



## Policy Brief

# Implementing a Value-based STEM Approach to Address Tanzania's Educational and Industrial Needs

Salim Abdullah Salim Slemy

## Abstract

Tanzania is undergoing a curriculum transformation toward a competence-based education system, as directed by the Ministry of Education. Universities are expected to evolve into Productive value-driven institutions, aligning with Vision 2050 of the Revolutionary government of Zanzibar as part of the United Republic of Tanzania, aspire to transform into an innovation-driven economy, and COSTECH mission, which emphasizes fostering science, technology, and innovation for sustainable development. However, challenges like curriculum irrelevance, unemployment, lack of innovation, and limited industrial advancement persist. This policy paper proposes the implementation of a value-based STEM Approach at the university level to empower students to address real-world challenges, develop prototypes, and commercialize solutions. The program will develop students' competencies, foster innovation, and empower youth in entrepreneurial skills to enhance industrialization, transform universities into hubs of productivity and value addition, and achieve Tanzania's sustainable development goals.

Keywords: STEM Education, STEM-Policy, Policy Paper, Innovation

## Introduction

STEM education, as a learning approach that integrates STEM content, skills, and values to solve contextual problems, is widely supported in the literature (Kelly & Knowles, 2016; Najib, S. A. et al., 2020). The proposed STEM approach aligns with the directives of the Ministry of Education by equipping students with practical skills, critical thinking abilities, and entrepreneurial competencies. In support of this, the Government of Tanzania, through the Tanzania Institute of Education (TIE) and the Ministry of Education and Vocational Training, revised the secondary school curriculum starting in 2005 (MoEVT, 2006), with a more significant transformation occurring in 2023. This revised curriculum adopted a competence-based approach (CBC), emphasizing student-centered teaching methods. The key focus for STEM subjects under the new curriculum is project-based and inquiry-based learning aimed at building students' knowledge, skills, and attitudes (TIE, 2019).

Globally, STEM programs have drawn substantial academic attention. Many studies have demonstrated their effectiveness in developing innovation skills that address societal problems, while others have explored the challenges of implementing STEM approaches in classroom settings (Fitriyana, N. et al., 2024; Mikhaylovsky et al., 2021;

Yussuf et al., 2022; Nurhaliza & Syafiri, 2021; Toma, R. B. et al., 2024). Zanzibar Vision 2050

Fostering innovation and industrialization supports Zanzibar's aspiration to become an innovation-driven economy. The government's efforts focus on strengthening the quality of education and emphasizing curriculum development to promote science, technology, and innovation. At the same time, these efforts aim to ensure that cultural practices are used to promote the country internationally, while customs and norms are preserved for the benefit of both current and future generations. Within this context, the Zanzibar Development Vision 2050 (ZDV-2050) emphasizes the conservation, revival, management, and promotion of national values, including Islamic and other traditional cultures, as a means to foster patriotism. Through Vision 2050, the Revolutionary Government of Zanzibar has established a national key performance indicator: measuring the proportion of higher education students specializing in STEM disciplines (RGZ, 2020).

## Tanzania Commission for Science and Technology(COSTECH)

The Government of the United Republic of Tanzania established the Commission for Science and Technology (COSTECH) to drive the nation towards becoming a science-, technology-, and innovation-led economy. COSTECH's mission is to promote and coordinate the utilization of knowledge-based products to accelerate socio-economic development (COSTECH, 2024). The Commission operates under core values of integrity, excellence, customer focus, professionalism, accountability, and teamwork. Guided by these principles, COSTECH has successfully initiated several programs and projects to advance its mission and benefit society (COSTECH, 2024).

Introducing a value-based STEM approach in higher learning institutions—particularly universities aligns with and strengthens COSTECH's mission of fostering science, technology, and innovation (STI) for sustainable development. One of COSTECH's key initiatives is supporting innovation in higher learning institutions through the Higher Education for Economic Transformation (HEET) project, which has attracted significant interest and applications.

In 2024, COSTECH launched efforts to develop the National Information System for Science, Technology, and Innovation (NISSTI). This system aims to streamline research and innovation activities across the country, enhance collaboration, and improve

access to relevant data. In parallel, COSTECH has established comprehensive frameworks to foster academic-industry linkages. These include guidelines for assessing scientific research competence and for the establishment and management of higher learning institutions, research and development (R&D) centers, and industries engaged in STI for sustainable development.

