teaching and learning by collaborating with educational organizations for curricular improvement, teacher training, and capacity enhancement to satisfy current and future expectations and to cultivate STEM talent to fit STEM work environments (Education Development Center, 2025).

3.1 The Role of K-12 Schools

Leaders at the helm of policy formulation have urged stakeholders in the K-12 teaching and learning environment to do their part in contributing to the health, well-being, and security in all aspects of national life by equipping students with the relevant expertise to excel at STEM and satisfy America's ever-increasing need for STEM talent. Students in K-12 who are exposed to STEM-related material get the opportunity to consider their interests concerning the materials they are exposed to. For those who discover an interest in STEM at this level (K-12), this exposure serves as a building block to pursue STEM education into industry practice. There is a need for deliberate action on the part of STEM teachers in the formal and informal and informal education sectors to formulate personalized approaches, expertise, and practices to advance the training of STEM talent (Reider et al., 2016).

In Project Lead The Way (PLTW), learners engage in hands-on activities, projects, and problem-solving tasks that parallel real-world issues. This immersive, hands-on methodology arms students with critical,

marketable skills that are valued by top-tier companies worldwide. It connects the academic experience in the classroom to real-world applications and builds foundations for students on their specific career paths. PLTW believes that students gain an advantage when exposed to practical learning experiences. These help students attain success in further education and professional endeavors. This practical exposure to STEM is offered in courses such as engineering, computer science, and biomedical science (Project Lead The Way, 2025).

3.2 Community Colleges

The significant impact of community colleges on the advancement of STEM has not received the acknowledgment it deserves. This is due mainly to the unresolved definition of STEM. Community colleges provide considerable STEM technical training and serve as preparatory bases for students to enter universities and colleges. They also provide training where jobs demand more than a high school diploma. Of the 29.8 million community college-trained STEM workers, 22%, representing 6.6 million, are in STEM jobs, and they earn 12% to 19% more than U.S. workers in other sectors (Belfield & Brock, 2023). The NSF's Advanced Technical Education (ATE) program is an initiative that supports workforce development at the tertiary level. The program assists two-year tertiary institutions. The program encourages collaboration between educational institutions, industry, and economic development partners to improve the training of science and engineering technicians. Through some interventions such as teacher training, curriculum development, and research support, the ATE program sets out to improve and fortify America's technical workforce as a key driver of economic growth and technological progress (National Science Foundation, 2024).

According to Belfield and Brock (2023), to properly frame STEM education, it must be viewed from the two perspectives of what STEM education seeks to achieve at the community college level: STEM-Transfer and STEM-Tech.

STEM-Transfer programs are designed for those who wish to pursue academic paths within the disciplines of STEM so they can seamlessly transfer to four-year colleges and universities in comparable fields. These programs include biological sciences, chemistry, the earth sciences, engineering, mathematics, physics, and production technologies. This definition of STEM becomes the default framework policymakers and researchers will use to design and evaluate educational initiatives and transfer pathways (Belfield & Brock, 2023).

According to Carnevale et. al. (2020), the STEM-Tech aspect of community college STEM training focuses on transferable training into the job market. An overwhelming majority of training in community colleges is closely connected to industry-specific jobs. The inclusion of STEM training at this level had a direct impact on the STEM workforce because STEM-Tech deals with the technical disciplines that are taught and for which students are certified (Carnevale, Garcia, Ridley, & Quinn, 2020).

A study conducted by Belfield and Brock (2023) revealed that STEM contributions can be quantified in terms of the number of workers in STEM professions as well as their aggregated compensation. The study further highlights that there is inconsistency among agencies as to the definition of STEM occupations; for example, the Occupational Employment and Wage Statistics (OEWS) program has determined there to be 105 STEM occupations, while the Occupational Information Network (O*NET) has identified 205 STEM occupations. Some of these classifications are less relevant for many healthcare and Computer Information Systems (CIS) occupations, which are important components of community college certifications. Based on better alignment with the missions of community colleges, STEM occupations are divided into STEM-Transfer disciplines and STEM-Tech disciplines, producing 44 STEM-Transfer

occupations and 172 STEM-Tech occupations. According to the Bureau of Labor Statistics (BLS), as of 2023, the total U.S. employment stood at approximately 167.8 million workers. Of these, about 10.7 million (6.4%) were employed in STEM occupations as defined by the BLS (U.S. Bureau of Labor Statistics, 2025). But the broader classifications, including STEM-Transfer and STEM-Tech occupations, show that the STEM workforce is nearly 36.8 million workers (24%) (National Science Board, 2024). Such a workforce is essential, and community colleges constitute a large share of it by contributing to the education of a substantial portion of the STEM workforce (Belfield & Brock, 2023). Notably, over half of the STEM workforce does not hold a bachelor's degree, highlighting the importance of community college-level education in preparing individuals for STEM (National Science Board, 2024; National Science Foundation, 2024).

