



From Global Trends to Local Transformation: Reimagining STEM Teaching and Learning for Global Competence and Sustainable Development in Zimbabwe

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ABSTRACT

As the world shifts towards knowledge-driven economies, it's more important than ever for our educational systems to foster global competence and promote sustainable development. This paper takes a closer look at the pressing need to rethink how we teach and learn STEM (Science, Technology, Engineering, and Mathematics) in Zimbabwe, aiming to connect global trends with local realities. While international STEM frameworks are increasingly focusing on inquiry-based learning, digital integration, and essential skills like critical thinking and teamwork, Zimbabwe's education system still clings to exam-focused, theoretical methods that don't adequately prepare students for the challenges of the 21st century. This study advocates for a transformative approach that weaves global STEM trends into the unique socio-economic and cultural context of Zimbabwe. By incorporating Indigenous Knowledge Systems (IKS), utilising affordable technological innovations, and embracing problem-based learning that addresses local sustainability issues such as climate-smart agriculture, renewable energy, and water resource management Zimbabwe can nurture a generation of problem-solvers who are both globally aware and locally engaged. The paper suggests a comprehensive framework that aligns teacher training, curriculum changes, and community partnerships to develop STEM literacy not just as a measure of academic success, but as a means for active citizenship and sustainable livelihoods. Ultimately, this reimagining of STEM education can serve as a powerful driver for national development, empowering Zimbabwean students to make meaningful contributions to both local resilience and the global sustainable development agenda.

Keywords: STEM Education, Indigenous Knowledge Systems, Sustainable Development, Heritage-Based Education 5.0, Problem-Based Learning, Global Competence

INTRODUCTION

The global educational landscape is experiencing a significant shift as countries confront the intertwined challenges of climate change, technological disruption, food insecurity, growing social inequalities, and the urgent need for sustainable development. In this evolving scenario, Science, Technology, Engineering, and Mathematics (STEM) education has become a vital force for driving innovation, enhancing economic competitiveness, building resilience, and promoting sustainable development (Kennedy & Odell, 2014; Marginson et al., 2013). Yet, in many postcolonial nations like Zimbabwe, STEM education often remains stuck in a rigid, exam-focused approach that doesn't adequately equip students for the complexities of the 21st century (Chikuvadze & Jatakulula, 2025; Dziva et al., 2025).



This paper delves into the pressing need to rethink STEM teaching and learning in Zimbabwe, aiming to bridge the divide between global trends and local realities. By examining recent policy changes, academic discussions, and new frameworks for STEM transformation, the paper advocates for a comprehensive approach that aligns global STEM trends with Zimbabwe's distinct socio-economic and cultural context. By incorporating Indigenous Knowledge Systems (IKS), utilising affordable technological innovations, and embracing problem-based learning strategies centered on local sustainability challenges, Zimbabwe can nurture a generation of problem-solvers who are both globally aware and locally engaged.

The paper posits that this transformation goes beyond mere educational reform; it serves as a catalyst for national development, empowering Zimbabwean students to make meaningful contributions to local resilience and the global sustainable development agenda. This perspective is framed within Zimbabwe's broader developmental vision, as outlined in the National Development Strategy 2 (NDS2) and Vision 2030, which seek to elevate the country into an empowered and prosperous upper-middle-income economy (Government of Zimbabwe, 2021).

THE IMPERATIVE FOR STEM EDUCATION TRANSFORMATION

Global Trends in STEM Education

The 21st century is all about rapid technological growth, globalisation, and an incredible amount of information at our fingertips. Because of this, it's crucial for people to develop skills that will help them thrive in this new landscape, these are often called 21st-century skills (Voogt & Roblin, 2012). Key skills include critical thinking, problem-solving, creativity, collaboration, communication, digital literacy, and global competence (Ananiadou & Claro, 2009; Partnership for 21st Century Skills, 2009). Zimbabwe's education system needs to weave these competencies into the curriculum, as they empower individuals to adapt to change, think critically, and tackle problems effectively (UNESCO, 2017). Global STEM frameworks are increasingly focusing on inquiry-based learning, which gets students involved in the scientific process by encouraging them to ask questions, design experiments, and draw conclusions based on evidence (National Research Council, 2012). Digital integration has also become a key element of modern STEM education, with tools like coding platforms, robotics, 3D printing, and artificial intelligence making their way into classrooms around the globe (Holm-Nielsen et al., 2021). Moreover, transversal skills such as critical thinking, collaboration, and creativity are now seen as essential outcomes of STEM education, rather than just nice-to-have extras (OECD, 2019). At the Sixth Blended Annual Education for Sustainable Development Interdisciplinary Research Conference held at the National University of Science and Technology, Professor Lwazi Sibanda, the Executive Dean of the Faculty of Science and Technology Education, highlighted this shift in perspective:

