

**Equity and Diversity in Education: Science, technology, Engineering, Mathematics (STEM)
Versus Science, Technology, Engineering, Arts, Mathematics (STEAM)**

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Abstract

Equity and diversity in education are critical for achieving inclusive and sustainable development globally particularly in the context of Science, Technology, Engineering, Mathematics (STEM) and Science, Technology, Engineering, Arts, Mathematics (STEAM). While STEM is skewed towards sciences, STEAM incorporates the Arts. Both models aim to prepare students for the demands of the 21st century workforce. STEM Education emphasises innovation and economic growth, despite its efforts to enhance access and participation significant disparities persist across gender, socio economic status, and cultural background. To address these issues, there is transition from STEM to STEAM which integrates the Arts/Humanities into STEM. STEAM has gained momentum as a potential strategy for fostering inclusivity, creativity and engagement. This paper explores the issues of equity and diversity in education through the lens of STEM and STEAM, highlighting common barriers to participation, the role of cultural relevance, and implications for equitable policy and practice. It argues for a balanced approach where STEM provides technical rigor and STEAM broadens participation by incorporating diverse perspectives, this is informed by sociocultural theory which states that learning is mediated through both technical and cultural tools cognitive development is enhanced when learners engage with diverse perspectives. The study recommends that the government should formulate and develop comprehensive education equity policies that directly address barriers to participation in STEM and STEAM. Assistive technologies, accessible infrastructure should be provided for students with disabilities to ensure equitable participation in STEM and STEAM education.

Keywords: Equity, Diversity, Inclusion, STEM, STEAM

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Introduction

Education has been described as the foundation of any country's development because it equips the citizen with the requisite skills to contribute significantly to the improvement of the society. Education plays a vital role as a key factor and a driving force for economic development, (Nguyen, 2023). Education also promotes economic, prosperity and harmony. Education is a vital tool for national development thence, emphasis on (Science, Technology, Engineering and Mathematics) STEM education indicates a policy reaction driven by global reaction to economic competitiveness and technological innovation in the 21st century. The 21st century has ushered in an era where science, technology, engineering and mathematics (STEM) education is globally recognised as a

driver of innovation economic development and competitiveness (National Science Foundation NSF 2021), Although education remains a powerful tool for addressing social inequalities, access to education and participation in certain fields are often stratified by gender, socioeconomic status, race and cultural background (Banks, 2016).

STEM education drives innovation and economic growth in this era of rapid technological progress. Globally, Science, Technology, Engineering and Mathematics (STEM) education has been promoted as essential for technological advancement and workforce development (Bybee, 2013). Despite significant investments and initiatives to promote STEM education worldwide, equity and diversity issues persist (Beasley & Fischer 2019). STEM has been criticised for its narrow focus and limited inclusivity. (United Nations Educational, scientific and cultural organisation, 2021) highlights underrepresentation of women, racial minorities, students from low income backgrounds and learners with disabilities remain a major challenge across different educational system. STEAM (Science, Technology, Engineering, Arts and Mathematics) model has emerged in response, integrating arts transitioning from STEM to STEAM as a way to promote creativity, emotional intelligence, engagement and cultural relevance.

STEAM is an approach which integrates the arts into traditional STEM curricula to foster creativity, innovation and cultural responsiveness (Yakman & Lee, 2019). This paper explores the issues of equity and diversity in education using STEM and STEAM comparing both approaches and discusses strategies for balancing both approaches to ensure fair participation in education.

Equity and Diversity in Education

Equity and diversity in education, as explained by (Banks, 2020), are grounded in social justice theories that emphasise fairness, inclusion and dismantling of systemic barriers that marginalize certain groups. Equity in education refers to the principle of fairness in providing learners with opportunities, resources and support tailored to their needs enabling them to succeed regardless of gender, race, socio economic status or disability (Organisation for Economic Co-operation Development, 2019).. Critical pedagogy advocates for educational approaches that challenge power imbalances and promote transformative learning as described by Freire (1970). Ladson-Billings (1995) culturally relevant pedagogy reinforce the essentiality of incorporating learners' cultural identities into teaching practices, ensuring that education does not sustain inequities but rather addresses them directly. Diversity is recognising and valuing the differences in learners' backgrounds, experiences and identities (Banks, 2020). This framework provides the background for analysing STEM and STEAM education through an equity lens.