3.3 Universities

American universities are critical drivers of innovation that generate economic growth and contribute to the improvement of living standards in the United States. U.S. universities incur about $75 billion a year in research expenditures, representing 13 percent of total American research and development (R&D) spending. The majority of this spending supports research in the STEM fields. This research focus promotes practical training and enhances students' critical thinking and problem-solving abilities, which are must-have skills to thrive in STEM careers (George W. Bush Presidential Center, 2018).

U.S. universities are at the forefront of developing STEM labor talent through robust training across all disciplines of STEM. These programs provide students with both the basic knowledge and advanced skills required for STEM careers, based on practical research knowledge, to broaden their experience. Universities partner with industry to ensure that their curricula match industry job requirements. These collaborative partnerships are in the areas of curricula development, internship training opportunities, and leadership of capstone projects. Those are also enhanced by continuous learning opportunities like professional development courses so that working professionals can keep themselves updated and ultimately improve the STEM workforce (National Science Foundation, 2024).

Universities can provide STEM education based on the strong framework of graduate and undergraduate degree programs. These programs are vital to providing students with the basic knowledge and advanced skill sets necessary for STEM professions. For example, according to the National Science Foundation (NSF), approximately 6.6 million to 7.5 million workers employed in science and engineering (S&E) occupations (those that require at least a bachelor's degree) had at least a bachelor's degree in S&E as of 2019, and close to 20 million workers had their highest degree in an S&E field (National Science Board, 2021).

The Universities Research Association (URA) contributes to STEM workforce development by providing scholarships and internships that link universities (national laboratories). Through this cooperation, graduates acquire technical know-how that prepares them for employment opportunities in industry (Universities Research Association, 2025).

According to a report by West (2023), to keep up with the ever-evolving job market, it is important for both community colleges and universities running four-year programs to equip their trainees with expertise in emerging technologies. This is essential for enhancing the skills of working professionals and promoting continuous educational development (West, 2023). Universities contribute to this continuous education by providing smaller, focused training that targets specific skills, electronic certificates to indicate completion of training in specific skills and training that integrates knowledge from different fields. All these are achieved using Artificial Intelligence-enhanced platforms and virtual reality (National Science

Foundation, 2024).

Universities help to address the issue of underrepresentation in STEM. Digital technology and learning platforms help to address disparities in professional training as they extend access to STEM education. Scholarship programs, mentorship programs, and collaborative efforts with Historically Black Colleges and Universities (HBCUs) are being implemented by universities (O'Rourke, 2021). LabXchange, in collaboration with the Amgen Foundation, which offers science education tailored to individual learner needs through a digital instruction platform in over 13 languages, is one such program. It is available to primary, secondary, and tertiary students (Amgen Foundation, 2025). This program addresses challenges like access, quality of teaching and learning materials, location constraints, and language barriers.

Figures from the Pew Research Center (PRC) indicate that Black and Hispanic students are underrepresented in STEM education. Asian students have a higher representation. 7% of STEM degrees awarded in the 2017-2018 academic year went to Black students. They, however, got 10% of all the degrees awarded in all fields. The 3% gap highlights the level of underrepresentation at the undergraduate level. Black students received 9% of master's degrees awarded in STEM but only 6% in doctoral and STEM fields (Kennedy, Fry, & Funk, 2021).

The study further reveals that Hispanic students received 15% of all degrees awarded at the undergraduate level but earned 12% of STEM undergraduate degrees. At the advanced degree levels, Hispanic students earned 6% of research doctorates and 7% of work-related doctorate degrees.

With just 7% of overall master's degrees, Asian students earned 11% of master's degrees in STEM (Kennedy, Fry, & Funk, 2021).

In sharp contrast, White students received 62% of bachelor's degrees in STEM and 60% of all undergraduate degrees. They also earned 67% of research doctorates in STEM and 63% of all doctorates (Kennedy, Fry, & Funk, 2021).

Note. The table below shows the percentages of degrees awarded for STEM and all degrees for U.S. citizens and permanent residents. These adults are classified into Black, Hispanic, Asian, and Other (Pew Research Center, 2021).