"STEM education is no longer simply about producing scientists and engineers. It is about developing problem-solvers, innovators, entrepreneurs, climate champions, digital leaders, and active citizens capable of transforming society" (Sibanda, 2026). NUST Vice-Chancellor Professor Mqhele Dlodlo also emphasised the pressing need to rethink education in this context.

ZIMBABWE'S POLICY FRAMEWORK: HERITAGE-BASED EDUCATION 5.0

The Heritage-Based Education 5.0 Model

Zimbabwe has responded to global trends through the adoption of the Heritage-Based Education 5.0 model, which integrates teaching, research, community service, innovation, and industrialisation (Shava, 2026b). This model positions higher and tertiary education institutions as engines of innovation and economic transformation rather than institutions that merely produce graduates for the formal employment market.

The Heritage-Based Education 5.0 philosophy challenges institutions to go beyond teaching, research, and community service to embrace innovation, industrialisation, and commercialisation as integral components of



their mandate (Shava, 2026c). Minister Shava explained that "knowledge must solve societal challenges, create employment, improve livelihoods and contribute directly to national development" (Shava, 2026c). This vision aligns with Zimbabwe's National Development Strategy 2 and Vision 2030, which aim to transform the country into an empowered and prosperous upper-middle-income economy (Government of Zimbabwe, 2021).

The model draws on Zimbabwe's cultural heritage, including the philosophy of Unhu/Ubuntu/Vumunhu, which emphasises interconnectedness, mutual responsibility, and community well-being. This philosophical grounding distinguishes Zimbabwe's approach from purely technocratic STEM frameworks and provides a culturally resonant foundation for educational transformation (Mugumbate & Nyanguru, 2013).

The Heritage-Based Curriculum

The government has also introduced the Heritage-Based Curriculum at primary and secondary education levels, designed to mould productive learners who cherish and practice the Zimbabwean philosophical orientation of Unhu/Ubuntu/Vumunhu (Moyo, 2025). Primary and Secondary Education Minister Dr Torerayi Moyo explained that this curriculum seamlessly integrates coding and robotics within its STEM education framework, empowering pupils with the skills and knowledge necessary to excel in these disciplines (Moyo, 2025).

From the earliest stages of primary education, pupils develop foundational coding skills through engaging interactive games and puzzles, advancing to designing and constructing sophisticated robots using cutting-edge platforms such as Lego Mindstorms or Arduino as they progress to secondary school (Moyo, 2025). This progressive approach to STEM education aligns with international best practices that emphasise early exposure to computational thinking and hands-on engineering experiences (Bers, 2018).

Government Investment in STEM Infrastructure

The government's commitment to STEM integration is demonstrated through tangible investments in educational infrastructure. For example, the commissioning of three Advanced Level science laboratories at St Pauls High School in Gokwe, constructed for US\$237,000, represents a significant investment in practical science education (Ncube, 2025). Minister Moyo noted that by providing students with access to modern laboratories, educational institutions can facilitate hands-on learning and experimentation, crucial for developing critical thinking and problem-solving skills (Ncube, 2025).

These investments are being replicated across the country, with the government prioritising the construction and rehabilitation of science laboratories, technical workshops, and computer laboratories in both urban and rural schools. The goal is to ensure that all learners, regardless of their geographic location or socio-economic background, have access to quality STEM education (Mugumbate, 2025).

Impact on Tertiary Education

The impact of these policy directions is already evident in tertiary education. Bulawayo Polytechnic graduated 3,917 students in August 2026, with 47.6% completing STEM-related programmes (Shava, 2026b). Of the 6,588 students enrolled at the institution, 4,387 are pursuing STEM-related disciplines (Shava, 2026b). Similarly, Kwekwe Polytechnic reported 84% of its graduating class enrolled in STEM programmes, with 82.2% of its total student population pursuing STEM-related disciplines (Shava, 2026c).