The Commission has also implemented the National Framework for Linkages between Higher Learning Institutions, R&D institutions, and industries. This framework is designed to boost the contribution of research and innovation outputs to Tanzania's economic development (COSTECH, 2024). Moreover, COSTECH is responsible for supervising and developing standard operating procedures for the establishment and operation of research ethics committees (URT, 2022). Therefore, the proposed value-based STEM framework aligns closely with COSTECH's ethical mandates and its broader objectives for national STI advancement.

## Problem statement

**Curriculum Irrelevance and Lack of Competence-Based Education:** Traditional science curricula in Tanzanian universities emphasize theoretical knowledge over practical application, leaving graduates ill-equipped to contribute to the innovation-driven economy envisioned in Zanzibar Vision 2050. These curricula also fall short of aligning with the Ministry of Education's directives for a competence-based approach. As a result, students often struggle to apply their knowledge to real-world challenges, limiting the transformation of universities into productive and value-generating institutions. This disconnect contributes to widespread concern about the quality of science education and deters many students from enrolling in STEM specializations—a key objective of ZDV-2050 (RGZ, 2020).

**Underperformance in Innovation and Value Addition:** Universities are not adequately equipped to generate innovations or add value to natural resources, both of which are crucial for achieving the goals of Zanzibar Vision 2050 and the COSTECH mission. This underperformance hampers progress toward industrialization and sustainable economic development.

**Lack of Innovation and Entrepreneurship in Education:** The current education system fails to foster creativity and innovation, contradicting COSTECH's mission to advance

science and technology for solving societal challenges. Without exposure to entrepreneurial thinking, students are unable to develop practical solutions to real-life problems or contribute meaningfully to economic growth and industrial transformation.

**Unemployment and Limited Entrepreneurial Opportunities:** Graduates lack both entrepreneurial skills and an innovation-oriented education. This gap leaves them unprepared to create employment opportunities or contribute to industrial expansion, which runs counter to the objectives of competence-based education.

**Limited Contribution to Industrial Development Using Natural Resources:** Despite Tanzania and Zanzibar's abundance of natural resources, the lack of industry-focused educational programs limits the country's ability to convert these assets into engines for industrialization. The absence of technological development and practical application further inhibits the effective utilization of these resources.

## Policy solutions

### Implementation of value-based STEM Chemistry programs

Introduce competence-based value-driven STEM chemistry curriculum which align with the ministry of education's competence-based framework emphasizing hands-on learning focused on real-world problem-solving, innovation, and ethical considerations at University level. The program include:

**Hackathons:** Students collaborate to identify and address local challenges using chemistry and STEM knowledge.

**Prototype development:** Practical sessions where students design, test, and refine solutions to real-life problems.

**Value-based learning:** Integrating societal values, environmental sustainability, and ethical practices into STEM education.

### Establishing innovation and entrepreneurship pipelines

Support the commercialization of innovative ideas through a structured pathway:

**Incubation:** provide mentorship, resources, and funding to refine prototypes.

**Acceleration:** Partner with industries and investors to scale innovations.

**Commercialization:** Launch products that contribute to industrialization and entrepreneurship, empowering youth.

Universities as productive and value-added institution

Transform university into innovation hubs that contribute to industrialization and societal development.

This include: Establishing innovation centers for prototype development and testing. Creating partnerships with industries to add value to natural resources. Encourage faculty members and students to engage in research that addresses national priorities. Leverage natural resources for industrialization include innovation in chemical extraction and processing; sustainable agricultural products, such as bio-fertilizers and renewable energysolutions using local materials.

### Implementation plan

The implementation of the integrated STEM program demand effective professional development model for in-service and pre-service teachers for effective STEM program skills development. This is due to the fact that translate the integrated STEM approach in classroom practices demand in multiple disciplines to solve problem (Toma, R.B. et.al.(2024).

Phase 1: Curriculum refinement and stakeholder engagement.

Collaborate with universities, COSTECH, and industries to design the curriculum aligned with national vision and train faculty in value-based and innovation-focused teaching methodologies that foster innovation and entrepreneurship.

Phase 2: Program implementation and student engagement. Program launch and hackthons implementation.

Pilot the value-based STEM Approach in selected universities or students.

Organize hackthons and innovation challenges to engage students in real-world problem-solving. Hackthons can be organized to foster collaboration among students, industries, and policy makers.