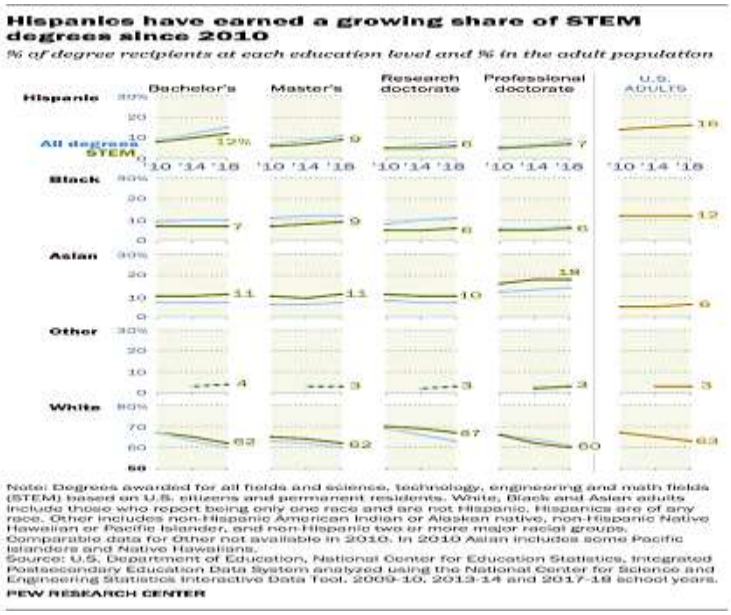

Figure 1: Percentage of degree recipients at each educational level and percentage in the adult population

The dynamism of technology is giving rise to emerging fields. As such, universities must ensure that their curricula are abreast of these changes. The NSF's Innovation in Graduate Education (NSF IGE) provides financial support to programs geared towards the infusion of interdisciplinary education, practical problem-solving, and cooperation with industry stakeholders into graduate STEM education. The IGE program aims to help make the STEM workforce not just technically adept, but versatile solution providers at the forefront of addressing worldwide challenges (NSF, 2024).

There can be no effective analysis of the STEM education workforce in the United States. without a discussion of the roles and impact of community colleges and universities. They are major contributors to training professionals for the STEM industry. They are key stakeholders in ensuring that the United States in ensuring that it achieves its aim of global leadership in science and engineering and maintains its competitive edge over its global peers.

4. Industry and Private Sector Contribution

The corporate sector plays a critical role in STEM workforce development in the United States. The collaboration between universities and industry, which takes the form of various programs and activities, is significant in addressing workforce skills gaps and equipping STEM students to meet the requirements of future STEM workplaces.

"The private sector, industry, and philanthropy invest almost $800 billion a year in science and technology, but the $200 billion in basic research and other investments done by the federal government are critical" (Parikh, 2025).

4.1 Google

In 2025, Google continued with its commitment to STEM workforce training with a $250,000 donation to Clayton State University (CSU). This program is open to students of the university studying courses related to technology, secondary school students interested in STEM, students in CSU, members of the community interested in artificial intelligence for career development, and CSU instructors. Among the core training provided by the program is practical industry experience and technological skills training. These are aimed at exposing these trainees to the technology industry. (Clayton State University, 2025).

Google has also developed the Skills Trades and Readiness (STAR) Program. This program is targeted at new entrants into the technology industry and is geared towards providing them with short-term training to prepare them for entry-level jobs in construction and skills trades. This program is part of Google's commitment to workforce development. The program provides practical training in skills including carpentry, fiber optics, math, safety certifications, and mechanical and electrical skills (Google, 2024).

4.2 Microsoft

Microsoft has also made significant contributions to the STEM workforce in the United States. In 2025, Microsoft's focus is on providing skills training in Artificial Intelligence to the American workforce. Microsoft has targeted to equip 2.5 million Americans with skills in Artificial Intelligence. The program will focus on learners from K-12 to tertiary level, professionals seeking career advancement for survival and adaptation to the ever-changing job market, and members of the public. This is Microsoft's contribution to the national agenda of staying ahead of America's global peers in the charge towards technological supremacy. This program is aimed at presenting Artificial Intelligence at an introductory level and offering training to people to keep up with the job market evolution (Smith, 2025).

The Microsoft collaboration with Pearson is to provide employers, professionals, and students with products and services in AI to equip them now and for future industry changes in an economy heavily infl-

uenced by AI (Johnson, 2025).

To address gender disparity in STEM fields, Microsoft has developed the Microsoft Scholarship Program for Women Pursuing STEM Careers 2025. This initiative provides financial support of $5,000 each to 26 women who wish to pursue careers in STEM. The support is provided at the commencement of higher education. Microsoft recognizes that funding is one of the constraints that prevent female students from pursuing higher education in STEM (Opportunity Desk, 2025).