These figures demonstrate a significant shift towards STEM education in Zimbabwe's tertiary institutions, reflecting both government policy direction and student demand for skills that are perceived as relevant to employment and entrepreneurship. However, the quality of STEM education and its alignment with industry needs remain areas requiring ongoing attention (Shava, 2026d).



CHALLENGES IN STEM EDUCATION IMPLEMENTATION

Resource Constraints

Despite these policy advances, significant challenges remain in implementing effective STEM education in Zimbabwe. One of the main challenges is the shortage of resources—some schools lack the necessary materials, including textbooks, teaching aids, and laboratory equipment, to implement the new curriculum effectively (The Free Library, 2023). This lack of resources makes it difficult for teachers to create a conducive learning environment and facilitate hands-on learning activities.

In rural areas, the resource deficit is particularly acute. Many schools lack electricity, internet connectivity, and basic laboratory equipment, making it challenging to implement the technology-intensive aspects of the Heritage-Based Curriculum (Mugumbate, 2025). The digital divide between urban and rural schools thus threatens to perpetuate existing inequalities rather than reduce them.

Teacher Training and Professional Development

There is also a need for more comprehensive training for teachers. Many teachers are not adequately trained to implement the new curriculum effectively and may lack the necessary skills, knowledge, or understanding of child-centred education and 21st-century skills (The Free Library, 2023). This lack of training can lead to a mismatch between the curriculum's goals and the teaching methods used in the classroom.

The rapid pace of technological change further compounds this challenge. Even teachers who have received initial training in technology integration may struggle to keep up with emerging technologies and pedagogical approaches (Holm-Nielsen et al., 2021). Continuous professional development is therefore essential but is often underfunded and fragmented in the Zimbabwean context.

Furthermore, large class sizes in many schools make it difficult for teachers to implement child-centred education, as providing individualised attention to each child and creating a conducive learning environment becomes challenging (The Free Library, 2023). This is particularly problematic in STEM education, which requires hands-on activities, group work, and individualised support for learners who may struggle with abstract concepts.

Marginalisation of Indigenous Knowledge Systems

Research has also highlighted the marginalisation of Indigenous Knowledge Systems (IKS) in Zimbabwe's science curriculum. Dziva, Mudavanhu, and Mutseekwa (2025) observed that IKS have been extensively marginalised in Zimbabwe's science curriculum, leading to a schism between what is taught in higher education and the real experiences of many educators. This marginalisation results in educators struggling to perceive the relevance of science education in their lives and to their communities.

Similarly, Chikuvadze and Jatakulula (2025) noted that despite the curriculum framework's emphasis on grounding science learning activities in cultural knowledge, the infusion of IKS into science learning remains limited at the secondary school level. This disconnect between the curriculum's intentions and its implementation reflects deeper challenges related to teacher preparation, resource availability, and the lingering influence of colonial epistemologies.

Examination-Centric Pedagogies

The continued dominance of examination-centric pedagogies represents another significant challenge. Despite policy shifts towards competency-based education, many teachers and schools continue to prioritise examination preparation over holistic learning (Ncube, 2025). This examination-centric approach narrows the curriculum, limits opportunities for hands-on learning, and fails to develop the critical thinking and problem-solving skills that are essential for the 21st century.



The high-stakes nature of national examinations, which determine access to tertiary education and employment opportunities, reinforces this focus on examination preparation. Until assessment systems are reformed to align with the goals of the Heritage-Based Curriculum, teachers and learners will continue to prioritise examination performance over deeper learning and skill development (Moyo, 2025).

INTEGRATING INDIGENOUS KNOWLEDGE SYSTEMS INTO STEM EDUCATION

The Value of Indigenous Knowledge Systems

The integration of Indigenous Knowledge Systems (IKS) into STEM education represents a crucial step towards decolonising knowledge and creating inclusive, relevant learning spaces that reflect culture (Dziva et al., 2025). Indigenous knowledge in Zimbabwe has played a significant role in shaping communities' understanding of agriculture, health, engineering, mathematics, and the environment over time, yet much of this knowledge has been marginalised in formal education (Sunzuma et al., 2025).

