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The Role of Policy-Influenced Instructional Leadership and School Culture in Enhancing Stem Learner Achievement in Kenya

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ABSTRACT: STEM (science, technology, engineering, and mathematics) integration is increasingly acknowledged as critical to societal resilience, economic competitiveness, and sustainable development. Nonetheless, learner success discrepancies continue to exist, underscoring the necessity of pedagogical and cultural change in the secondary school system. In order to produce evidence-based insights on leadership techniques that encourage inquiry, perseverance, and innovation in Kenya, the current study looked at the relationship between school leadership, culture, and STEM accomplishment. Using a conceptual research approach, the study combined theory and practice with an emphasis on better STEM learning outcomes by critically examining legislation, policy papers, international frameworks, and academic literature. Seligman's (2011) PERMA model of well-being, which shows how flourishing occurs when these interconnected dimensions are fostered under Vygotsky's social constructivist prism, served as the basis for the investigation. The study comes to the conclusion that a comprehensive and integrated strategy is needed for sustainable STEM education reform, whereby leadership potential, policy alignment, and a positive school culture function as a coherent ecosystem. On the other hand, schools become dynamic settings that foster creativity, critical thinking, and lifetime involvement with STEM when these components are successfully linked. In order to position mathematics and science as engines of innovation and sustainable development, the study concludes that expanding STEM education necessitates the dual strategy of developing leadership capacity and fostering cultural conditions that allow learners to thrive.

KEYWORDS: STEM education, Instructional Leadership, School Culture, Learner Achievement, Sustainable Development

INTRODUCTION

In today's world, STEM (science, technology, engineering, and mathematics) education plays a crucial and strategic role. According to Osafehinti (2015), STEM fosters technical innovation, supports evidence-based policymaking, and empowers society to address challenging environmental and socioeconomic issues. It is generally accepted that this comprehensive integration of STEM fields is essential to societal resilience, economic competitiveness, and sustainable development. Furthermore, Oyier et al (2017) proposed that science and mathematics are the intellectual engines of technological advancement and that the full potential of STEM fields is realized when they are combined with engineering and technology to spur industrial transformation and national growth. Effective STEM education, however, requires innovative instructional leadership in addition to curriculum coverage. In line with these ideas, Maftuh et al. (2023) stated that STEM education calls for creative pedagogical approaches that help students acquire higher-order skills including critical thinking, creativity, teamwork, and problem-solving techniques.

Lesseig et al. (2019) emphasize that STEM education requires both a strong school vision and a culture that encourages innovation and risk-taking. In actuality, a culture that welcomes diversity via experimentation encourages self-assurance and curiosity in both educators and students. According to Ackah-Jnr and Danso (2019), such a culture offers a socio-motivational setting that significantly influences STEM learning trajectories. In actuality, the self-efficacy, outcome-expectancy beliefs, and career awareness of secondary school students would have a significant impact on their acquisition of knowledge. According to Watson et al. (2022), learning, the development of 21st-century abilities, and STEM job goals are all positively impacted by a culture that increases self-efficacy. According to LaForce et al. (2016), these elements are especially promoted by immersive, integrated STEM experiences that merge engineering design, biomimicry, scientific inquiry, and emerging technology. In addition to expanding students' knowledge of STEM routes, fostering such environments boosts each person's confidence in pursuing them in higher education and the workforce. Additionally, Tus (2020) emphasized how crucial a supportive school culture is in influencing students' involvement and perseverance in STEM education. Similarly, it has been demonstrated that integrated STEM education that incorporates elements of empathy-building and community engagement significantly boosts students' persistence. According to this study, a policy climate that fosters empathy and a feeling of citizenship is crucial for long-term STEM engagement and the development of socially conscious problem solvers.

