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Bridging societal inequities and enhancing stem workforce diversity through social science-driven educational reforms and evidence-based policy development

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Abstract

Bridging societal inequities and enhancing workforce diversity in STEM (Science, Technology, Engineering, and Mathematics) requires a multifaceted approach rooted in educational reform and policy innovation. This review explores the critical role that social science-driven reforms and evidence-based policy development play in addressing underrepresentation and inequities in STEM education and careers. Historically, marginalized groups such as women, racial minorities, and low-income communities have faced systemic barriers in accessing quality STEM education, leading to significant disparities in workforce representation. By integrating insights from disciplines like sociology, psychology, and cultural studies, social science can help reshape STEM education to be more inclusive and responsive to diverse student needs. Educational reforms, including curriculum redesign and culturally responsive teaching strategies, can foster a learning environment where underrepresented students feel supported and valued. Teacher training programs, early intervention initiatives, and increased access to resources in underserved areas are also crucial steps in this direction. Moreover, evidence-based policy development is essential for ensuring that these reforms are sustained and scaled. Policies aimed at increasing funding, promoting equity in STEM programs, and encouraging participation from marginalized groups are vital to driving systemic change. This review also examines successful case studies of educational reforms and policies that have effectively improved diversity in STEM fields. Despite ongoing challenges such as resistance to change, limited funding, and entrenched societal biases the integration of social science perspectives in education and policy can significantly enhance diversity. By fostering interdisciplinary collaboration and ensuring that policy decisions are data-driven, it is possible to create a more equitable and diverse STEM workforce that better reflects the societal fabric. The review concludes with recommendations for future research and action to maintain momentum in bridging societal inequities in STEM.

Keywords: Societal Inequities; STEM Workforce; Policy Development; Review

1 Introduction

Societal inequities in education and workforce representation are persistent challenges that disproportionately affect marginalized groups, such as racial minorities, women, and individuals from low-income communities (Jones and Burrell, 2022; Kuchynka *et al*., 2022). These inequities arise from systemic barriers that limit access to quality education and career opportunities, creating a cycle of underrepresentation and limited upward mobility (Odulaja *et al*., 2023). In the context of Science, Technology, Engineering, and Mathematics (STEM), these disparities manifest in significant underrepresentation of minorities and other disadvantaged groups, both in academic institutions and in the workforce. Societal inequities in education refer to the unequal distribution of resources, opportunities, and support systems that contribute to differing educational outcomes. In the workforce, these inequities are reflected in disparities in hiring,

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promotion, and career advancement, where underrepresented groups often face obstacles that prevent them from thriving in STEM fields (Popo-Olaniyan *et al*., 2022; Ogedengbe *et al*., 2023).

Diversity in STEM is essential for fostering innovation, creativity, and problem-solving. A diverse workforce brings together individuals with varied perspectives, experiences, and approaches to addressing complex challenges. In STEM fields, where the ability to think critically and solve problems creatively is crucial, diversity is a key driver of progress (Fay *et al*., 2021). Moreover, the inclusion of diverse voices ensures that technological advancements and scientific discoveries are more inclusive and equitable, addressing the needs of broader communities. Research has shown that diverse teams are more effective at generating novel ideas, reducing biases, and producing outcomes that are more representative of society at large. Without diversity, STEM fields risk stagnation and exclusion of valuable talent, which limits the potential for scientific and technological advancements that benefit everyone. Despite its importance, achieving diversity in STEM remains an ongoing challenge. Systemic barriers such as unequal access to quality STEM education, lack of mentorship, and biased hiring practices have contributed to the persistent underrepresentation of women, racial minorities, and individuals from socioeconomically disadvantaged backgrounds (Nkrumah and Scott, 2022; Graves *et al*., 2022). These challenges underscore the need for deliberate and targeted efforts to increase diversity through educational reforms and policies designed to address inequities.

The social sciences, which encompass disciplines such as sociology, psychology, and education, play a critical role in addressing societal inequities in STEM education and workforce representation. By examining the social, cultural, and economic factors that contribute to disparities, social sciences provide valuable insights into how inequities are formed and perpetuated (Elenbaas *et al*., 2020). For instance, sociological research can shed light on the ways in which institutional biases and structural inequalities affect marginalized students' access to quality STEM education. Psychology contributes to understanding the cognitive and emotional challenges faced by underrepresented groups, such as stereotype threat and imposter syndrome, which can impact their performance and persistence in STEM fields. The social sciences also offer strategies for mitigating these challenges (McKinley *et al*., 2020). Culturally responsive teaching, inclusive pedagogy, and equity-focused educational policies are some of the ways in which social sciences inform efforts to create more inclusive learning environments. Additionally, social science research helps identify effective interventions, such as mentorship programs and early STEM exposure, that can support underrepresented students in their academic journeys and encourage their participation in STEM careers. By integrating social science insights into educational reforms, it is possible to develop strategies that address the root causes of inequities and promote lasting change (Tyagi *et al*., 2021).

The purpose of this review is to explore how social science-driven educational reforms and evidence-based policy development can bridge societal inequities and enhance diversity in the STEM workforce. Through a multidisciplinary approach, this review aims to identify key factors contributing to underrepresentation in STEM and highlight strategies for addressing these challenges. By examining the role of social science in driving educational reform, this review will explore how curricula can be redesigned to be more inclusive, how teaching practices can be adapted to meet the needs of diverse learners, and how educational policies can be shaped to support equitable access to STEM opportunities. Furthermore, this review will emphasize the importance of evidence-based policy development in ensuring that educational reforms are effective, scalable, and sustainable. It will also present case studies of successful interventions and policies that have demonstrated success in improving diversity in STEM fields. Ultimately, this review aims to provide actionable insights for educators, policymakers, and institutions seeking to create a more equitable and diverse STEM workforce, benefiting both the scientific community and society as a whole.

2 Understanding Societal Inequities in STEM Education

Societal inequities in STEM (Science, Technology, Engineering, and Mathematics) education present significant challenges that result in the underrepresentation of minorities and marginalized groups (Whitcomb and Singh, 2021; Neally, 2022). These disparities, stemming from various social, economic, and cultural factors, limit the access and opportunities available to disadvantaged students, ultimately affecting the diversity of the future STEM workforce. Understanding the root causes of these inequities is essential for developing targeted interventions to promote inclusivity and equality in STEM education.