Scholars have argued that IKS are complex, dynamic, and rooted in culture and tradition, frequently associated with the natural environment and playing a vital role in biodiversity conservation and resource management (Mawere, 2015). IKS practices offer valuable insights and solutions for sustainable development, particularly in areas such as agriculture, medicine, and resource management (Shizha, 2013).

When IKS is appreciated and respected, it can serve to enhance cultural identity and Ubuntu principles and consequently facilitate cultural knowledge transfer to future generations (Dziva et al., 2025). This cultural dimension of education is particularly important in Zimbabwe, where the colonial legacy continues to influence educational practices and where there is growing recognition of the need to reclaim and valorise indigenous knowledge.

Frameworks for Integration

Sunzuma, Zezekwa, Mudzamiri, and Chikuvadze (2025) argue for a framework that enables the meaningful integration of IKS into STEM disciplines, providing a bridge between theoretical, practical, and contextual aspects of incorporating IKS into Zimbabwe's STEM curriculum. Such integration would not only enrich the curriculum but also foster a deeper understanding of sustainable practices and values among students and educators.

The integration of IKS into science educators' professional development programmes has been proposed as a mechanism for cultural sustainability (Dziva et al., 2025). When IKS is appreciated and respected, it can serve to enhance cultural identity and Ubuntu principles and consequently facilitate cultural knowledge transfer to future generations. Dziva, Mudavanhu, and Mutseekwa (2025) recommend further interrogation of how IKS enhances science teaching-learning in higher education.

Practical Examples of IKS Integration

Practical examples of IKS integration in STEM education include the use of indigenous agricultural practices to teach concepts of ecology, sustainability, and climate resilience. For instance, traditional methods of soil conservation, crop rotation, and water harvesting can be used to illustrate scientific principles while also demonstrating their practical application in local contexts (Mawere, 2015).

Similarly, indigenous architectural designs, such as the use of locally available materials and climate-responsive building techniques, can be used to teach engineering concepts while also promoting sustainable building practices. Indigenous mathematical systems, including counting systems, measurement techniques, and geometric patterns, can enrich mathematics education and demonstrate the universality of mathematical thinking (Sunzuma et al., 2025).

The integration of IKS also extends to indigenous medicine, where traditional healing practices can be used to



teach concepts of biology, chemistry, and pharmacology. This approach not only validates indigenous knowledge but also provides opportunities for learners to explore the relationships between traditional and modern scientific practices (Shizha, 2013).

LOW-COST TECHNOLOGICAL INNOVATIONS AND CRITICAL THINKING

The Role of Technology in STEM Education

The development of critical thinking skills through STEM education is a global concern, particularly in underserved communities. Technology has the potential to transform STEM education by enabling hands-on learning experiences, providing access to authentic data and tools, and facilitating collaboration and communication (Holm-Nielsen et al., 2021).

However, the high cost of technology often limits its accessibility in developing countries. This has led to growing interest in low-cost technological innovations that can provide affordable solutions for STEM education while still delivering meaningful learning experiences (Khan et al., 2024).

Evidence from Low-Cost Technology Interventions

Research conducted in Pakistan on the use of low-cost 3D-printed microscopes revealed that students in underprivileged areas often have a poor foundation for developing critical thinking skills (Khan et al., 2024). Approximately 70% of students were not confident in applying theoretical knowledge in experimentation, 72% encountered challenges during microscopic-based experiments, and 60% were unable to identify and differentiate the microstructures of organisms (Khan et al., 2024).

However, the study also demonstrated the effectiveness of hands-on learning experiences using low-cost technological tools. After performing experiments and getting the opportunity for hands-on learning using the designed microscope, more students developed an interest in scientific knowledge, with around 80% recommending that such hands-on learning experiences could improve theoretical learning skills (Khan et al., 2024). Importantly, the total cost of the educational microscope was under \$100, making it affordable for schools in underdeveloped areas (Khan et al., 2024).

Implications for Zimbabwe

This finding has significant implications for Zimbabwe, where resource constraints have been identified as a major challenge in implementing effective STEM education (The Free Library, 2023). Low-cost technological innovations can provide affordable solutions that enable hands-on learning, develop critical thinking skills, and make STEM education more accessible to underserved communities.