Perspectives on STEM Achievement and Development

As catalysts for innovation, problem-solving, and socioeconomic improvement, science and mathematics-related fields play a crucial role in global development (UNESCO, 2024). The impact of STEM on economic development should ideally depend on both curriculum design and the creation of a supportive school culture that encourages diversity, trust, and high standards among students. According to a study done in Malaysia, Krishnan et al. (2023) said that STEM graduates' capacity offers a revolutionary foundation for creative ideas and innovation needed to improve the economic circumstances of developing nations. Odundo and Oyier (2017) emphasized the necessity of establishing learning communities where educators work together to improve practice and boost STEM learner outcomes in order to transform Kenya. STEM requires sophisticated educational techniques integrated into inquiry-driven approaches to have an impact on economic growth and national development. Furthermore, according Tus (2020), strategies like dispersed and transformational instructional leadership strengthen collective efficacy and empower educators and students to take on innovative and enduring roles in the advancement of the country. Simultaneously, Stoehr et al. (2023) claimed that school culture has a significant impact on students' motivation, resilience, sense of belonging, and participation in national goals.

According to Selimi, Berisha and Vula (2025), STEM education gives students the tools they need to accelerate technical advancement and make significant contributions to national development by fostering inquiry-driven thinking, logical reasoning, problem-solving skills, higher-order cognition, and teamwork. In support of this stance, Adams et al. (2023) contended that by proactively addressing equity inequalities in STEM engagement at the instructional level, inclusive school leadership will boost confidence. Learning in a welcoming and supportive STEM environment forces students to comprehend challenges, identify obstacles, and grasp procedures that result in creative solutions that go beyond academic success. Similar to Stoehr et al. (2023) and Adams et al. (2023), this study took into account a positive school culture as a prerequisite for providing sufficient and pertinent facilities and equipment for successful learning in STEM education. According to Adams et al (2023), school administrators must be involved in the achievement of global frameworks like the Sustainable Development Goals (SDGs) in order to link facilities, create a learning atmosphere that is pleasant to students, and develop a positive attitude toward STEM education. Quality learning settings are just as important as access, and STEM and mathematics should be positioned as strategic drivers of long-term national growth rather than just academic fields. Accordingly, a school culture that incorporates creativity, teamwork, and belonging serves as the basis for giving students the problem-solving abilities needed for the advancement of the country. STEM education needs a positive school culture in order to prosper in a quickly changing knowledge economy and make a significant contribution to global technical and social advancement.

Statement of the Problem

STEM education is being emphasized in international and regional frameworks as being crucial for country development and innovation. Kenya has responded by incorporating many of these pledges into its legal and policy frameworks. It is unclear, therefore, to what degree these strategies successfully create supportive school climates that raise STEM achievement. Many secondary schools continue to function in settings with inadequate instructional leadership, scarce resources, and dispersed implementation of STEM reforms, despite governmental emphasis on inquiry-driven learning, collaboration, and equitable participation. Because of this, learner agency, inclusion, problem-solving, and design-based learning—aspirational ideals ingrained in the global and regional STEM agenda—are not regularly mirrored in classroom practice. Learner motivation, resilience, and engagement in STEM paths are all compromised by the mismatch between policy aim and school-level culture. As a result, STEM achievement is still below potential, which limits its ability to contribute to the advancement of the country. Thus, this study investigates how the development of a positive school culture and increased STEM achievement are impacted by the domestication of international and regional instruments into national policy.

Purpose of the Study

The goal of this research is to investigate how Kenya's national legal and policy frameworks' domestication of international and regional instruments affects the development of supportive school cultures that raise student accomplishment in STEM education. The study specifically aims to examine how national policies reflect international commitments to STEM education, how these policies influence instructional leadership practices, and how these practices in turn promote school cultures that support learning based on collaboration, equity, and innovation. The project intends to offer empirical insights into how national and international policy alignment might improve STEM learning environments and lead to better learning outcomes in secondary schools by examining the relationship between policy, leadership, and culture.