4.3 General Motors

General Motors' investment in STEM workforce development stems from their admission that the aspirations of their organization hinge on readying professionals with the requisite skills to achieve their net-zero carbon, all-electric goals. In rolling out their STEM workforce agenda, they take cognizance of prevailing issues of lack of access to STEM education in areas with low representation in STEM fields. Their initiatives aim to bridge these gaps in access (General Motors).

In their quest towards full usage of electric vehicles, General Motors recognizes the need to equip their present and future workforce through skills training, education, and funding dedicated to STEM education (Siemen, 2025).

Through the Technical Education Program (TEP), General Motors provides scholarships to its workers pursuing advanced degrees in System Architecting and Engineering. Courses in these fields are crucial to technological development in the vehicle manufacturing industry (University of Southern California Viterbi School of Engineering)

Another workforce development initiative is the General Motors-United Auto Workers Apprenticeship Program, which equips beneficiaries with technical skills and practical insights into manufacturing and engineering jobs in the automotive sector (Morrison, 2025).

There are also internship opportunities for students lasting up to 3 months. This initiative gives students the chance to practice knowledge from the classroom in real-life work environments. This initiative also helps them in their long-term career decisions, especially with General Motors. General Motors utilizes these initiatives to scout and train workforce talent with critical sector experience and provide a clear path to future careers in STEM fields within the company (General Motors, n.d.).

4.4 Intel

One of Intel's contributions to STEM training and workforce development is the Semiconductor Education and Research Program (SERP). In partnership with institutions of higher learning, this initiative is centered on the provision of teaching and learning equipment, assistance in curriculum development, and the creation of experiential learning opportunities in semiconductor-related fields. Ohio State University is a beneficiary institution of this initiative (Hulsey, 2024).

Intel collaborated with the NSF to increase access to semiconductor-related education. Intel made available a total of $100 million to support 2-year and 4-year tertiary institutions in STEM education. Under this program, higher learning institutions targeting minority groups receive support, and underrepresented students receive scholarships (Freed, 2022).

Intel has championed programs to encourage more women and minority participation in STEM. They have offered scholarships, internships, and collaborations with Historically Black Colleges and Campuses (HBCUs) to enhance STEM training programs (Intel, 2017). Some of the diversity and inclusion efforts include a $4.5 million grant to aid HBCU students and scholarships for African Americans, Latinx, Native Americans, women, and veterans in STEM programs at the graduate and undergraduate levels (Intel).

Major corporations in the private sector, especially in science, technology, and engineering, as this section

shows, are contributing their quota to STEM workforce training and the promotion of STEM fields as an attractive career option for students. While some of the programs and policies of these corporations are designed with long-term benefits to these organizations, the contributions of these initiatives and interventions on the overall economic health and global competitiveness of the U.S. in science technology and engineering cannot be overlooked.

5. Barriers to STEM Workforce Training in the United States

Despite the efforts of federal and state governments and the contributions of industry enumerated above, challenges persist in maximizing the population potential in raising a formidable body of workforce talent capable of further advancing America's position in global leadership in science, technology, and engineering.

According to a study by West (2023), with the evolution of robotics, AI, and manufacturing, more people are being replaced by technology-driven systems and solutions. Consequently, there is a need to upgrade the skills of the American workforce. West points out that if policymakers, industry players, and higher learning institutions are unable to devise ways to keep up with the pace of technological transformation, the huge benefits of this rapidly evolving sector will elude the nation. West identifies the rapid development of AI, which the current workforce's expertise is unable to match, as a challenge. Goldman Sachs (Briggs & Kodnani, 2023) identified jobs that would be severely impacted by AI in the areas of administration. engineering and graphic design. Additionally, West highlights a study by McNeilly (2023), which indicates that 80% of jobs held by women could be replaced by the deployment of technology and systems (McNeilly, 2023).

"Semiconductors are the brains of modern electronics, enabling advances in medical devices and health care, communications, computing, defense, transportation, clean energy, and technologies of the future, such as artificial intelligence, quantum computing, and advanced wireless networks. The U.S. semiconductor industry is the worldwide market leader with about half of global market share and sales of $275 billion in 2022. The semiconductor industry directly employs more than 300,000 people in the U.S. and supports nearly 1.8 million additional U.S. jobs" (Semiconductor Industry Association [SIA], 2023, para. 1, 2, 3). America needs 50,000 engineers and close to 300,000 skilled tradesmen to meet the reported workforce shortfalls. This will improve America's ability to produce these computer chips (West, 2023).