Disparities in STEM education access are widespread, affecting students at all levels of education. Access to quality STEM education is often unevenly distributed, with students from disadvantaged backgrounds facing significant barriers (Godec *et al*., 2022). Schools in low-income or rural areas frequently lack the resources necessary to provide high-quality STEM instruction, including well-trained teachers, modern laboratory equipment, and advanced technology. These limitations prevent students from developing strong foundations in STEM subjects, placing them at a disadvantage compared to their more privileged peers. Moreover, early exposure to STEM fields is critical for

developing interest and proficiency, yet many marginalized students have limited opportunities to engage with STEM activities outside of the classroom. This lack of exposure exacerbates disparities, as students from wealthier backgrounds often have access to extracurricular programs, tutoring, and mentorship that reinforce STEM learning (Thiem and Dasgupta, 2022). As a result, disparities in STEM education access begin early in a student's academic journey and continue to widen over time, creating systemic inequalities that are difficult to overcome.

Several factors contribute to the underrepresentation of minorities and marginalized communities in STEM education. These factors are deeply intertwined with broader social and economic inequalities. Students from low-income families often face multiple challenges that impede their access to quality STEM education. Financial constraints may limit their ability to attend well-funded schools or participate in enrichment programs. Additionally, these students may lack access to the resources needed to succeed in STEM, such as computers, internet access, and advanced textbooks. Socioeconomic status also influences parental involvement in education, which can be a critical factor in a student's academic success. Geographic disparities in education also play a significant role in perpetuating inequities in STEM. Rural and underserved urban communities frequently lack the infrastructure and funding to provide robust STEM programs. Students in these areas may have limited access to STEM-focused schools, specialized teachers, or state-of-the-art facilities (Dardis *et al*., 2021). Geographic isolation also hinders opportunities for students to engage in STEM-related extracurricular activities, competitions, or internships. Gender disparities in STEM are well-documented, with girls and women often being underrepresented, particularly in fields such as engineering, computer science, and physics. These disparities can be attributed to societal stereotypes and biases that suggest STEM fields are more suited for males. As a result, girls may receive less encouragement to pursue STEM subjects, leading to lower enrollment and participation rates. In higher education and the workforce, women in STEM often face additional challenges, such as implicit bias, lack of mentorship, and gender-based discrimination. Racial and ethnic minorities, particularly Black, Latinx, and Indigenous students, remain underrepresented in STEM education. Historical and systemic inequities, such as segregation and underfunding of schools in minority communities, have contributed to this gap. In addition, minority students often experience lower expectations from teachers and administrators, which can affect their academic performance and interest in STEM subjects (Park-Taylor *et al*., 2022). The lack of representation of minority role models in STEM fields also perpetuates the perception that these fields are not accessible to students of color.

The underrepresentation of minorities and marginalized groups in STEM education has significant consequences for the diversity of the future STEM workforce. When students from disadvantaged backgrounds are systematically excluded from high-quality STEM education, they are less likely to pursue STEM degrees and careers (London *et al*., 2021). This creates a workforce that does not reflect the diversity of society, limiting the perspectives, creativity, and innovation that come from diverse teams. A lack of diversity in the STEM workforce also perpetuates existing social and economic inequalities. STEM careers tend to offer higher salaries and greater opportunities for upward mobility, making them critical pathways to economic advancement. By excluding marginalized groups from these opportunities, societal inequities are reinforced, contributing to persistent income inequality and limited social mobility for underrepresented populations.

Systemic barriers play a central role in perpetuating disparities in STEM education. These barriers are deeply ingrained in educational institutions, policies, and practices, making it difficult for marginalized students to break the cycle of inequity. Some of these systemic barriers include. Public school funding is often tied to local property taxes, resulting in significant disparities between wealthy and low-income areas (Baker *et al*., 2022). Schools in affluent communities are better equipped to offer high-quality STEM programs, while those in low-income areas struggle to provide basic educational resources. Many schools serving marginalized communities lack adequately trained STEM teachers. Teachers in these schools may have limited access to professional development opportunities, which hinders their ability to provide effective STEM instruction. Additionally, teachers may harbor implicit biases that lower their expectations for students from minority or low-income backgrounds, further limiting these students' opportunities for success. Standardized curricula and teaching methods may not always accommodate the diverse learning needs of marginalized students. STEM education that fails to incorporate culturally relevant pedagogy can alienate students from minority communities, making it harder for them to engage with the material and see themselves as part of the STEM community. Marginalized students often have limited access to advanced STEM courses, such as AP (Advanced Placement) or IB (International Baccalaureate) programs. Without access to these courses, students are less prepared for college-level STEM studies, reducing their chances of pursuing STEM degrees (Cohodes *et al*., 2022).

Understanding the complex interplay of factors that contribute to inequities in STEM education is crucial for addressing the underrepresentation of minorities and marginalized groups. Socioeconomic status, geographic location, gender, race, and systemic barriers all play a role in limiting access to quality STEM education (Pierszalowski *et al*., 2021). These disparities have long-term implications for the diversity of the STEM workforce, highlighting the urgent need for targeted reforms and policies to bridge these inequities and create a more inclusive future in STEM.

2.1 The Role of Social Sciences in Educational Reforms

Social sciences play a vital role in addressing the societal inequities present in Science, Technology, Engineering, and Mathematics (STEM) education. Through interdisciplinary approaches, educational psychology, sociological insights, and cultural studies, social sciences provide frameworks and strategies for developing more inclusive, equitable STEM learning environments. By understanding the underlying social, cultural, and psychological barriers faced by marginalized students, educators and policymakers can develop reforms that not only improve STEM education but also foster greater diversity in the future STEM workforce (Fuller *et al*., 2021).

One of the most powerful ways to address inequities in STEM education is through interdisciplinary approaches that combine social sciences and STEM fields. This integration allows for a more holistic understanding of the educational challenges that marginalized students face and offers strategies to overcome these barriers. For instance, educational research that blends insights from sociology and psychology can uncover how social contexts and cognitive factors impact learning outcomes in STEM subjects. By incorporating these findings, educators can design STEM curricula that are more inclusive and supportive of diverse learning needs (O'Leary *et al*., 2020). Interdisciplinary approaches also promote collaboration between educators, policymakers, and social scientists to ensure that STEM education reforms are both evidence-based and culturally sensitive. For example, when developing policies aimed at increasing diversity in STEM, it is essential to consider the social and economic contexts in which students live. These factors may influence their access to resources, their motivation to pursue STEM subjects, and their ability to persist in challenging academic environments. The intersection of social sciences and STEM thus creates pathways for reforms that address both the technical and social dimensions of education, fostering environments where all students can thrive.