METHODOLOGICAL APPROACH

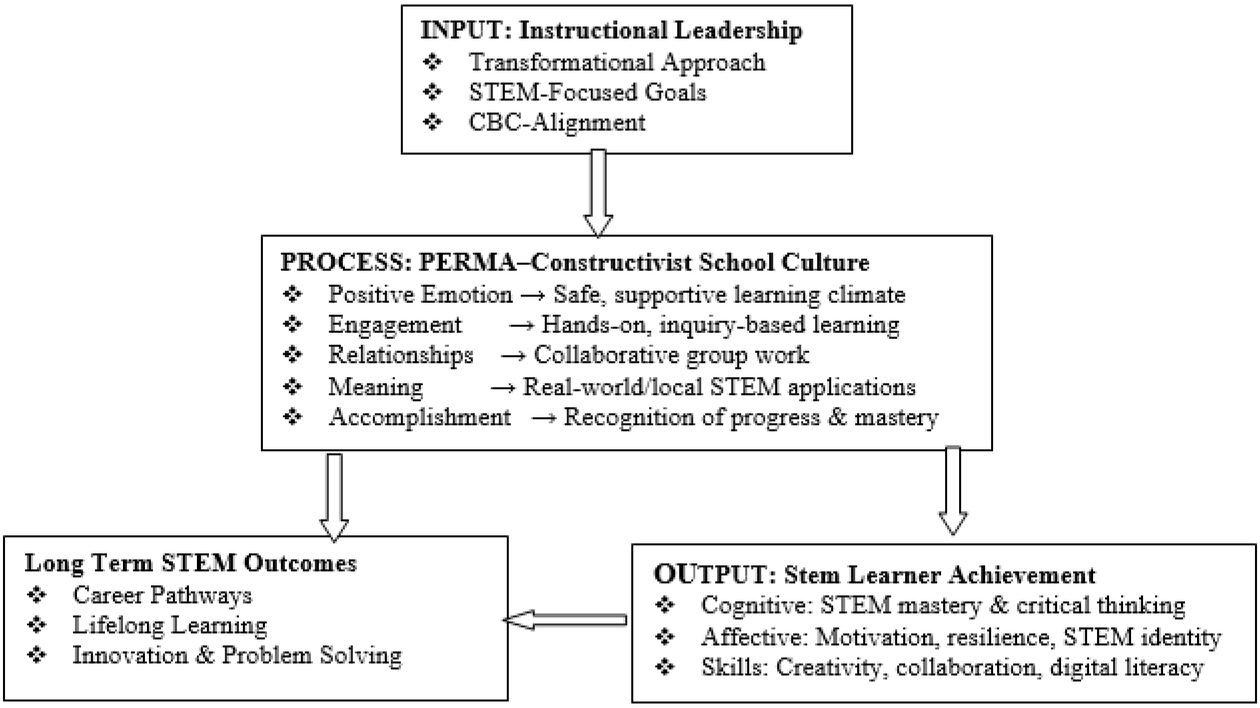
A critical analysis of the literature and policy frameworks served as the foundation for this study's conceptual research design. The goal was to synthesize information on the relationship between school culture, instructional leadership, and learner accomplishment in STEM education in order to integrate theory and practice (Kilonzo and Ojebode, 2023). Statutes, government policy papers, international treaties, and publications that promote STEM education as a cornerstone of sustainable development were cited in the review. The desk review method, as recommended by Newman and Gough (2020), was used to find, evaluate, and interpret current research and policy materials that are pertinent to school culture and leadership in STEM education. Peer-reviewed journal articles, national curriculum revisions, Ministry of Education studies, UNESCO and OECD publications, and other institutional and regulatory frameworks were among the sources. A purposive approach was used in the document selection process, with an emphasis on materials that addressed the following topics: the influence of school culture on STEM learning achievement; the role of leadership in shaping school culture; and policy changes governing science and math education in Kenya and similar contexts. For this work, a conceptual and policy-oriented review was deemed suitable for two reasons. First, there may not be enough empirical research on the connection between school culture, leadership, and STEM outcomes in Kenya because the majority of studies that are currently accessible concentrate on general academic accomplishment rather than STEM-specific learning. Second, since educational changes like the global STEM agenda and Kenya's competency-based curriculum are policy-driven, it is crucial to look at institutional and statutory frameworks as a basis for directing future empirical research. In order to integrate current theoretical, empirical, and policy-based insights to guide research and practice, a conceptual review provides an essential initial step.

