

## STEM Education Reform in Ghana: Equipping Youth for Industrial Workforce Demands

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**ABSTRACT:** Ghana's transition to an industrialized economy requires urgent reforms in secondary STEM education to address critical workforce shortages. This paper examines how strategic integration of science, technology, engineering, and mathematics (STEM) into Ghana's secondary curriculum can cultivate skills for emerging technology sectors while supporting inclusive development. Drawing on global, continental, regional, and national perspectives, the review identifies best practices, gaps, and opportunities. The findings highlight systemic barriers including weak teacher capacity, limited infrastructure, gender disparities, and inadequate industry linkages. Comparative insights from China, South Korea, Kenya, Nigeria, and South Africa demonstrate the importance of holistic policies, robust teacher development, and strong industry-education linkages (Freeman, Marginson, & Tytler, 2019; Yusuf & Afolabi, 2021; Zhou & Zhang, 2020). The paper concludes with recommendations for Ghana to strengthen teacher training, invest in infrastructure, promote gender equity, and enhance policy implementation, ultimately ensuring that STEM education becomes a driver of industrial workforce readiness (Adeyemo, 2021; Ampofo & Osei, 2020).

**KEYWORDS:** STEM education, Ghana, workforce development, industrialization, policy reform

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### 1.0 INTRODUCTION

Education is central to sustainable development and industrial growth. In the 21st century, science, technology, engineering, and mathematics (STEM) education has become a global priority, recognized as the foundation for innovation, technological advancement, and workforce competitiveness (Schwab, 2016; Beers, 2018). For developing economies such as Ghana, STEM education is not only about academic knowledge but also about building the human capital needed to drive industrial transformation (Owusu & Addo, 2019; Yidana & Ameyaw, 2022).

Despite progress in expanding access to education through policies such as the Free Senior High School (SHS) program, Ghana faces persistent challenges in aligning secondary education outcomes with workforce demands. Employers consistently report that graduates lack problem-solving, digital, and technical skills required in the modern economy (Boateng & Ofori, 2021; Nyarko & Anane, 2022). At the same time, gender disparities, rural-urban inequities, and inadequate infrastructure limit the inclusiveness and effectiveness of STEM reforms (Osei & Mensah, 2022; UNESCO, 2017). This paper examines STEM education reform in Ghana with a focus on workforce development. By situating Ghana's experiences within global, continental, regional, and national contexts, the study identifies strategies that can strengthen STEM education to equip young people for industrial workforce demands (Adeyemo, 2021; UNESCO, 2021).

### 2.0 LITERATURE REVIEW

#### 2.1 Thematic Perspectives on STEM Education Reform

Globally, STEM education has become a cornerstone of national competitiveness. Countries like the United States, China, and South Korea have adopted systemic reforms that link STEM education to economic growth (National Science Foundation, 2019; Zhou & Zhang, 2020)

In the United States, the STEM 2026 Vision emphasizes problem-based learning, interdisciplinary integration, and partnerships between schools, universities, and industry (National Science Foundation, 2019). Similarly, China has heavily invested in STEM teacher development, ICT integration, and hands-on learning, positioning itself as a global technology leader (Zhou & Zhang, 2020). South Korea has integrated digital technology across all subjects while ensuring rigorous teacher training, leading to a highly innovative, technology-driven workforce (Lee & Kim, 2019).

A key lesson from global practice is that reforms succeed when they are systemic, targeting teachers, curriculum, infrastructure, and industry linkages simultaneously (Freeman, Marginson, & Tytler, 2019; Schwab, 2016). Conversely, reforms that focus only on

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access or curriculum revision without teacher support often fail to yield desired workforce outcomes (OECD, 2019; World Bank, 2021).

### 2.2 Challenges in STEM Education

Across Africa, STEM education has been prioritized under the African Union's Agenda 2063 and the Continental Education Strategy for Africa 2016–2025 (CESA 16–25) (African Union, 2015, 2016). These frameworks emphasize skills for science, innovation, and technology as drivers of industrialization and sustainable development (Adeyemo, 2021).

However, African countries face systemic barriers. According to Oketch (2016), secondary education in Sub-Saharan Africa is underfunded, examination-driven, and weakly aligned with labor market needs. Okebukola (2020) adds that Nigeria's STEM system struggles with outdated curricula, lack of teacher training, and insufficient industry engagement. Similarly, South Africa, despite progressive policies, faces persistent inequalities between rural and urban schools (Reddy, Gastrow, Juan, & Roberts, 2016).

Nevertheless, innovative practices are emerging. Kenya's Competency-Based Curriculum (CBC) emphasizes problem-solving, applied learning, and entrepreneurship (Republic of Kenya, 2017). Nigeria's Science, Technology and Innovation Roadmap (2017–2030) outlines strategies for repositioning STEM to support industrialization (Federal Ministry of Science and Technology, 2017). These experiences demonstrate that African countries are rethinking STEM, though systemic challenges remain (Yusuf & Afolabi, 2021).