Educational psychology offers valuable insights into how students learn and how different learning environments impact their success, particularly in STEM subjects. By studying cognitive development, motivation, and learning styles, educational psychologists can inform teaching strategies that promote inclusion and equity in STEM classrooms (Moore *et al*., 2020). One key contribution of educational psychology is the concept of growth mindset, which encourages students to view challenges as opportunities for growth rather than as insurmountable obstacles. This mindset is especially important for underrepresented students in STEM, who may feel discouraged by stereotypes or biases suggesting they are less capable in these fields. Moreover, educational psychology addresses issues such as stereotype threat the fear of confirming negative stereotypes about one's social group which can impair academic performance, especially in high-stakes STEM environments. By fostering supportive, low-pressure environments and using inclusive teaching practices, educators can mitigate the effects of stereotype threat and help all students reach their full potential. Inclusive teaching practices informed by educational psychology, such as differentiated instruction and collaborative learning, can be used to tailor STEM education to diverse learning styles and needs, creating more equitable opportunities for success.

Sociology contributes critical insights into the structural and institutional barriers that marginalized students face in STEM education. Sociological research shows that educational inequities are often rooted in broader social and economic inequalities, such as poverty, racial discrimination, and gender biases (Richardson, 2021). These barriers manifest in various ways, including unequal access to high-quality STEM programs, lack of mentorship, and limited exposure to STEM-related activities. Racial and gender biases within educational institutions can also lower teachers' expectations for marginalized students, affecting their academic performance and engagement in STEM subjects. Understanding these barriers through a sociological lens allows educators and policymakers to design interventions that address not only the symptoms of inequity but also its root causes, such as systemic discrimination and unequal distribution of resources.

Cultural studies play a key role in developing culturally relevant pedagogy, which is essential for making STEM education more inclusive. Culturally relevant pedagogy involves teaching methods that recognize and respect students' cultural backgrounds, integrating their experiences and perspectives into the learning process (Howard, 2021). This approach is particularly important in STEM education, where traditional teaching methods may not resonate with students from diverse cultural backgrounds. By incorporating cultural studies into STEM education reforms, educators can develop curricula that reflect the diverse experiences and knowledge of their students. For example, lessons in biology, engineering, or environmental science can include case studies or examples that highlight contributions from non-Western cultures or that address issues relevant to marginalized communities. This approach not only makes STEM subjects more engaging for diverse learners but also helps to challenge the dominant narratives that often exclude the contributions of women and minorities in STEM fields. Cultural studies also emphasize the importance of representation in education. When students see role models from similar cultural backgrounds succeeding in STEM, they are more likely to believe in their own potential and pursue careers in these fields. By integrating culturally relevant content and

promoting diversity in STEM role models, educators can create a more inclusive and inspiring learning environment for all students.

The integration of social sciences into STEM education reforms is crucial for addressing the systemic barriers that limit access and opportunities for marginalized students. Interdisciplinary approaches, educational psychology, sociological insights, and culturally relevant pedagogy all contribute to creating more inclusive STEM learning environments (Nasir *et al*., 2021). These reforms not only improve educational outcomes for underrepresented students but also help build a more diverse and innovative STEM workforce, ultimately benefiting society as a whole.

2.2 Educational Reforms to Bridge Inequities in STEM

Educational reforms aimed at bridging inequities in STEM (Science, Technology, Engineering, and Mathematics) must be multi-faceted, addressing systemic barriers and ensuring inclusive environments for students from diverse backgrounds. By focusing on curriculum redesign, equity-centered teaching strategies, early intervention programs, teacher training, and increased access to STEM resources, these reforms can create a more equitable educational landscape and enhance diversity in the future STEM workforce (Khalil and Kier, 2021; Bickerstaff *et al*., 2022).

One of the foundational steps in bridging inequities in STEM education is redesigning the curriculum to reflect diverse perspectives. Traditional STEM curricula often overlook the contributions of underrepresented groups, such as women, racial minorities, and non-Western cultures, leading to a lack of representation and relatability for marginalized students. Curriculum redesign should incorporate contributions from diverse cultures, highlighting the achievements of minority scientists, engineers, and mathematicians, and showcasing STEM advancements from different parts of the world. In addition to including diverse role models, the curriculum should integrate social justice topics relevant to STEM (Dare *et al*., 2021). For example, lessons on environmental science could include discussions on the disproportionate impact of climate change on marginalized communities. This approach not only makes the curriculum more inclusive but also fosters critical thinking and problem-solving skills that connect STEM with real-world issues, engaging a broader range of students in the subject matter.

Equity-centered teaching strategies, such as culturally responsive teaching, are essential for fostering an inclusive STEM learning environment. Culturally responsive teaching recognizes the cultural backgrounds and experiences of students, using them as assets in the learning process. This approach encourages teachers to draw on students' cultural knowledge and incorporate it into STEM lessons, making learning more relevant and accessible to all students. In STEM classrooms, culturally responsive teaching might involve using examples or problems that reflect the diverse communities from which students come or engaging students in group work those values diverse perspectives and collaborative problem-solving. Equity-centered teaching also emphasizes the importance of high expectations for all students, regardless of background, ensuring that each student receives the support they need to succeed (Sullivan et l., 2022).

Early intervention programs are critical in fostering interest and success in STEM for underrepresented students. These programs, which may begin as early as elementary school, aim to build foundational STEM skills, provide mentorship, and expose students to STEM careers. Programs like summer STEM camps, after-school STEM clubs, and mentorship initiatives connect students with role models in STEM fields, helping to demystify these subjects and increase students' confidence in their abilities. Early interventions also focus on addressing gaps in STEM education that can emerge due to socioeconomic status, gender, or race (Van Sickle *et al*., 2020). By providing additional resources, tutoring, and enrichment opportunities, these programs help level the playing field for students who might not otherwise have access to advanced STEM courses or extracurricular activities.

Effective educational reforms must include comprehensive teacher training and professional development to equip educators with the tools and knowledge needed to foster inclusivity in STEM. Teacher training programs should focus on helping educators recognize and combat biases, implement equity-centered teaching strategies, and develop culturally responsive lesson plans. Training should also provide strategies for creating inclusive classroom environments where all students feel supported and encouraged to participate (Sanger, 2020). Professional development in STEM education should also emphasize the importance of continuous learning about diversity and inclusion. As research on educational equity evolves, teachers must stay informed about the latest findings and best practices for addressing the needs of marginalized students. Providing opportunities for teachers to collaborate and share their experiences can also promote the spread of effective strategies for enhancing inclusivity in STEM education.