THEORETICAL FRAMEWORK

Seligman's (2011) paradigm of well-being, often known as the PERMA model (Positive Emotion, Engagement, Relationships, Meaning, and Accomplishment), served as the foundation for this investigation. The approach highlights that cultivating these five interconnected dimensions leads to flourishing. PERMA has been used in education to show how learning, motivation, and persistence are improved by good psychological situations (Jones et al., 2014). While each domain makes a distinct contribution to the experiences of learners, their interdependence creates harmony in educational settings that promote achievement, curiosity, and resiliency. Positive feelings like curiosity and self-assurance bolster persistence in the face of mentally taxing tasks in STEM contexts, while engagement encourages ongoing investigation and problem-solving. Collaboration is encouraged by supportive relationships, meaning links STEM knowledge to larger social goals, and achievement strengthens motivation by acknowledging advancements. Leadership strategies that consciously cultivate these areas foster inclusive and goal-oriented school environments, which improve science and math performance (Selimi et al, 2025)

PERMA is not discipline-specific and places greater emphasis on affective domains than cognitive processes, although offering a strong framework for tying school culture, wellbeing, and learning together. The study also makes use of Vygotsky's social constructivist viewpoint, which emphasizes the importance of social interaction, scaffolding, and cultural instruments in learning, in order to overcome this constraint. By emphasizing cognitive and instructional aspects, social constructivism presents knowledge formation as a socially mediated process. When paired with PERMA, the paradigm captures the dual significance of affective and cognitive development by striking a balance between rigorous intellectual engagement and attention to emotional well-being. In STEM education, where students must maintain motivation and participate in solving challenging challenges, this integration is especially pertinent. The study presents PERMA and social constructivism as complementing viewpoints by acknowledging that good leadership and school culture must promote well-being and enable organized knowledge-building. When combined, they offer a thorough foundation for examining how cultural norms and leadership styles influence STEM learning outcomes.

Conceptual Framework: STEM-PERMA Synergy Model



According to the STEM-PERMA Synergy Model, a strong school culture acts as a mediator between instructional leadership and learner achievement in STEM. Through vision alignment, strategic resource allocation, and ongoing teacher professional development that prioritizes inquiry-based and collaborative pedagogies, instructional leadership operationalizes national and international STEM policies. This leadership effect is spread through a school culture that combines Vygotsky's social constructivism with Seligman's PERMA framework. Positive feelings promote psychological safety in this mediating space, scaffolded learning experiences increase engagement, relationships foster collaborative knowledge construction, contextualized, real-world STEM applications provide meaning, and accomplishment increases mastery and learner agency. Students can actively construct knowledge through social engagement in a setting that fosters emotional well-being. As a result, this synergy enhances overall student accomplishment in STEM education by producing better cognitive outcomes, greater STEM identity and resilience, and the development of crucial 21st-century skills.

FINDINGS

An organized, multi-level thematic framework that illustrates how policy, leadership, school culture, and student results interact within the STEM–PERMA Synergy Model is used to explain the study's findings. The study investigates how broad policy instructions are converted into classroom practice and learner experience using a top-down to bottom-up analytical lens. STEM is mandated as a catalyst for innovation and sustainable development at the macro level by global, continental, and regional frameworks promoted by UNESCO, AU Agenda 2063, and EUC Vision 2050. These themes are operationalized at the meso level in Kenya through instructional leadership, especially through the Centre for Mathematics, Science and Technology Education in Africa (CEMASTEA) and CBC, where pedagogical assistance, capacity building, and vision-setting are prioritized. A PERMA-Constructivist lens shows how school surroundings impact student involvement at the micro level through connections, pleasant emotions, and inquiry-based learning. In the end, the results emphasize outcomes that go beyond grades, such as STEM identity, resilience, and career goals, highlighting the fact that lasting success results from a comprehensive alignment of learning environments, leadership, and policy.

Thematic Pillar 1: Macro-Level Drivers (The Policy Input)

A fundamental mandate for STEM education as a catalyst for innovation, sustainable development, and global competitiveness is provided by global policy frameworks. The significance of inclusive, equitable, and high-quality education systems is emphasized by agendas including the United Nations 2030 Agenda, Rio+20, and the Education 2030 Incheon Declaration—promoted by the UN and UNESCO (United Nations, 2012, 2015; UNESCO, 2015). These frameworks put STEM at the forefront of international responses to economic transition, technological advancement, and climate change. Empirical data also highlights the important mediating roles that supportive school cultures and instructional leadership play in accomplishing these objectives. STEM results greatly improve when school administrators foster learner engagement, support teacher professional development, and encourage teamwork (van Horne et al., 2022; Penuel & Reiser, 2022). Furthermore, research from throughout the world demonstrates that positive school cultures with learner agency, autonomy-supportive instruction, and peer learning improve students' motivation, creativity, and problem-solving abilities in science and math (Jones et al., 2014; Lee & Anderson, 2020).