STEM

STEM is an acronym for Science, Technology, Engineering and Mathematics. STEM education emphasises science, technology, engineering and mathematics, this fields are perceived as critical for economic development and innovation. STEM represents an interdisciplinary approach to education that integrates four fields to promote critical thinking, problem solving, innovation and collaboration. STEM aimed to produce skilled professionals in high demand areas; it focuses on technical and scientific disciplines. Analytical thinking and logic are emphasised. Technical disciplines critical for innovation and economic growth is emphasised by STEM education. STEM education is focused on developing workforce capable of championing scientific and technological innovation.

STEAM

STEAM recognises creativity as central to innovation and problem solving, it integrates the Arts. It fosters comprehensive learning through creativity and cultural expression. STEAM adds arts to STEM, promoting creativity, critical thinking and inclusive learning. STEAM is to make learning more accessible to diverse learner through inclusion of arts and humanizing scientific inquiry. Henrisken (2014) highlighted STEAM education as recognising creativity, emotional intelligence and cultural expression as vital to problem solving and innovation.

Equity and Diversity in STEM Education

Equity in STEM education involves establishing fair access, participation and outcomes for all learners regardless of their social, cultural or economic background (Bybee, 2013). STEM education has been considered as the answer to global challenges ranging from technological innovation to sustainable innovation. However, STEM has been marked by disparities, STEM careers are perceived as male dominated, discouraging girls from pursuing them (Banks, 2016). Women account for less than 30% of the world's STEM researchers while students from rural and marginalised communities face systemic barriers (UNESCO, 2021).

Issues of Equity and Diversity in STEM Education

Even though decades of initiatives designed aimed at broadening participation, STEM education continues to encounter equity and diversity challenges globally. Equity issues in stem include limited access to quality education and opportunity gaps. Access to quality education remains unequal. Students from rural, under resourced and historically marginalised communities are often excluded due to lack of infrastructure, qualified teachers and funding (Margolis et al., 2017). Digital divide affecting the availability of computers, internet access and lab equipment necessary for meaningful participation are compounded by these disparities. Socioeconomic status is also a major factor in determining which students can participate in high quality STEM initiatives, STEM curriculum can be resources intensive. Programs that require materials for robotics, coding or arts supplies benefit students from wealthier background intensifying existing educational inequities (Milner, 2015).

The field of STEM are historically dominated by males especially in engineering and technology with lower number of females and individual with disabilities. (NSF, 2021; UNESCO, 2017) While STEM is important it often replicates existing social inequalities. Curricula tend to emphasise technical knowledge above cultural relevance thereby excluding students who do not see their selves represented. Gender stereotypes, implicit biases and lack of mentorship contributes to underrepresentation (National Science Foundation, 2020)

Emergence of STEAM

Arts were integrated into STEM to address cognitive and cultural gaps in education and it is aimed to humanise scientific inquiry and promote scientific learning. STEAM incorporated subjects such as design, music, literature and visual arts. Arts introduced creativity, design empathy and critical perspectives which broaden participation and make scientific knowledge more culturally relevant (Yakman, 2008). Inclusion of design thinking, storytelling and cultural expression into STEM

subject is likely to engage learners who may feel excluded. Self-expression, interdisciplinary thinking and cultural validation pathways provided by Arts is an appeal to diverse learners. Teachers can create learning environment that are not only academically tasking but socially just by adopting STEAM approaches. STEAM can increase motivation among girls and minority students reducing barrier to entry for those who might feel excluded (Henricksen, 2014). However, critics argue that STEAM risks diluting the technical rigour of STEM, if the Arts are not carefully implemented (Perignat & Katz- Buonincontro, 2019). To balance creativity with scientific depth meaningful implementation is needed.

STEAM Education: Prospect of Addressing Equity and Diversity

Integrating Arts into STEAM offers channels for inclusion. Interdisciplinary thinking and culturally responsive pedagogy and project-based learning are encouraged by STEAM approaches. It supports differentiated instruction and values diverse talents and intelligences, aligning more closely with inclusive education principles (Sousa & Pilecki, 2013). STEAM has gained global attention as a potential strategy to make science and technology more accessible and inclusive (Yakman & Lee 2019). STEAM encourages creativity and enhances engagement, design thinking and creativity imagination is introduced into traditional STEM learning by STEAM approaches. STEAM makes science and technology more approachable through self-expression. It allows students to connect scientific concept to real world cultural and social context (Guyotte et al., 2015). It supports interdisciplinary problem solving, interdisciplinary method makes STEM subjects more relatable, it fosters a sense of ownership and engagement among students which may not feel included in by rigid and technical instructions.