A significant barrier to equity in STEM education is the lack of access to resources and opportunities in underserved communities. Schools in low-income areas often have fewer STEM resources, such as laboratories, technology, and

advanced coursework, limiting students' ability to engage fully in STEM learning. Addressing this disparity requires targeted investments in these communities to ensure that all students have access to high-quality STEM education. Increasing access can take various forms, such as providing funding for STEM labs, offering scholarships for students to attend STEM enrichment programs, and expanding online learning platforms that make STEM resources more accessible (Ashcroft *et al*., 2021). Partnerships between schools, businesses, and community organizations can also help bring STEM opportunities to underserved areas, such as internships, apprenticeships, and STEM-related field trips that expose students to potential careers.

Bridging inequities in STEM education requires a comprehensive approach that addresses both the curriculum and the broader educational environment. By redesigning curricula to include diverse perspectives, promoting equity-centered teaching strategies, supporting early intervention programs, providing robust teacher training, and increasing access to STEM resources in underserved communities, educational reforms can create a more inclusive and equitable STEM landscape. These reforms not only benefit marginalized students by giving them the tools to succeed but also strengthen the future STEM workforce by increasing diversity and fostering innovation.

2.3 The Role of Evidence-Based Policy Development

Evidence-based policy development is critical in addressing systemic inequities and fostering diversity in STEM (Science, Technology, Engineering, and Mathematics) education and workforce participation (Sarma and Bagiati, 2021). By grounding policies in data and research, policymakers can create targeted, effective strategies that address disparities, improve access to quality education, and encourage broader participation among underrepresented groups. This review explores the importance of data-driven policies, the role of government and educational institutions, and frameworks for monitoring progress in diversity.

Data-driven policy decisions are essential in addressing inequities in STEM because they allow for informed, targeted interventions. By using data, policymakers can identify where disparities exist, such as in underfunded schools, marginalized communities, or demographic groups that are underrepresented in STEM fields (Bottia *et al*., 2021). Data collection and analysis also allow for the assessment of the root causes of these inequities, whether they stem from socioeconomic status, racial discrimination, gender bias, or geographic location. Using data ensures that policies are tailored to meet specific needs, avoiding one-size-fits-all approaches that may overlook the complexities of marginalized students' experiences. For example, data might reveal that certain schools in rural areas lack access to advanced STEM courses, prompting policymakers to direct resources and funding to those areas. Ultimately, evidence-based policies ensure that interventions are more effective, efficient, and equitable, leading to meaningful improvements in STEM education and workforce diversity (Pearson *et al*., 2022).

Improving access to quality STEM education requires targeted policies that address disparities in funding, resources, and opportunities. Funding allocation is a critical aspect, as schools in underserved areas often lack the resources necessary to provide high-quality STEM education, including well-equipped laboratories, technology, and qualified teachers. Evidence-based policies can ensure that funding is directed toward schools and communities with the greatest needs, helping to bridge gaps in access to STEM education. Scholarship programs and financial aid initiatives are also vital in increasing access to STEM education for underrepresented students. By providing financial support, scholarships remove barriers to higher education and help create pathways for students who might not otherwise have the means to pursue STEM careers (Sweeder *et al*., 2021). These policies also encourage a diverse range of students to enter STEM fields, increasing the overall pool of talent and innovation in the workforce.

Encouraging participation in STEM among women, minorities, and other underrepresented groups requires policies that specifically address the unique challenges these groups face. Mentorship programs and internship opportunities that connect underrepresented students with STEM professionals can provide role models and networking opportunities, helping to demystify STEM careers and inspire participation. Policies that mandate or incentivize such programs can significantly enhance the representation of marginalized groups in STEM fields (Davies *et al*., 2021). Additionally, policies should focus on combating stereotypes and biases that deter underrepresented groups from pursuing STEM careers. For example, policies promoting inclusive teaching practices and bias training for educators can create more supportive learning environments, encouraging students to persist in STEM studies despite societal and institutional barriers. These initiatives help foster a sense of belonging and capability among marginalized students, increasing their likelihood of success in STEM education and careers.

Both government and educational institutions play crucial roles in fostering a more diverse STEM workforce. Governments, through their policy frameworks, can mandate changes in education systems and provide the necessary funding and support for diversity initiatives (Cerna *et al*., 2021). For example, federal or state governments can allocate

funds specifically for diversity programs in STEM or set diversity goals for institutions that receive public funding. Additionally, governments can implement policies that promote diversity in STEM industries, such as tax incentives for companies that hire underrepresented groups or mandates for diversity in research grants (Kong *et al*., 2020). Educational institutions also play a pivotal role in this process by implementing inclusive practices and curricula. Universities and schools can adopt policies that promote diversity in admissions, faculty hiring, and program development. Initiatives such as STEM bridge programs, which help underrepresented students transition from high school to university-level STEM courses, are effective in closing gaps in representation. Collaboration between government bodies and educational institutions is essential for ensuring that diversity policies are effectively implemented and monitored.

To ensure the long-term success of diversity initiatives in STEM, policy frameworks must include mechanisms for monitoring and evaluating progress. Regular data collection and reporting on diversity metrics, such as the representation of women, minorities, and low-income students in STEM programs, are essential for assessing the effectiveness of policies. Governments and educational institutions can develop accountability systems that track diversity outcomes, ensuring that policy goals are being met. Evaluation processes should also include qualitative measures, such as surveys and interviews, to gather insights from students and educators about the inclusivity of STEM learning environments (Singer *et al*., 2020). These evaluations can inform future policy adjustments, ensuring that diversity initiatives remain responsive to changing demographics and societal needs. Policies should be adaptive, allowing for continuous improvement based on evidence and feedback from the affected communities.

Evidence-based policy development is fundamental to addressing inequities in STEM education and fostering a more diverse workforce (Pearson *et al*., 2022). By relying on data, governments and educational institutions can create targeted interventions that improve access to quality education, encourage participation among underrepresented groups, and monitor progress toward diversity goals. These policies not only address existing disparities but also pave the way for a more inclusive, innovative, and equitable STEM future.

2.4 Case Studies and Success Stories in Increasing Diversity in STEM

The push for diversity in STEM (Science, Technology, Engineering, and Mathematics) fields has gained momentum through various educational reforms, community initiatives, and industry partnerships. By examining successful case studies, we can identify effective strategies and practices that have increased representation and participation of underrepresented groups in STEM.