Pedagogical strategies including integrated STEM curricula, project-based learning (PBL), and inquiry-based instruction demonstrate the actual implementation of these global agendas. These methods are widely acknowledged as successful tactics for promoting active student involvement and interdisciplinary comprehension (Lou et al., 2021; Maftuh et al., 2023). They greatly improve students' self-efficacy, engagement, and capacity to integrate information across disciplines when they are used in a supportive school environment (Li et al., 2021). In order to convert policy goals into meaningful classroom experiences, teachers' collaborative practices and facilitation skills are essential (Shernoff et al., 2020). Additionally, research from around the world shows that STEM environments that incorporate autonomy, collaboration, and reflective practices promote students to pursue STEM careers while addressing ongoing disparities in equity and gender (Areepattamannil et al., 2023; Kelley & Knowles, 2022). Additionally, these settings link what is learned in the classroom to practical issues, highlighting the need of STEM education.

STEM education is in line with Africa's goals for industrialization, technological advancement, and socioeconomic transformation at the continental level thanks to frameworks like Agenda 2063 and the Continental Education Strategy for Africa (CESA 2016–2025), which are led by the AU and backed by the Association for the Development of Education in Africa (ADEA) (African Union, 2015; ADEA, 2016). These frameworks support competency-based, participatory education systems and recognize science and math as essential developmental levers. Teachers and students can co-construct knowledge and acquire important STEM competencies through initiatives like ICQN-MSE and professional development platforms that foster collaboration, peer learning, and knowledge exchange (ADEA, 2024; CEMASTEA, 2025). Positive school cultures, which are characterized by inclusivity, emotional balance, and cooperative teacher communities, have been shown to enhance learning engagement, motivation, and resilience (Sahin, Top, & Capraro, 2021; Odundo & Oyier, 2017).

The significance of coordinating policy with school-level practice is further reinforced by regional and continental implementation. To promote regional integration, skill mobility, and economic growth, the EAC places a high priority on harmonizing scientific and math curricula (EAC, n.d.; EAC, 2022). Teacher exchanges, curricular alignment, and cross-border STEM collaboration are made easier by Kenya's leadership in programs like ICQN-MSE (ADEA, 2024; CEMASTEA, 2025). Harmonized curricula incorporate experiential learning and problem-solving through practical methods such as STEM model schools, mentorship programs, and ICT-supported instruction (IUCEA, 2021, 2024; World Bank, 2023). These programs foster inclusive, cooperative, and inquiry-based school environments that raise student success and engagement (Watson, Peters-Burton, & Pruitt, 2022; Wieselmann et al., 2021). Education systems foster STEM competencies necessary for innovation, equity, and socioeconomic transformation by integrating global, continental, and regional priorities to create coherent pathways through which policy translates into practice (Bybee, 2020; Beauchamp et al., 2021; UNESCO, 2024; Henriksen et al., 2021).

Thematic Pillar 2: Meso-Level Integration (Instructional Leadership as the Bridge)

Kenya's STEM education system reflects a process of contextual adaptation and domestication, showing a conscious connection between national implementation tactics and global policy imperatives. The UN 2030 Agenda and the Education 2030 Incheon Declaration, two frameworks promoted by the UN and UNESCO, place a strong emphasis on inclusive and equitable high-quality education (United Nations, 2015; UNESCO, 2015). Through national programs like the creation of CEMASTEA and the Strengthening of Mathematics and Science Education (SMASE), these global priorities are put into action. These programs highlight pedagogical innovation, digital integration, and teacher professional development as key pillars of STEM advancement (Odundo & Oyier, 2017; CEMASTEA, 2025; Watson et al., 2022). By encouraging collaborative school cultures, supporting learner-centered pedagogies, and coordinating institutional objectives with national STEM priorities, instructional leadership plays a crucial role in this process. As a result, while participating in encouraging and resilient learning contexts, students acquire critical thinking, creativity, and problem-solving abilities (Kelley & Knowles, 2022; Nicole et al., 2023).