### 2.3 Policy Innovations and Best Practices

In West Africa, STEM reforms reflect both national aspirations and regional collaboration through the Economic Community of West African States (ECOWAS). Ghana, Nigeria, and Sierra Leone have launched policies to expand access and improve quality in secondary STEM education (World Bank, 2020; Zuilkowski & Betancourt, 2020). Nigeria's reforms emphasize digital literacy, entrepreneurship, and practical skills (Okebukola, 2020). Sierra Leone has focused on expanding access for marginalized groups and strengthening teacher capacity (World Bank, 2021). Ghana has introduced specialized STEM schools and policies to promote ICT in education (Ghana Ministry of Education, 2020; Owusu & Addo, 2019).

Despite these reforms, the region continues to face low enrollment in STEM, poor infrastructure, and gender disparities. According to UNESCO (2017), women represent less than 30% of STEM graduates in West Africa. Tuwor and Sossou (2008) attribute this to cultural norms, early marriage, and lack of role models. Addressing these inequities is essential for inclusive workforce development (Osei & Mensah, 2022; Boateng & Ofori, 2021).

### 2.4 African and Ghanaian Perspective

Ghana has acknowledged the central role of science, technology, engineering, and mathematics (STEM) education in driving industrial transformation. To address this priority, the government has introduced several initiatives. The Free Senior High School (SHS) Program, launched in 2017, was designed to expand access to secondary education (Ghana Ministry of Education, 2020). From 2020, specialized STEM Senior High Schools were established to strengthen STEM-focused instruction at the pre-tertiary level (Owusu & Addo, 2019). In addition, the ICT in Education Policy introduced in 2015 aimed to integrate technology into teaching and learning processes (Ghana Ministry of Education, 2020). Curriculum reforms have also been implemented to emphasize critical thinking and problem-solving skills as essential components of modern education (Anamuah-Mensah, 2020).

Despite these measures, significant challenges persist. Teacher shortages and quality gaps remain widespread, as many STEM teachers have not received advanced training or exposure to contemporary pedagogical approaches (Owusu-Mensah & Amedeker, 2018; Asare & Nti, 2021). Infrastructure deficits also hinder effective STEM delivery, with more than 60% of schools lacking adequately equipped laboratories (UNESCO, 2020; Dzidzonu & Sackey, 2022). Furthermore, equity concerns persist, as girls, rural learners, and students from disadvantaged backgrounds remain underrepresented in STEM fields (Bame, Adjei, & Osei, 2021; Osei & Mensah, 2022). Weak linkages between industry and education compound these issues, as employers frequently report skills mismatches and graduates who lack practical competencies (Nyarko & Anane, 2022; Boateng & Ofori, 2021). Collectively, these systemic gaps continue to undermine Ghana's efforts to align education with workforce needs and achieve sustainable industrial transformation (Adeyemo, 2021; Yidana & Ameyaw, 2022).

## 3.0 DISCUSSION

### 3.1 Comparative Insights: Ghana and Global Experiences

Global literature demonstrates that successful STEM education reforms rely on a holistic and systemic approach. Countries such as China, South Korea, and the United States have achieved significant progress not by isolated curriculum changes but through integrated strategies connecting policy, teacher training, industry partnerships, and equity-focused interventions (Zhou & Zhang, 2020; Lee & Kim, 2019; Freeman, Marginson, & Tytler, 2019).

Compared with China's state-led systemic model, Ghana's reforms appear fragmented. China's large-scale investments in teacher development, coupled with strong university-industry collaboration, ensure graduates are prepared for real-world challenges (Zhou

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& Zhang, 2020). Ghana, by contrast, invests in infrastructure and access but underfunds professional development, leaving many STEM teachers underqualified (Owusu-Mensah & Amedeker, 2018; Asare & Nti, 2021).

South Korea's experience underscores the importance of teacher quality and digital integration. By embedding ICT into all subjects and providing rigorous training for educators, South Korea created a technologically literate society that supports industrial competitiveness (Lee & Kim, 2019; National Science Foundation, 2019). Ghana's ICT in Education policy is comparable in vision, but its uneven implementation—particularly in rural schools—limits impact (Ghana Ministry of Education, 2020; Dzidzonu & Sackey, 2022).

Kenya's Competency-Based Curriculum (CBC) emphasizes applied learning, entrepreneurship, and problem-solving, moving beyond rote memorization (Republic of Kenya, 2017; Yusuf & Afolabi, 2021). Ghana, though reform-oriented, still relies heavily on exam-driven learning, which discourages creativity and inquiry-based approaches (Boateng & Ofori, 2021; Ampofo & Osei, 2020).

### **3.2 Systemic Barriers in Ghana's STEM Education**

Several systemic barriers continue to constrain the growth and effectiveness of STEM education in Ghana. A critical challenge is teacher capacity, as many educators, particularly those in rural schools, lack advanced pedagogical training and exposure to modern teaching practices (Owusu-Mensah & Amedeker, 2018; Asare & Nti, 2021). Infrastructure and resource limitations further compound the problem, with fewer than 40% of Ghanaian schools reported to have functional science laboratories (UNESCO, 2020; Dzidzonu & Sackey, 2022).