According to the National Science Board (NSB), 36.8 million workers, representing 24% of the U.S. workforce, were employed in STEM occupations (National Science Board [NSB], 2024). This number needs to increase to match public and private sector adaptation to digitalization. Large numbers of Americans are not getting involved in STEM fields. With immigration being a divisive, hotbed issue, challenges arise about how the workforce employment deficit can be reduced (West, 2023). In 2019, 45% of STEM workers with doctorate degrees were non-native Americans (National Science Board [NSB], 2021).

Immigration policies have adversely affected the attraction and recruitment of STEM teachers in secondary schools. These immigration policies hinder the United States from addressing the shortage of STEM professionals as it strives to maintain its leadership in technological advancement and build the skilled workforce needed to integrate AI into the economy and everyday life in the United States (West, 2023).

The Semiconductor Industry Association (SIA) projects a 115,000-job growth by 2030. However, there

could be no STEM-trained talent to fill 58% of these jobs if tertiary students continue to graduate at the rate they currently do. Technicians will make up 39% of jobs that would not have workers. 35% will be engineers or computer scientists trained in 4-year tertiary institutions, and 26% of these jobs will be in roles that require master's or PhD-level engineers (Semiconductor Industry Association, 2023).

Apart from the semiconductor industry, other critical sectors of the U.S. economy face the same workforce shortage challenge. These sectors include "clean energy, medical technology, artificial intelligence, the Internet of Things, cybersecurity, next-generation communication, aerospace, automotive, and advanced manufacturing" (Semiconductor Industry Association, 2023).

5.1 Addressing These Challenges

The Vision for American Science and Technology (VAST) report makes some recommendations to address present challenges. These include the promotion of collaboration between tertiary institutions, skills training schools, and industry to offer career advancement opportunities and continuous professional education; offer perks that encourage industry players to fund programs that improve the skills of the workforce for critical sectors of the economy; train more K-12 STEM teachers, offer better remuneration, and opportunities for professional development and address challenges keeping sections of the U.S. population out of STEM education. Other noteworthy recommendations are the need to design deliberate and effective approaches to hiring foreign science and engineering talent to the U.S. and the reexamination of visa programs to retain rare and exceptional STEM workforce talent in the U.S. (VAST, 2023).

West (2023) proposes some solutions to the STEM workforce challenges. Among these solutions are the full rollout of the U.S. CHIPS and Science Act to enhance America's capabilities and ensure improvements in STEM instruction and workforce expertise, the importance of encouraging indigenous Americans to enroll in STEM while creating a professional track for foreign STEM talent, a more representative workforce which assists women and minorities to get into STEM as failure to do this could mean losing two-thirds of the population who could have gained career opportunities in STEM.

According to Goger and Ozkazanc-Pan (2023), in order to increase access to STEM fields for students, tertiary institutions consider easing qualification requirements, accepting credit for prior learning, providing "earn-and-learn options", and putting systems in place against discrimination and ensuring adherence to these systems. These strategies will not only help to promote STEM but also instill confidence in students who wish to pursue STEM fields.

Institutions of higher learning need to pay attention to equipping adults to adapt to the evolving industry environment. With emerging trends and the dynamism of technology, there is the need for people to update their knowledge and skills to match the pace of technological transformation (West, 2023).

Policies and initiatives that support the retention of foreign STEM talent are crucial to address workforce shortages occasioned by low indigenous participation in STEM fields (West, 2023).

6. Conclusion

The U.S. has made considerable investments in building a STEM workforce to meet current and future trends, challenges, and in an attempt to maintain its position as a global powerhouse in science and technology innovation. At the federal and state levels, efforts have been made to grow America's STEM workforce through a series of programs, policies, and interventions over the years. The private sector and industry players have also made contributions to workforce development.

As this review highlights, America has considerable work to do to build a formidable workforce to rival its global competitors like China. This starts with a coordinated effort from all sectors and a genuine

commitment to including all demographics who have been traditionally marginalized in STEM workforce development efforts. These challenges are exposed by the emergence and rapid development of AI, and the increasing demand for semiconductors highlights the urgency of addressing the STEM workforce shortage situation.

Foreign STEM talent can provide immediate solutions to the worker shortage problem while the U.S. addresses the long-term issues from K-12 to community and 4-year colleges. An integrated effort involving all stakeholders from communities, state, federal, and industry, with the sole aim of securing America's future, will lead to more harmonized approaches, which will ultimately lead to interventions that secure America's security, economy, everyday life, and position in the world.

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