The importance of STEM in socioeconomic transformation is further reinforced at the continental level by Kenya's domestication of frameworks like Agenda 2063 and the Continental Education Strategy for Africa (CESA 2016–2025), which are supported by AU and ADEA (African Union, 2015; ADEA, 2016). Strategic initiatives like CEMASTEA's Strategic Plan (2023–2027), which prioritizes inclusive access, e-learning, digital literacy, and teacher accreditation, demonstrate national implementation (CEMASTEA, 2025; UNESCO, 2024). By encouraging teamwork, ongoing professional development, and student engagement, these strategies reinforce a strong school culture. In order to increase student motivation and engagement in STEM fields, instructional leaders play a crucial role in fostering settings that emphasize inclusion, creativity, and innovation (Beauchamp et al., 2021; Sahin et al., 2021). Through these initiatives, Kenyan schools ensure that students gain abilities pertinent to Africa's economic and technological ambitions by aligning classroom practices with continental aspirations.

Kenya's strong engagement in EAC-coordinated projects, such as curriculum harmonization and the ICQN-MSE platform, further strengthens its integration of STEM policies both domestically and regionally (EAC, n.d.; EAC, 2022; IUCEA, 2021, 2024; World Bank, 2023). Digital literacy, sustainability, and global citizenship are integrated into STEM education through domestic policy frameworks like the Constitution of Kenya (2010), Vision 2030, and the CBC (Republic of Kenya, 2010; Government of Kenya, 2007; KICD, 2025; Institute of Engineers Kenya, 2025). Technology-enabled tutoring platforms and community-based learning programs are examples of complementary innovations that show how instructional leadership, a positive school culture, and digital tools come together to improve student outcomes (Stefansson & Jonsdottir, 2025; Uwezo, 2021). The importance of leadership in linking policy and practice is highlighted by this multi-level integration, which guarantees that STEM education supports both regional competitiveness and national development.

Thematic Pillar 3: Micro-Level Environment (The PERMA-Constructivist Culture)

School leadership is crucial in creating the cultural environments that affect STEM learning and success at the micro level. Learner motivation and performance are strongly impacted by the common norms, attitudes, and practices that secondary school leaders foster. Research indicates that collaborative, inclusive, and inquiry-based educational environments greatly improve STEM achievements (Sahin et al., 2021). Students are more engaged, resilient, and curious when their leaders encourage teamwork, reflective practice, and learner-centered teaching. On the other hand, disjointed or poorly expressed school cultures discourage perseverance and restrict success in STEM fields. Research shows that schools with strong collaborative cultures report better student performance, especially in science and math (van Horne et al., 2022). Effective leaders create environments that mainstream experimentation, inquiry, and design-based learning by establishing a clear vision, setting high standards, and encouraging group accountability (Beauchamp et al., 2021). In this situation, school culture and leadership work together to shape the calibre of STEM learning outcomes and experiences.

The practical alignment of teaching methods with policy-driven STEM priorities is another aspect of instructional leadership's job, which goes beyond vision-setting. According to academics, STEM policy frameworks necessitate leaders who can create real, inquiry-based learning opportunities at all educational levels (Honey & Kanter, 2022). Leaders must invest in teacher capacity and provide chances for experiential learning because integrated STEM approaches emphasize interdisciplinarity, cooperation, and problem-solving as critical competences (Li et al., 2021). In actuality, this entails encouraging collaborative teaching, increasing access to laboratory resources, and incorporating inquiry-driven and design-based activities into classroom learning. The significance of equity-driven and learner-centered approaches that link STEM education to students' identities and lived experiences is highlighted by recent revisions (Stroupe et al., 2025). Leaders may ensure that STEM education is inclusive, relevant, and engaging for a diverse student body by connecting school missions with these concepts, which improve equity and creativity.

Furthermore, effective STEM engagement and accomplishment are sustained by the integration of leadership, policy, and school culture. Students can apply their knowledge in real-world situations when instructional leaders use project-based and problem-based learning approaches, which promote coherence across disciplinary boundaries (Penuel & Reiser, 2022). Leaders enhance learning and foster critical thinking in STEM education by connecting instructional strategies to policies that prioritize equity and participation. Students exhibit greater self-assurance, better STEM identities, and greater perseverance in STEM paths when STEM is institutionalized as a fundamental organizational and cultural focus (Kelley et al., 2023). In these kinds of settings, students are encouraged to tackle difficult problems and acquire skills necessary for economies that are driven by innovation. In the end, leadership that incorporates vision, culture, and policy guarantees that schools not only enhance academic performance but also equip students for active engagement in the scientific and technological environments of the twenty-first century.