Examples of low-cost technologies that could be deployed in Zimbabwe include:

- Open-source hardware platforms such as Arduino and Raspberry Pi for teaching electronics and programming
- Locally manufactured scientific equipment using 3D printing and locally available materials
- Mobile-based learning applications that leverage the widespread availability of mobile phones
- Citizen science platforms that enable learners to contribute to real scientific research
- Offline digital resources that overcome challenges of internet connectivity

The KPIs for such interventions—providing access to quality education, developing critical thinking skills, and improving economic development—align with Zimbabwe's national development priorities (Government of Zimbabwe, 2021; Shava, 2026a).



PROBLEM-BASED LEARNING AND LOCAL SUSTAINABILITY ISSUES

The Problem-Based Learning Approach

Problem-Based Learning (PBL) has emerged as an effective pedagogical approach that aligns with the goals of 21st-century STEM education. The AIPLE framework (AI-Enhanced Problem-Based Learning for Sustainable Engineering Education) provides a context-adapted pedagogical model grounded in constructivist learning theory (Holm-Nielsen et al., 2021). This framework integrates experiential learning theory, social constructivist theory, and education for sustainable development theory to create a holistic learning environment.

The AIPLE framework consists of five interconnected stages that form a cyclical learning process, designed to be a practical tool for educators providing a clear structure for implementation and assessment (Holm-Nielsen et al., 2021). The iterative nature of the framework allows for continuous refinement and deeper learning as students cycle through research, conceptualisation, and experimentation.

The five stages of the AIPLE framework are:

1. Problem Identification: Students identify and define a real-world problem relevant to their context
2. Knowledge Acquisition: Students research the problem, gathering relevant information and concepts
3. Conceptualisation: Students develop potential solutions or approaches to the problem
4. Experimentation: Students test and refine their solutions through hands-on activities
5. Reflection and Iteration: Students evaluate their learning and iterate on their solutions

Local Sustainability Issues in Zimbabwe

In the Zimbabwean context, PBL can be rooted in local sustainability issues such as climate-smart agriculture, renewable energy, water resource management, and rural industrialisation. Minister Shava has emphasised the need for universities to strengthen interdisciplinary research and innovation to become centres of technological advancement, entrepreneurship, and economic transformation (Shava, 2026a). He identified key focus areas including renewable energy, climate-smart agriculture, biotechnology, artificial intelligence, sustainable mining, advanced manufacturing, water management, and digital education (Shava, 2026a).

Examples of PBL projects addressing local sustainability issues include:

- Climate-Smart Agriculture: Designing drought-resistant cropping systems, developing efficient irrigation technologies, or creating mobile applications for weather monitoring and agricultural advice
- Renewable Energy: Designing solar-powered systems for rural communities, developing biogas digesters from agricultural waste, or creating energy-efficient cookstoves
- Water Resource Management: Designing water purification systems, developing rainwater harvesting technologies, or creating monitoring systems for water quality
- Waste Management: Developing recycling systems, creating biodegradable packaging alternatives, or designing waste-to-energy technologies
- Rural Industrialisation: Designing appropriate technologies for small-scale processing of agricultural products, creating business models for rural entrepreneurship, or developing value-added products from local resources

Benefits of Contextualised PBL

The integration of PBL with local sustainability issues enables learners to develop practical solutions to national and global challenges while building the skills needed for the Fourth Industrial Revolution. As noted



at the NUST conference, "The education systems of yesterday cannot prepare learners for the realities of the Fourth Industrial Revolution, the digital economy or the green transition. We must therefore reimagine STEM education—not simply by reforming curricula, but by transforming how we teach, how we learn, how we innovate and how we collaborate" (Dlodlo, 2026).