Phase 3: Innovation and commercialization infrastructure: Incubation, acceleration and commercialization.

Establish innovation hub enable universities to support incubation, acceleration, and commercialization stages.

Foster industry-university partnerships to enhance value addition and productivity.

## Conclusion and recommendations

The implementation of a value-based STEM approach offers a strategic solution to Tanzania's educational and industrial challenges. It supports the nation's shift toward competence-based education while addressing key issues such as unemployment, innovation deficits, and industrialization needs. By transforming universities into productive and value-driven institutions, this initiative aims to empower youth, drive economic development, and align with both Zanzibar Vision 2050 and COSTECH's mission. By leveraging natural resources and prioritizing educational reform, Tanzania can achieve sustainable development and transition into an innovation-driven economy. Immediate action and coordinated efforts among stakeholders are essential to realize this vision.

### Policy Recommendations

- Prioritize funding for value-based STEM programs: Implement competence-based STEM chemistry programs in universities. Allocate resources to support program development and expansion, including infrastructure upgrades, faculty training, and mentorship initiatives.

- Invest in innovation infrastructure and industry partnerships: Provide funding for innovation hubs and strengthen public-private partnerships (PPPs). Collaborate with industries, COSTECH, and other stakeholders to offer mentorship, funding opportunities, and support for commercialization and industrialization.
- Transform universities into productive and value-driven institutions: Encourage higher education institutions to actively engage in research, prototype development, and value addition to natural resources. Redesign science curricula to emphasize practical application, problem-solving, and innovation. Ensure alignment with Zanzibar Vision 2050 and COSTECH's mission to foster science, technology, and innovation (STI) for societal development.
- Monitor and evaluate program outcomes: Establish metrics to assess the program's effectiveness in enhancing competence development, employment, and industrialization. Develop performance indicators to track its impact on innovation and economic growth.

## References

COSTECH.(2024).HEET. Newsletter. [www.heet.costech.or.tz](http://www.heet.costech.or.tz).

Fitriyan,N.,Wiyarsi,A., Pratomo,h.,&Marfuatan,M.(2024). The importance of integrated STEM learning in chemistry lesson: Perspectives from high school and vocational school chemistry teachers.Journal of technology and science education,14(2),418-437.  
<https://doi.org/10.3926/jotse.2356>.

Kelley,T.R., and Knowles,J.G.(2016). A conceptual framework for integrated STEM education. International Journal of STEM education 3(1),1-11.

Mikhaylovsky,M.N.,Karavanova,L.Zh.,Medved,E.I.,Deberdeeva,N.A.,Buzinova,L.M & Zaychenko, A. A.(2021).The model of STEM Education as an innovative technology in the system of higher professional education of Russian Federation. EURASIA Journal of mathematics, science and technology education.17(7),em2007 ISSN:1305-8223.  
<https://doi.org/10.29333/ejmste/11173>

Najib,S.A.,M.,Mahat,H.,Baharudin,N.H.(2020).The level of STEM Knowledge,Skills and Values among the students of bachelor's degree of education in geography. International Journal of Education and Research in Education(IJERE).9(1).69-76.  
ISSN:22252-8822,

<https://doi.org/10.11591/ijere.v9i1.20416>

Nurhaliza, P., & Syafitri, Y. (2021). Meta Analysis of the effect of STEM Implementation in learning Models in science and Physics subjects on students skills in the UNP Postgraduate physics Education master study program. 7(2), 1-8.

RGZ-Revolutionary Government of Zanzibar (2020). Zanzibar Development Vision 2050. <https://www.planningzanz.go.tz>.

Toma, R. B., Yanez-Perez and Meneses-Villagra. (2024). Towards a Socio-Constructivist Didactic Model for Integrated STEM Education. Interchange. 55:75-91.

<https://doi.org/10.1007/s10780-024-09513-2>

TIE (2019). Curriculum for ordinary level secondary education in Tanzania, Tanzania Institute of education, Dar es salaam, Tanzania. <https://www.tie.go.tz>.

URT-United Republic of Tanzania. (2022). COSTECH. 2022/2023. Understand costech. [www.costech.or.tz](http://www.costech.or.tz).

Yussuf, I., Ma'rufi, & Nurdin. (2022). STEM Approach to improve critical thinking ability and student learning motivation in mathematics learning. Cognitive : Journal of HOTS Research in mathematics education, 2(1), 26-40.