Thematic Pillar 4: Outcome Synthesis (The Achievement Output)

At the result level, research shows that fostering a positive STEM-focused school culture is essential to helping students develop the skills they need to participate in the economy and improve society. Cohesive leadership that fosters environments where students are inspired to explore and invent and encourages shared accountability for STEM accomplishment is what creates such cultures. Research demonstrates that students flourish in educational environments that encourage experimentation, curiosity, and ongoing involvement in STEM fields (Tus 2020). In addition to fostering a feeling of identity and belonging, shared values, standards, and beliefs inspire students to pursue STEM greatness and sustained engagement (Logan, 2019). Learner attitudes and engagement are greatly influenced by classroom settings with good teacher-student relationships and encouraging emotional climates. Research shows that students react well to STEM settings that provide autonomy, peer cooperation, communication, and enough time for problem-solving (Nicole, Rekha, & Rachel, 2023). Additionally, effective planning and execution of STEM programs are ensured by inclusive and collaborative leadership, and instructional strategies that prioritize problem-solving and teamwork lead to quantifiable increases in knowledge and cognitive abilities (Beauchamp et al 2021).

The results emphasize the crucial role that learner perceptions, agency, and social support play in influencing STEM engagement and accomplishment in addition to cognitive advances. Learners' views and long-term commitment to STEM routes are greatly influenced by their sense of belonging and their capacity to exert agency in STEM contexts (Gutiérrez & Jurow, 2021). Schools that promote parental support, supportive teacher relationships, and peer collaboration build ecosystems that increase students' enthusiasm and perseverance in STEM learning (Wong et al., 2024). Additionally, giving students the chance to exercise autonomy and co-design learning experiences boosts their self-efficacy and engagement, which results in a long-lasting interest in STEM fields

(Areepattamannil et al., 2023). These results imply that successful STEM outcomes entail the growth of self-assurance, identity, and purpose in addition to academic achievement. Institutions can enhance learning outcomes and nurture students who are driven to pursue STEM-related occupations and make significant contributions to innovation and development by integrating agency and collaboration into school culture.

Crucially, the summary of results highlights how STEM learning environments that are contextually relevant and culturally sensitive can increase engagement and maintain success. Particularly among marginalized groups, research shows that community-based and culturally grounded STEM practices improve students' science identity, self-efficacy, and motivation (Lee & Anderson, 2020). These strategies prevent alienation and guarantee inclusive and accessible STEM education. Furthermore, integrating inquiry-based and design-oriented pedagogies, strong leadership, collaborative school cultures, and socio-emotional support systems are all necessary for effective STEM teaching at the secondary level, which is intrinsically complex (McGee et al., 2021). Together, these components help students develop their critical thinking, resilience, and problem-solving abilities. In the end, the results confirm that STEM education produces holistic outcomes—from academic achievement to identity formation and career readiness—when school culture, leadership, and pedagogy are aligned. This prepares students for active participation in innovation-driven and knowledge-based economies.

Discussion: The Nexus of Policy, Leadership, and STEM Culture

The results confirm that STEM education and mathematics are essential tools for creativity, problem-solving, and sustainable growth. Learner achievement is closely linked to the quality of educational environments, according to global frameworks like those promoted by UNESCO, such as the Incheon Declaration and SDG4 (UNESCO, 2015, 2024). This study confirms that professional learning communities, collaborative pedagogies, and inclusive instructional leadership are not peripheral interventions but rather central drivers of STEM outcomes, in line with emerging scholarship (Stoehr et al., 2023). Additionally, learners' resilience, confidence, and persistence are greatly influenced by cultural aspects of education, such as trust, inclusivity, recognition, and belonging, especially among marginalized groups (Adams et al., 2023). These results support the idea that welcoming, positive school cultures supported by strong leadership provide the relational framework required to convert STEM changes into significant and long-lasting learning outcomes.