Contextualised PBL offers several specific benefits:

- **Relevance:** Learners see the connection between what they are learning and the challenges facing their communities
- **Engagement:** Real-world problems are inherently motivating and engaging for learners
- **Skill Development:** PBL develops critical thinking, problem-solving, collaboration, and communication skills
- **Innovation:** PBL encourages creative thinking and the development of novel solutions
- **Entrepreneurship:** PBL projects can lead to commercial products and business opportunities
- **Community Impact:** PBL projects can directly benefit local communities and contribute to sustainable development

MULTI-STAKEHOLDER COLLABORATION AND INCLUSIVE STEM EDUCATION

The Importance of Collaboration

The transformation of STEM education in Zimbabwe requires meaningful collaboration between government, institutions of higher learning, industry, researchers, communities, and international partners (Shava, 2026a). Minister Shava articulated this vision:

> "Government provides policy direction and an enabling environment. Universities generate knowledge and innovation. Industry commercialises research and provides practical experience. Communities contribute local knowledge and real-world perspectives. When these strengths converge, transformative outcomes become possible" (Shava, 2026a).

The NUST Education for Sustainable Development Interdisciplinary Research Conference brought together policymakers, academics, researchers, industry leaders, students, and development partners to deliberate on the future of STEM education and sustainable development (Sibanda, 2026). Such multi-stakeholder platforms are essential for strengthening partnerships that promote innovation, research, and sustainable development.

Inclusive STEM Education

Inclusive STEM education has been identified as both a moral imperative and a strategic national investment (Shava, 2026b). Minister Shava stressed the need to make STEM education more inclusive by encouraging greater participation of women and girls, learners with disabilities, and students from disadvantaged communities (Shava, 2026b).

The government has demonstrated commitment to this goal through programmes such as the Integrated Skills Expansion Outreach Programme, which trained 691 people, including 71 inmates from the Zimbabwe Prisons and Correctional Services (Shava, 2026b). The Work-for-Fees scheme has also supported financially constrained learners, enabling them to continue their education despite economic challenges (Shava, 2026b). At Bulawayo Polytechnic, 21 students living with disabilities were enrolled through partnerships with the Forum for African Women Educationalists Zimbabwe and SATWILD (Shava, 2026b).

International Partnerships

The Midlands STEM Leadership Symposium, which attracted innovators and experts from Russia, the United States, South Africa, and Zimbabwe, demonstrates the importance of international partnerships in driving transformative STEM education and innovation (Ncube, 2025). Minister Owen Ncube noted that "this strategic



alliance is driving transformative STEM education and innovation in Zimbabwe, with a deliberate focus on bridging the digital divide and fostering a culture of inclusivity" (Ncube, 2025).

International partnerships bring several benefits, including access to expertise, technology, and funding. They also provide opportunities for Zimbabwean students and educators to engage with global best practices and to contribute to international research and innovation networks. However, such partnerships must be carefully managed to ensure that they are mutually beneficial and that they respect Zimbabwean sovereignty and developmental priorities.

Industry-Education Linkages

Strengthening linkages between education institutions and industry is essential for ensuring that STEM education is relevant to labour market needs and that graduates have the skills required by employers (Shava, 2026d). These linkages can take various forms, including internships, apprenticeships, industry-sponsored research projects, curriculum development partnerships, and technology transfer arrangements.

Institutions like Kwekwe Polytechnic have demonstrated this approach through practical innovations, including a Pfumvudza hole-digging machine and a silage-making machine, while its smart hybrid density-control traffic-light system has already been installed in Mutare (Shava, 2026c). These innovations demonstrate that institutions are not only centres of learning but are becoming engines of innovation, industrialisation, and community development.

FROM JOB SEEKERS TO JOB CREATORS

The Entrepreneurship Imperative

A central goal of STEM education transformation in Zimbabwe is to shift graduates from being job seekers to job creators. The Heritage-Based Education 5.0 model is producing graduates equipped not only to seek employment but also to create jobs, develop innovative products, and provide solutions to national challenges (Shava, 2026c). Minister Shava challenged graduates to "embrace entrepreneurship, innovation and problem-solving rather than relying solely on the shrinking formal job market" and to "establish businesses, develop products, offer services and create jobs" (Shava, 2026c).

This entrepreneurial orientation is essential in the Zimbabwean context, where the formal employment sector is unable to absorb the growing number of graduates. The country's economy, while showing signs of recovery, continues to struggle with high unemployment rates, particularly among young people (World Bank, 2022). STEM education that fosters entrepreneurship can address this challenge by enabling graduates to create their own employment opportunities and to contribute to economic growth.