STEAM supports artistic perspectives inclusion and promotes cultural responsiveness. STEAM education encourages the inclusion of artistic and cultural perspective in STEM activities which can resonate with students from diverse cultural backgrounds (Yakman & Lee 2019). STEAM broadens learning styles, participation and reduces barrier. Artistic, visuals and kinaesthetic learners who are usually not inclusive in STEM settings are accommodated. STEAM education creates multiple entry points for learners, potentially reducing gender and socio economic disparities.(Perignat & Kattz- buonincontro, 2019). STEAM is shifting the focus from purely technical expertise to interdisciplinary problem solving.

Challenges of STEAM Education

One of the major challenges of STEAM education is its implementation, especially regarding curriculum design, teacher training and assessment which remains significant barriers to effective practice (Perignat & Katz-Buonincontro, 2019) STEAM education faces several challenges that hinder its effectiveness as a solution to equity issues. Unavailability of a standardised framework is one of the challenges that limit STEAM. There is no universally accepted model for integrating Arts into STEM leading to inconsistent implementation across schools and regions (Herro & Quiley 2017). Lack of training and teacher preparedness also hinders the STEAM as a solution to equity issues. Many STEM teachers lack the training to effectively incorporate arts into their teaching, resulting in superficial integration that does not achieve equity goals (Henrisken, 2014). Lack of policy support and resources constraints are another factor limiting STEAM, implementation of STEAM requires funding. STEAM programs require additional resources, materials and policy support which are often not available in under resourced school (Martin, 2020). Limited empirical review is another challenge hampering the implementation of STEAM. Perignant & Katz- Buonincontro, (2019) explained that anecdotal evidence suggests STEAM

benefits diversity, rigorous, large scale studies comparing STEM and STEAM outcomes are scarce.

STEM versus STEAM: Finding the Balance

The difference between STEM and STEAM should be seen as complimentary rather than competitive. A balanced approach can ensure educational equity. Access to resources can help to balance STEM and STEAM, schools should ensure that learning materials, technology and qualified teachers are distributed fairly. There should be inclusive curriculum, learning should be made more meaningful and accessible, content should reflect diverse cultures, perspective and discipline. Multicultural and interdisciplinary approaches that validate all learners experience should be integrated. Technical foundation necessary for economic competitiveness is provided by STEM while STEAM reinforces equity, engagement and creativity. Policies that integrate both perspectives can address inequities while ensuring academic rigor. Designing curriculum that reflect both the technical and humanistic dimensions of learning.

Teaching strategies should be adapted to different learning styles backgrounds and abilities so that no group is disadvantaged. By promoting interdisciplinary teaching school can achieve this balance and also training educators in culturally responsive pedagogy and investing equitable access to resources. Scholarships, Mentorships and tutoring should be provided for underrepresented students in STEM and STEAM fields. Educators should be trained in culturally responsive pedagogy and equity- focused practices.

Conclusion

Equity and diversity remain constant challenges in education especially within STEM disciplines where systemic barriers limit participation by women, minorities and students from disadvantaged communities. Rise of STEAM provides favourable framework for addressing inequities by fostering creativity, inclusivity and cultural relevance. The success of STEAM depends on meaningful incorporation that compliments the meticulousness of STEM education rather than weakens it. Educators, policymakers and researchers must collaborate to design, curriculum, mentorship programs and learning environments that expand access, validate diverse perspectives and prepare all students to thrive in a rapidly evolving global society.

Recommendations

- i. Government should formulate and develop comprehensive equity policies, education policies that directly address barriers to participation in STEM and STEAM including gender biases, resources inequities and exclusion of minority groups should be created and enforced.
- ii. Global and regional collaboration, developing nations should be supported by international organisations through funding, infrastructures development and policy frameworks aimed at reducing global disparities in STEM and STEAM education
- iii. Accessible learning environments, institutions must provide assistive technologies, adaptive teaching materials and accessible infrastructure for students with disabilities to ensure equitable participation in STEM and STEAM education.

- iv. Parental and community involvement, community outreach initiatives can help dismantle stereotypes and encourage families to support girls, minorities and disadvantaged students in pursuing STEM and STEAM pathways.
- v. Empirical impact studies, more longitudinal research is needed to assess the actual impact of STEAM on participation rates among underrepresented groups, especially in low resource educational settings. This leverage on ecological systems theory which emphasizes time (chronosystem), accounts for resources disparities, justifies longitudinal research designs. Longitudinal research designs are essential to assess the sustained impact of STEAM initiatives on participation among learners who are underrepresented especially in low resource educational settings where structural conditions may delay or diminish observable outcomes.

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