Several educational reforms and policies have been implemented across various regions to enhance diversity in STEM education. One notable example is the Federal TRIO Programs in the United States, which are designed to support low-income and first-generation college students, including those pursuing STEM degrees (Kezar and Kitchen, 2020). Programs such as Upward Bound and Talent Search provide critical services such as tutoring, mentorship, and college preparation, significantly increasing the number of underrepresented students entering STEM fields. Another successful initiative is the Next Generation STEM Learning Program in California, which emphasizes the integration of STEM education with a focus on equity and inclusivity. This program has successfully partnered with schools in low-income areas to redesign curricula that incorporate diverse perspectives and culturally relevant content, thus engaging students from various backgrounds. The program has reported an increase in the enrollment of underrepresented minorities in advanced STEM courses and improved student outcomes, demonstrating the effectiveness of inclusive educational policies.

Community-based initiatives have also played a pivotal role in addressing societal inequities in STEM education. One successful example is the Black Girls Code initiative, which aims to increase the number of women of color in STEM fields by providing girls ages 7 to 17 with opportunities to learn programming and computer science skills. Through workshops, coding camps, and mentorship programs, Black Girls Code empowers young girls to pursue careers in technology and engineering. The organization has reached thousands of girls across the United States and has seen a significant increase in their interest and enrollment in STEM-related courses (Arredondo *et al*., 2022). Another noteworthy initiative is the Society of Hispanic Professional Engineers (SHPE), which focuses on empowering the Hispanic community in STEM through education, professional development, and networking opportunities. SHPE offers scholarships, mentorship programs, and community engagement activities that promote STEM education among Hispanic youth. The success of SHPE can be seen in its significant impact on the enrollment and graduation rates of Hispanic students in engineering and technology programs across the country.

Partnerships between industry and educational institutions have emerged as a powerful strategy for supporting underrepresented STEM students (Bennett *et al*., 2020). One prominent example is the STEM Workforce Challenge

initiative, which involves collaboration between universities and tech companies to create internship and mentorship programs for underrepresented students. Companies like Google and Microsoft have partnered with universities to develop programs that provide real-world experience, professional networking, and skill-building opportunities, significantly enhancing the employability of these students in STEM fields. The ACE (Achieving the Dream) initiative is another successful partnership model that has brought together community colleges and local businesses to create pathways for underrepresented students in STEM. This initiative focuses on developing customized curricula and training programs that align with industry needs, ensuring that students acquire the skills necessary for in-demand STEM careers. Through such collaborations, students receive hands-on training, access to internships, and potential job placements upon graduation, thus bridging the gap between education and employment (Askren and James, 2021).

Case studies and success stories in increasing diversity in STEM demonstrate the importance of comprehensive strategies that combine educational reforms, community initiatives, and industry partnerships. Programs such as the Federal TRIO Programs and Black Girls Code highlight the effectiveness of targeted support and mentorship in empowering underrepresented students. Meanwhile, collaborations between educational institutions and industry leaders illustrate the potential for creating sustainable pathways for success in STEM careers. By continuing to invest in and replicate these successful models, we can foster a more diverse and inclusive STEM workforce that reflects the rich tapestry of society.

2.5 Challenges and Barriers in Implementing Reforms

Implementing reforms within educational and policy systems is often a complex endeavor fraught with numerous challenges and barriers (Johannis *et al*., 2021). These obstacles can hinder the progress of initiatives designed to improve educational outcomes, particularly in the realms of science, technology, engineering, and mathematics (STEM).

One of the most prominent barriers to reform is the inherent resistance to change within educational and policy frameworks. Educational institutions and policymakers often operate within established norms and practices, which can create a sense of inertia. Teachers, administrators, and policymakers may be apprehensive about altering their methodologies or curricula due to fear of the unknown or a lack of familiarity with new approaches. This resistance can stem from various factors, including entrenched beliefs about teaching methods, concerns about job security, and a lack of adequate training or professional development to implement new reforms effectively. Consequently, successful reform initiatives require comprehensive change management strategies that address these concerns and foster a culture of innovation and adaptability within educational and policy settings (Vázquez *et al*., 2021).

Funding constraints pose a significant barrier to the effective implementation of reforms. Many educational institutions face budget limitations that restrict their ability to invest in necessary resources, such as training, technology, and instructional materials (Vershitskaya *et al*., 2020). When reforms demand substantial upfront investment, the challenge becomes even more pronounced. Policymakers often struggle to prioritize funding allocations amidst competing interests, leading to a misalignment between reform objectives and available financial resources. Moreover, disparities in funding can exacerbate existing inequities within the educational system, as schools in lower-income areas may lack the financial support to implement new initiatives effectively (Allegretto *et al*., 2022). Addressing funding constraints requires a concerted effort from government entities and educational stakeholders to ensure equitable resource distribution and create sustainable financial models that support long-term reform efforts.

Another critical challenge is the difficulty of measuring the effectiveness of educational reforms and policies. Determining whether a reform has achieved its intended outcomes requires robust evaluation frameworks that can capture both quantitative and qualitative data (Skivington *et al*., 2021). However, many existing assessment tools fail to provide a comprehensive picture of reform impact. Standardized testing, for instance, may not adequately reflect the complexities of learning processes or the skills necessary for success in STEM fields. Additionally, the time required to see tangible results can complicate assessments, leading to premature conclusions about a reform's effectiveness (Ingrams *et al*., 2020). To navigate this challenge, educational institutions must invest in developing innovative assessment strategies that encompass a wider range of indicators, allowing for a more nuanced understanding of reform outcomes.

Societal stereotypes and biases regarding STEM careers present another significant barrier to reform. Traditional gender roles and cultural perceptions can discourage underrepresented groups, particularly women and minorities, from pursuing STEM fields. These biases may be perpetuated through educational practices, media representations, and even the language used in the classroom. To counteract these stereotypes, it is essential for educational reforms to incorporate diversity and inclusivity initiatives that actively promote the participation of all students in STEM (White *et al*., 2020). This can include revising curricula to highlight contributions from diverse figures in science and

technology, providing mentorship programs, and creating supportive learning environments that encourage all students to explore STEM opportunities. Overcoming societal biases requires a collective effort from educators, policymakers, and community stakeholders to reshape perceptions and foster an inclusive culture that values diversity in STEM careers.