Developing Entrepreneurial Mindsets

The emphasis on STEM education, innovation, entrepreneurship, and practical skills is central to transforming higher and tertiary education from a system focused solely on teaching and research into one that promotes innovation, industrialisation, and the development of solutions tailored to Zimbabwe's socio-economic needs (Shava, 2026d). This approach aligns with global trends that position STEM education as a driver of innovation and resilience, cultivating critical thinking, creativity, ethical responsibility, and a mindset of sustainability.

Developing entrepreneurial mindsets in STEM education involves:

- Problem-Solving: Teaching students to identify problems and develop innovative solutions
- Risk-Taking: Encouraging students to take calculated risks and learn from failure
- Creativity: Fostering creative thinking and innovation
- Business Acumen: Developing understanding of business principles, marketing, and finance
- Resilience: Building persistence and the ability to overcome challenges

- Networking: Developing skills in building relationships and partnerships

Success Stories and Emerging Innovations

Zimbabwe has already seen the emergence of successful STEM entrepreneurs who have developed innovative products and services. These success stories serve as inspiration for current learners and demonstrate the potential of STEM education to drive economic transformation.

Examples include:

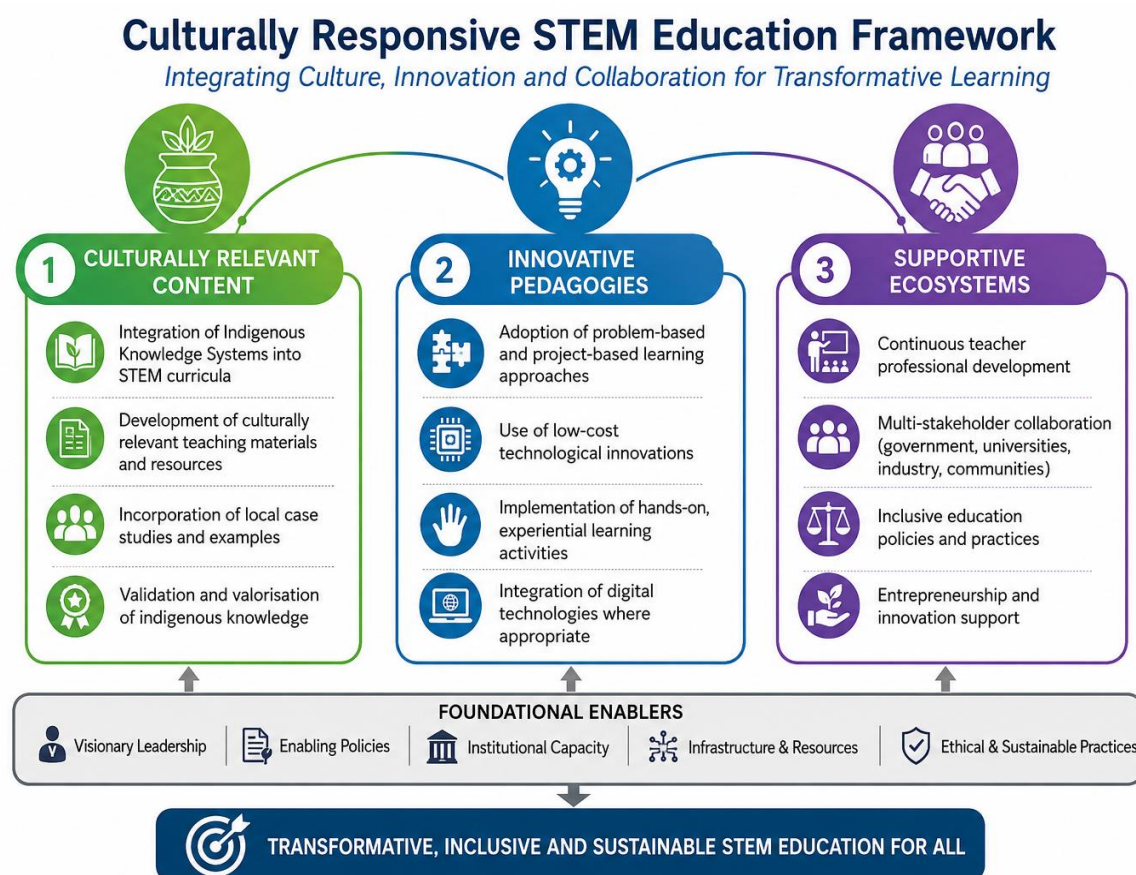
- AgriTech Innovations: Young entrepreneurs developing mobile applications for agricultural advice, drone-based crop monitoring, and digital marketplaces for agricultural products
- FinTech Solutions: Innovations in mobile banking, digital payments, and financial inclusion
- Renewable Energy Ventures: Startups developing solar energy solutions, biogas systems, and energy-efficient technologies
- Manufacturing Innovations: Development of locally manufactured products, from agricultural equipment to consumer goods
- Creative Industries: STEM applications in digital media, animation, and content creation