Equity and gender disparities also persist, as cultural and institutional barriers continue to discourage girls' participation in STEM-related fields (Bame, Adjei, & Osei, 2021; Osei & Mensah, 2022). Additionally, weak linkages between industry and education have resulted in persistent skills mismatches, with employers frequently noting that graduates lack the practical competencies required in the labor market (Nyarko & Anane, 2022; Boateng & Ofori, 2021). Although Ghana has developed strong policy frameworks to promote STEM, gaps in implementation—largely due to funding constraints and insufficient monitoring—have limited the impact of these policies (Yidana & Ameyaw, 2022; Mfum-Mensah, 2019).

### **3.3 Implications for Industrial Workforce Development**

The mismatch between STEM education and workforce demands has profound implications for Ghana's industrialization agenda. Without strong reforms, the country risks producing graduates ill-prepared for emerging industries such as renewable energy, ICT, biotechnology, and advanced manufacturing (Schwab, 2016; Beers, 2018). This gap perpetuates youth unemployment, currently estimated at 12.6% nationally, and higher among tertiary graduates (World Bank, 2020; Ghana Statistical Service, 2021). Conversely, effective STEM reforms could accelerate Ghana's transformation into a regional technology hub. The country's youthful population—over 57% under the age of 25—represents a demographic dividend that could fuel industrial growth if harnessed through skill-focused education (GSS, 2021; Adeyemo, 2021).

## **4.0 LIMITATIONS OF STUDY**

This study is limited by its reliance on document analysis and secondary data, which restricts the depth of empirical insights from classroom or industry contexts. Additionally, the focus on Ghana and selected comparator countries constrains the generalizability of the findings. Future studies should employ longitudinal, mixed-methods research with larger participant samples across diverse contexts to capture the long-term impact of STEM reforms on workforce readiness.

## **5.0 CONCLUSION**

The review has examined the global, African, regional, and national dimensions of STEM education reform, focusing on Ghana as a case study. The evidence indicates that while Ghana's initiatives—such as the Free Senior High School program and the establishment of specialized STEM schools—represent commendable steps forward, they are not yet fully aligned with the broader systemic drivers needed to improve educational quality and workforce relevance (Owusu & Addo, 2019; Ampofo & Osei, 2020). The central challenge for Ghana is not the absence of vision but a persistent gap in execution. Teacher shortages, inadequate infrastructure, and weak linkages between education and industry continue to impede meaningful progress (Owusu-Mensah & Amedeker, 2018; Nyarko & Anane, 2022). If left unaddressed, these barriers will significantly restrict Ghana's ability to develop a competitive industrial workforce (Yidana & Ameyaw, 2022).

Despite these concerns, Ghana stands at a crucial turning point. With targeted investments, improved governance, and sustained partnerships, the country has the potential to transform STEM education into a powerful driver of industrialization, job creation, and sustainable development (Adeyemo, 2021; UNESCO, 2021). Moving forward, Ghana must strengthen teacher professional development, expand investment in infrastructure and ICT, advance gender equity in STEM participation, and build stronger industry-education linkages. Robust policy implementation and accountability mechanisms are also essential to ensure that reforms

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translate into tangible improvements for students and employers. Taken together, these actions would position STEM education as a cornerstone of workforce readiness and national industrial transformation.

To achieve these outcomes, several strategic recommendations are proposed. Teacher professional development should be prioritized through the establishment of national STEM teacher training institutes (Darling-Hammond & Bransford, 2019), mandatory continuous professional development linked to performance (Asare & Nti, 2021), and incentives such as scholarships and housing for teachers serving underserved regions (Owusu-Mensah & Amedeker, 2018). Investment in infrastructure and ICT must be expanded, with particular attention to equipping rural schools with laboratories, internet access, and digital tools (Dzidzonu & Sackey, 2022; UNESCO, 2020). Public-private partnerships could provide cost-effective ICT solutions (Boadu & Essel, 2019), while equitable distribution of resources across districts should be ensured (Ghana Ministry of Education, 2020).

Gender equity in STEM should be advanced by implementing mentorship programs linking female students with STEM professionals (Osei & Mensah, 2022; Bame, Adjei, & Osei, 2021), offering scholarships and career guidance tailored to girls (UNESCO, 2017), and addressing stereotypes through public campaigns and inclusive teaching methods (Boateng & Ofori, 2021). Industry-education linkages require enhancement through advisory boards involving industry leaders in curriculum design (Nyarko & Anane, 2022), expanded internship and apprenticeship opportunities (Owusu & Addo, 2019), and the development of university-based innovation hubs and incubators (Schwab, 2016; Freeman, Marginson, & Tytler, 2019).

Finally, policy implementation and accountability must be improved. This includes strengthening monitoring and evaluation systems to track progress (Mfum-Mensah, 2019; Yidana & Ameyaw, 2022), decentralizing decision-making to empower schools and local authorities (Adeyemo, 2021), and increasing budgetary allocation for STEM education to at least 20% of overall education expenditure (World Bank, 2020). Together, these measures would help bridge the execution gap and ensure that STEM education reforms contribute effectively to Ghana's industrial and socio-economic transformation.

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### CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this review.

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