2.6 Future Directions and Recommendations

As the demand for skilled professionals in science, technology, engineering, and mathematics (STEM) continues to grow, it is imperative to explore future directions and recommendations that can enhance STEM education and workforce diversity. This outlines four key areas for development: promoting interdisciplinary research, strengthening collaboration among stakeholders, expanding mentorship and internship opportunities for underrepresented students, and establishing long-term strategies to sustain progress in bridging societal inequities.

Promoting interdisciplinary research is essential for driving continuous improvement in STEM education. By fostering collaboration across disciplines, educational institutions can develop innovative curricula and teaching methods that reflect the interconnectedness of real-world challenges (Bates *et al*., 2022). For instance, integrating concepts from engineering, biology, and computer science can lead to more comprehensive problem-solving approaches in fields like environmental science or healthcare technology. Moreover, interdisciplinary research can enhance student engagement by demonstrating the practical applications of STEM knowledge in diverse contexts. Institutions should encourage faculty to collaborate on research projects that span multiple disciplines and facilitate joint workshops and conferences to share best practices. By prioritizing interdisciplinary approaches, STEM education can become more dynamic, relevant, and effective in preparing students for future careers.

Strengthening collaboration among policymakers, educators, and communities is crucial for creating a cohesive framework that supports STEM education. Policymakers play a vital role in shaping educational policies, funding initiatives, and establishing standards that guide STEM curricula (Rodriguez *et al*., 2021). Engaging educators in the policy-making process ensures that the voices of those directly involved in teaching and learning are heard, leading to more effective and practical policies. Additionally, partnerships with community organizations can provide valuable resources, support, and opportunities for students (Rinaldo *et al*., 2022). For example, local businesses can offer real-world insights into industry needs, while community centers can serve as venues for STEM outreach programs. By fostering a collaborative ecosystem, stakeholders can work together to address the unique challenges faced by students in their communities, ultimately creating a more supportive environment for STEM education.

Expanding mentorship and internship opportunities for underrepresented STEM students is vital for fostering diversity and inclusion within the field. Research has shown that mentorship can significantly influence students' academic and career trajectories, particularly for those who may face systemic barriers. Educational institutions and industry partners should develop structured mentorship programs that connect students with professionals in their desired fields (Okolie *et al*., 2020). These programs can provide guidance, networking opportunities, and exposure to real-world experiences, which are essential for building confidence and competence in STEM. Additionally, increasing access to internships for underrepresented students can help bridge the gap between education and employment. By collaborating with businesses to create internship pathways, educational institutions can ensure that all students have equitable access to opportunities that enhance their learning and career prospects.

Finally, establishing long-term strategies for sustaining progress in bridging societal inequities and enhancing workforce diversity is essential for the future of STEM education. Policymakers and educational leaders must commit to regular assessments of diversity and equity initiatives to identify areas for improvement and celebrate successes (McCray *et al*., 2021). This can include collecting and analyzing data on student enrollment, retention, and outcomes across different demographics to inform targeted interventions. Additionally, creating policies that promote equitable funding for STEM programs, particularly in under-resourced schools, can help ensure that all students have access to high-quality education. Engaging stakeholders in ongoing discussions about diversity and equity can also foster a culture of accountability and shared responsibility for promoting inclusivity in STEM. By implementing these long-term strategies, the education system can work toward a more equitable future where diverse voices are represented in the STEM workforce (Olzmann, 2020).

3 Conclusion

In summary, addressing societal inequities in STEM (Science, Technology, Engineering, and Mathematics) education and workforce representation requires a multifaceted approach that combines educational reforms, community initiatives, and industry partnerships. Key points discussed include the importance of redesigning curricula to reflect

diverse perspectives, implementing equity-centered teaching strategies, and developing early intervention programs to support underrepresented students. Additionally, evidence-based policy development is crucial for creating targeted interventions that enhance access to quality STEM education and foster greater participation among women, minorities, and other marginalized groups.

The role of social sciences in informing these reforms cannot be overstated. Social science-driven approaches provide valuable insights into the barriers faced by underrepresented communities, enabling policymakers and educators to create inclusive learning environments that promote diversity. Evidence-based policies ensure that interventions are grounded in data, maximizing their effectiveness and accountability in achieving equitable representation in STEM fields.

As we move forward, it is imperative that all stakeholders' governments, educational institutions, industry leaders, and communities commit to continuous efforts aimed at building a diverse and inclusive STEM workforce. This requires not only sustained investment in effective programs and policies but also a commitment to ongoing evaluation and adaptation based on empirical evidence and community feedback. By working together, we can create a future where the STEM workforce reflects the diversity of society, fostering innovation, creativity, and progress for all. The call to action is clear: we must remain vigilant and proactive in our pursuit of equity in STEM, ensuring that every student, regardless of background, has the opportunity to thrive and contribute to a brighter future.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

[1] Allegretto, S., García, E. and Weiss, E., 2022. Public Education Funding in the US Needs an Overhaul: How a Larger Federal Role Would Boost Equity and Shield Children from Disinvestment during Downturns. *Economic Policy Institute*.

[2] Arredondo, P., Miville, M.L., Capodilupo, C.M. and Vera, T., 2022. *Women and the challenge of STEM professions*. Cham: Springer International Publishing.

[3] Ashcroft, J., Jaramillo, V., Blatti, J., Guan, S.S.A., Bui, A., Villasenor, V., Adamian, A., Chavira, G., Saetermoe, C., Horowitz, B. and Palacios, B., 2021. BUILDing equity in STEM: A collaborative undergraduate research program to increase achievement of underserved community college students. *Scholarship and practice of undergraduate research*, *4*(3), p.47.

[4] Askren, J. and James, W., 2021. Experiential learning methods in culinary course can bridge the gap: Student perceptions on how hands-on curriculum prepares them for industry. *Journal of Hospitality & Tourism Education*, *33*(2), pp.111-125.

[5] Baker, B.D., Di Carlo, M. and Green III, P.C., 2022. Segregation and School Funding: How Housing Discrimination Reproduces Unequal Opportunity. *Albert Shanker Institute*.

[6] Bates, R., Brenner, B., Schmid, E., Steiner, G. and Vogel, S., 2022. Towards meta–competences in higher education for tackling complex real–world problems–a cross disciplinary review. *International Journal of Sustainability in Higher Education*, *23*(8), pp.290-308.

[7] Bennett, J., Lattuca, L., Redd, K. and York, T., 2020. Strengthening Pathways to Faculty Careers in STEM: Recommendations for Systemic Change to Support Underrepresented Groups. Lessons from the APLU INCLUDES Project. *Association of Public and Land-grant Universities*.