The results support AU and ADEA's policy recommendations at the continental and regional levels, which emphasize STEM education as essential to socioeconomic change (ADEA, 2016, 2024). The importance of peer learning, collaborative capacity building, and context-responsive curriculum change is demonstrated by programs like ICQN-MSE. Frameworks like Agenda 2063 and CESA (2016–2025) emphasize that STEM success is both technical and cultural, necessitating inclusive, creative, and cooperative learning environments in schools (African Union Commission, 2015). The relevance of systemic alignment in improving student engagement and mobility is further highlighted by EAC's regional efforts to standardize curricula and credentials frameworks (EAC, 2022; IUCEA, 2024). In order for teachers and students to flourish in changing educational environments, these developments highlight the need for leadership models that are not only instructional but also relational and emotionally supportive.

The results broaden this discussion within Kenya by demonstrating how national reforms, like SMASE, initiatives spearheaded by CEMASTEA and CBE, aim to match STEM education with more general development agendas, such as Vision 2030 and Agenda 2063 (Republic of Kenya, 2010; Government of Kenya, 2007; CEMASTEA, 2025). However, ongoing performance discrepancies in mathematics (Uwezo, 2021) suggest that structural improvements are insufficient on their own without concurrent school-level cultural transformation. This emphasizes the necessity of policies that go beyond technical fixes in order to foster inclusive, inspiring, and innovative educational environments. Such cultures can operationalize reform and enhance learner outcomes, as demonstrated by emerging practices including maker spaces, community-based tutoring, and digital learning platforms (Stefansson & Jonsdottir, 2025). Overall, the results show the simultaneous necessity of enhancing leadership capability and fostering school cultures that sustain STEM achievement and socioeconomic transformation, positioning instructional leadership as the crucial mediator connecting policy ambitions to classroom realities.

CONCLUSION

This study used the STEM–PERMA Synergy Model to investigate how policy frameworks, instructional leadership, and school culture interact to influence STEM education results. The results show that whereas regional, continental, and global policies strongly encourage STEM as a catalyst for innovation and sustainable development, their influence is moderated by leadership styles and school cultures. Clear priorities for inclusive, equitable, and high-quality STEM education are established by frameworks promoted by UNESCO, AU, and EAC. However, how well they are domesticated and implemented in national and school-level contexts will determine whether they translate into significant student outcomes. The study emphasizes instructional leadership as the vital link between practice and policy. School administrators are better positioned to establish welcoming, inclusive school cultures that boost student engagement, resilience, and STEM achievement when they encourage teamwork, professional development, and inquiry-based pedagogies. At the micro level, learners' identities, self-efficacy, and goals for STEM jobs are all significantly influenced by the PERMA-Constructivist culture. Therefore, by highlighting the significance of socio-emotional and cultural factors in maintaining meaningful learning, the findings expand our knowledge of STEM accomplishment beyond grades. Overall, the study comes to the conclusion that a comprehensive and integrated strategy is needed for sustainable STEM education reform, whereby leadership potential, policy alignment, and a positive school culture function as a coherent ecosystem. Even well-designed policies run the danger of having little effect without this alignment. On the other hand, schools become dynamic settings that foster creativity, critical thinking, and lifetime involvement with STEM when these components are successfully linked.

RECOMMENDATIONS

The study's conclusions offer a number of important suggestions for improving STEM education. Governments should ensure that policies go beyond curriculum reform to foster inclusive, innovation-driven environments by aligning global, continental, and national frameworks with specific provisions for positive school culture and instructional leadership. School administrators should stress inclusion and student participation while implementing transformational and instructional techniques, professional learning communities, collaborative teaching, and inquiry-based, project-oriented classrooms. Teachers are urged to use problem-based, interdisciplinary, culturally sensitive pedagogies that foster creativity, critical thinking, and STEM identity. In order to close resource gaps and offer practical learning opportunities, mentorship programs, digital platforms, and innovation centres should be used to increase engagement with parents, communities, and industry stakeholders. Lastly, while future studies should look at the long-term effects of school culture and leadership on STEM career pathways and national development results, monitoring and evaluation systems should record learner agency, motivation, and resilience in addition to academic outcomes.

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