These examples demonstrate that STEM education can be a pathway not only to employment but to entrepreneurship and economic empowerment.

RECOMMENDATIONS AND PROPOSED FRAMEWORK

A Holistic Framework for STEM Transformation

Based on the analysis presented in this paper, we propose a holistic framework for reimagining STEM teaching and learning in Zimbabwe. This framework integrates three key pillars:





Specific Recommendations

Based on the framework, the following specific recommendations are proposed:

For Curriculum Reform:

1. Develop explicit guidelines for the integration of IKS into STEM curricula across all education levels
2. Align curriculum content with local sustainability challenges and national development priorities
3. Incorporate entrepreneurship education into STEM programmes
4. Review assessment systems to align with competency-based education goals

For Teacher Professional Development:

1. Develop comprehensive pre-service and in-service training programmes on IKS integration
2. Provide training on problem-based and project-based learning pedagogies
3. Offer continuous professional development on emerging technologies
4. Create communities of practice for STEM educators

For Resource Provision:

1. Invest in low-cost, locally manufactured STEM equipment and materials
2. Develop open educational resources for STEM education
3. Leverage mobile technology for STEM learning, particularly in rural areas
4. Establish community-based STEM learning centres

For Policy and Institutional Support:

1. Strengthen policy frameworks for STEM education transformation
2. Increase funding for STEM education at all levels
3. Establish mechanisms for multi-stakeholder collaboration
4. Develop monitoring and evaluation systems for STEM education outcomes

Implementation Considerations

Successful implementation of these recommendations will require careful attention to several factors:

- Political Will: Sustained political commitment to STEM education transformation
- Resource Allocation: Adequate and sustained funding for STEM education
- Capacity Building: Investment in teacher training and institutional capacity
- Stakeholder Engagement: Meaningful involvement of all stakeholders in the reform process
- Monitoring and Evaluation: Regular assessment of progress and adaptive management



- Sustainability: Ensuring that reforms are sustainable over the long term

CONCLUSION

This paper has examined the urgent need to reimagine STEM teaching and learning in Zimbabwe, bridging the gap between international trends and local realities. The analysis demonstrates that Zimbabwe has made significant policy advances through the Heritage-Based Education 5.0 model and the Heritage-Based Curriculum, which integrate teaching, research, community service, innovation, and industrialisation. However, significant challenges remain, including resource constraints, inadequate teacher training, large class sizes, and the marginalisation of Indigenous Knowledge Systems in formal education.

The paper has proposed a holistic approach that contextualises global STEM trends within Zimbabwe's unique socio-economic and cultural fabric. This approach integrates three key elements: (1) the incorporation of Indigenous Knowledge Systems to decolonise knowledge and create culturally relevant learning spaces, (2) the use of low-cost technological innovations to develop critical thinking skills and make STEM education more accessible, and (3) the adoption of problem-based learning methodologies rooted in local sustainability issues such as climate-smart agriculture, renewable energy, and water resource management.

Through multi-stakeholder collaboration and a commitment to inclusive STEM education, Zimbabwe can transform its education system to produce graduates who are not only academically competent but also equipped with critical thinking, digital literacy, creativity, entrepreneurial skills, and collaborative problem-solving abilities. The goal is not only to prepare graduates for employment but to empower them to create employment, develop innovative products, and provide solutions to national challenges.

In doing so, Zimbabwe can position STEM education as a catalyst for national development, empowering learners to contribute meaningfully to both local resilience and the global sustainable development agenda. The transformation of STEM education is not merely an educational reform but a strategic imperative for Zimbabwe's future prosperity, social cohesion, and sustainable development.

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