[8] Bickerstaff, S., Beal, K., Raufman, J., Lewy, E.B. and Slaughter, A., 2022. Five Principles for Reforming Developmental Education: A Review of the Evidence. *Center for the Analysis of Postsecondary Readiness*.

[9] Bottia, M.C., Mickelson, R.A., Jamil, C., Moniz, K. and Barry, L., 2021. Factors associated with college STEM participation of racially minoritized students: A synthesis of research. *Review of Educational Research*, *91*(4), pp.614-648.

[10] Cerna, L., Mezzanotte, C., Rutigliano, A., Brussino, O., Santiago, P., Borgonovi, F. and Guthrie, C., 2021. Promoting inclusive education for diverse societies: A conceptual framework.

[11] Cohodes, S.R., Ho, H. and Robles, S.C., 2022. *STEM summer programs for underrepresented youth increase STEM degrees* (No. w30227). National Bureau of Economic Research.

[12] Dardis, D.A., Fayed, A., Achee, B., Bahadir, M.E., Conarro, W.J., Williams, T., Saadeh, M. and Cobb, T., 2021, July. Introducing Multidisciplinary Engineering in a Diverse Interdisciplinary Virtual Summer Camp for Underrepresented 9th-12th Graders in Rural Louisiana (Evaluation, Diversity). In *2021 ASEE Virtual Annual Conference Content Access*.

[13] Dare, E.A., Keratithamkul, K., Hiwatig, B.M. and Li, F., 2021. Beyond content: The role of STEM disciplines, real-world problems, 21st century skills, and STEM careers within science teachers' conceptions of integrated STEM education. *Education Sciences*, *11*(11), p.737.

[14] Davies, S.W., Putnam, H.M., Ainsworth, T., Baum, J.K., Bove, C.B., Crosby, S.C., Côté, I.M., Duplouy, A., Fulweiler, R.W., Griffin, A.J. and Hanley, T.C., 2021. Promoting inclusive metrics of success and impact to dismantle a discriminatory reward system in science. *PLoS biology*, *19*(6), p.e3001282.

[15] Elenbaas, L., Rizzo, M.T. and Killen, M., 2020. A developmental-science perspective on social inequality. *Current Directions in Psychological Science*, *29*(6), pp.610-616.

[16] Fay, D.L., Hicklin Fryar, A., Meier, K.J. and Wilkins, V., 2021. Intersectionality and equity: Dynamic bureaucratic representation in higher education. *Public Administration*, *99*(2), pp.335-352.

[17] Fuller, J.A., Luckey, S., Odean, R. and Lang, S.N., 2021. Creating a diverse, inclusive, and equitable learning environment to support children of color's early introductions to STEM. *Translational Issues in Psychological Science*, *7*(4), p.473.

[18] Godec, S., Archer, L. and Dawson, E., 2022. Interested but not being served: mapping young people's participation in informal STEM education through an equity lens. *Research Reviews in Education*, *37*(2), pp.221-248.

[19] Graves Jr, J.L., Kearney, M., Barabino, G. and Malcom, S., 2022. Inequality in science and the case for a new agenda. *Proceedings of the National Academy of Sciences*, *119*(10), p.e2117831119.

[20] Howard, T.C., 2021. Culturally responsive pedagogy. *Transforming multicultural education policy and practice: Expanding educational opportunity*, pp.137-163.

[21] Ingrams, A., Piotrowski, S. and Berliner, D., 2020. Learning from our mistakes: Public management reform and the hope of open government. *Perspectives on Public Management and Governance*, *3*(4), pp.257-272.

[22] Johannis, A.A., Raveendaran, S., Tan, C.Y.X. and Hung, D.W.L., 2021. Cultural-historical gatekeeping: why educational change is difficult despite the influence of technology in Singapore schools. *Scaling up ICT-based Innovations in Schools: The Singapore Experience*, pp.49-66.

[23] Jones, T.R. and Burrell, S., 2022. Present in class yet absent in science: The individual and societal impact of inequitable science instruction and challenge to improve science instruction. *Science education*, *106*(5), pp.1032-1053.

[24] Kezar, A. and Kitchen, J.A., 2020. Supporting first-generation, low-income, and underrepresented students' transitions to college through comprehensive and integrated programs. *American Behavioral Scientist*, *64*(3), pp.223-229.

[25] Khalil, D. and Kier, M., 2021. Equity-centered design thinking in STEM instructional leadership. *Journal of Cases in Educational Leadership*, *24*(1), pp.69-85.

[26] Kong, S., Carroll, K., Lundberg, D., Omura, P. and Lepe, B., 2020. Reducing gender bias in STEM. *MIT Science Policy Review*, *1*(8), pp.55-63.

[27] Kuchynka, S.L., Eaton, A. and Rivera, L.M., 2022. Understanding and addressing gender-based inequities in STEM: Research synthesis and recommendations for US K-12 education. *Social issues and policy review*, *16*(1), pp.252-288.

[28] London, J.S., Lee, W.C. and Hawkins Ash, C.D., 2021. Potential engineers: A systematic literature review exploring Black children's access to and experiences with STEM. *Journal of Engineering Education*, *110*(4), pp.1003-1026.

[29] McCray, C.R., Beachum, F.D. and Reggio, P.F., 2021. *School leadership in a diverse society: Helping schools prepare all students for success*. IAP.

[30] McKinley, E., Acott, T. and Yates, K.L., 2020. Marine social sciences: Looking towards a sustainable future. *Environmental Science & Policy*, *108*, pp.85-92.

[31] Moore, M.E., Vega, D.M., Wiens, K.M. and Caporale, N., 2020. Connecting theory to practice: using self-determination theory to better understand inclusion in STEM. *Journal of microbiology & biology education*, *21*(1), pp.10-1128.

[32] Nasir, N.I.S., Lee, C.D., Pea, R. and McKinney de Royston, M., 2021. Rethinking learning: What the interdisciplinary science tells us. *Educational Researcher*, *50*(8), pp.557-565.

[33] Neally, K., 2022. An analysis of the underrepresentation of minoritized groups in science, technology, engineering, and mathematics education. *School Science and Mathematics*, *122*(5), pp.271-280.

[34] Nkrumah, T. and Scott, K.A., 2022. Mentoring in STEM higher education: a synthesis of the literature to (re) present the excluded women of color. *International Journal of STEM Education*, *9*(1), p.50.

[35] O'Leary, E.S., Shapiro, C., Toma, S., Sayson, H.W., Levis-Fitzgerald, M., Johnson, T. and Sork, V.L., 2020. Creating inclusive classrooms by engaging STEM faculty in culturally responsive teaching workshops. *International Journal of STEM education*, *7*, pp.1-15.

[36] Odulaja, B.A., Ihemereze, K.C., Fakeyede, O.G., Abdul, A.A., Ogedengbe, D.E. and Daraojimba, C., 2023. Harnessing blockchain for sustainable procurement: opportunities and challenges. *Computer Science & IT Research Journal*, *4*(3), pp.158-184.

[37] Ogedengbe, D.E., James, O.O., Afolabi, J.O.A., Olatoye, F.O. and Eboigbe, E.O., 2023. Human resources in the era of the fourth industrial revolution (4ir): Strategies and innovations in the global south. *Engineering Science & Technology Journal*, *4*(5), pp.308-322.

[38] Okolie, U.C., Nwajiuba, C.A., Binuomote, M.O., Ehiobuche, C., Igu, N.C.N. and Ajoke, O.S., 2020. Career training with mentoring programs in higher education: facilitating career development and employability of graduates. *Education+ Training*, *62*(3), pp.214-234.

[39] Olzmann, J.A., 2020. Diversity through equity and inclusion: the responsibility belongs to all of us. *Molecular biology of the cell*, *31*(25), pp.2757-2760.

[40] Park-Taylor, J., Wing, H.M., Aladin, M., Burke, E.K., Park, J. and Martinez, B.Y., 2022. STEM pathways for black and latinx middle and high school students. *The Urban Review*, *54*(4), pp.595-623.

[41] Pearson, J., Giacumo, L.A., Farid, A. and Sadegh, M., 2022. A systematic multiple studies review of low-income, first-generation, and underrepresented, STEM-degree support programs: Emerging evidence-based models and recommendations. *Education Sciences*, *12*(5), p.333.

[42] Pierszalowski, S., Bouwma-Gearhart, J. and Marlow, L., 2021. A systematic review of barriers to accessing undergraduate research for STEM students: problematizing under-researched factors for students of color. *Social Sciences*, *10*(9), p.328.

[43] Popo-Olaniyan, O., James, O.O., Udeh, C.A., Daraojimba, R.E. and Ogedengbe, D.E., 2022. Future-Proofing human resources in the US with AI: A review of trends and implications. *International Journal of Management & Entrepreneurship Research*, *4*(12), pp.641-658.

[44] Richardson, R., 2021. Racial segregation and the data-driven society: How our failure to reckon with root causes perpetuates separate and unequal realities. *Berkeley Tech. LJ*, *36*, p.1051.

[45] Rinaldo, S.B., Davis, D.F. and Borunda, J., 2022. Delivering value to community partners in service-learning projects. *Journal of Community Engagement and Scholarship*, *8*(1).

[46] Rodriguez, S.L., Espino, M.L., Le, B.D. and Cunniham, K.J., 2021. The influence of policy implementation in the Midwest: How a SSTEM program broadens participation and enhances engineering identity for community college students. *education policy analysis archives*, *29*(29), p.2.

[47] Sanger, C.S., 2020. Inclusive pedagogy and universal design approaches for diverse learning environments. *Diversity and inclusion in global higher education: Lessons from across Asia*, pp.31-71.

[48] Sarma, S. and Bagiati, A., 2021, August. Current innovation in STEM education and equity needs for the future. In *Symposium on Imagining the Future of Undergraduate STEM education, convened by the National Academy of Sciences, Engineering, and Medicine. Available at https://www. nationalacademies. org/event/10-21-2020/imagining-the-future-of-undergraduate-stem-education-symposium Accessed* (Vol. 16).

[49] Singer, A., Montgomery, G. and Schmoll, S., 2020. How to foster the formation of STEM identity: studying diversity in an authentic learning environment. *International Journal of STEM Education*, *7*, pp.1-12.

[50] Skivington, K., Matthews, L., Simpson, S.A., Craig, P., Baird, J., Blazeby, J.M., Boyd, K.A., Craig, N., French, D.P., McIntosh, E. and Petticrew, M., 2021. Framework for the development and evaluation of complex interventions: gap analysis, workshop and consultation-informed update. *Health technology assessment (Winchester, England)*, *25*(57), p.1.

[51] Sullivan, A.L., Nguyen, T. and Shaver, E., 2022. Foundations of Equity-Centered MTSS. Equity by Design. *Equity Assistance Center Region III, Midwest and Plains Equity Assistance Center*.

[52] Sweeder, R., Kursav, M.N. and Valles, S., 2021. A cohort scholarship program that reduces inequities in STEM retention. *Journal of STEM Education: Innovations and Research*, *22*(1).

[53] Thiem, K.C. and Dasgupta, N., 2022. From precollege to career: Barriers facing historically marginalized students and evidence-based solutions. *Social Issues and Policy Review*, *16*(1), pp.212-251.

[54] Tyagi, R., Vishwakarma, S., Rishi, M. and Rajiah, S., 2021. Reducing inequalities through education and skill development courses. In *Reduced Inequalities* (pp. 746-758). Cham: Springer International Publishing.

[55] Van Sickle, J., Schuler, K.R., Holcomb, J.P., Carver, S.D., Resnick, A., Quinn, C., Jackson, D.K., Duffy, S.F. and Sridhar, N., 2020. Closing the achievement gap for underrepresented minority students in STEM: A deep look at a comprehensive intervention. *Journal of STEM Education: Innovations and Research*, *21*(2).

[56] Vázquez, A.B., Orozco, A.M., Pérez, A.A. and Sierra, F.S., 2021. The e-portfolio in higher education: The case of a line of teaching innovation and complex change management. *Tuning journal for higher education*, *9*(1), pp.29-64.

[57] Vershitskaya, E.R., Mikhaylova, A.V., Gilmanshina, S.I., Dorozhkin, E.M. and Epaneshnikov, V.V., 2020. Present-day management of universities in Russia: Prospects and challenges of e-learning. *Education and Information Technologies*, *25*, pp.611-621.

[58] Whitcomb, K.M. and Singh, C., 2021. Underrepresented minority students receive lower grades and have higher rates of attrition across STEM disciplines: A sign of inequity?. *International Journal of Science Education*, *43*(7), pp.1054-1089.

[59] White, K.N., Vincent-Layton, K. and Villarreal, B., 2020. Equitable and inclusive practices designed to reduce equity gaps in undergraduate chemistry courses. *Journal of Chemical Education*, *98*(2), pp.330-339.