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Re-visioning Zimbabwe's Science, Technology, Engineering and Mathematics for Secondary Schools through the Science Teacher Education Programme

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ABSTRACT
The study highlights the necessity of developing innovation, creativity, and scientific competencies among Zimbabwean secondary school learners for their future social and economic engagement and participation. It explored the government's efforts to enhance access to STEM education through the Science Teaching Education Programme (STEP) for secondary schools. Five STEM lecturers and ten STEM student teachers were purposefully selected to participate in the study. Focus group discussions with respect to student teachers, in-depth interviews with lecturers and on-site observation of the infrastructure were the data collection instruments. The research, employing a phenomenological framework, identified challenges such as resource constraints, inadequate infrastructure, and lecturer turnover as factors threatening the successful implementation of the programme. The study recommended that the government and other educational stakeholders provide additional support and resources for STEM lecturers, such as professional development opportunities, mentorship programmes, and access to cutting-edge technology and tools to produce teachers who can make a difference through the STEP programme. Thus, the study expands knowledge on discourses regarding growing challenges related to the effective institutional provision of STEM education in Zimbabwe.

Keywords: College of Education, Science Teaching Education Programme (STEP), Science, Technology, Engineering and Mathematics (STEM), Secondary Schools, Student Teachers, Technology

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INTRODUCTION

In the rapidly evolving global economy, the significance of STEM fields in driving development is undeniable.[1] Engineers, technologists, and scientists are critical in advancing countries' technological landscapes through innovative solutions that promote economic development and growth prospects.[2] With an increased focus on STEM education and the pressing need for skilled STEM human capital,

[1] Lei Bao et al., "The STEM Aspirations of China's Future Workforce," *Journal of Science Education and Technology* 32, no. 4 (August 1, 2023): 567–82, https://doi.org/10.1007/s10956-023-10044-1.
[2] Joaquín Fuentes-del-Burgo et al., "Perceived Barriers and Benefits to Promoting Science and Engineering by University Lecturers through Outreach Lectures to Secondary School Students," *Journal of Technology and Science Education* 13, no. 3 (July 21, 2023): 673, https://doi.org/10.3926/jotse.2159; Margaret J. Mohr-Schroeder et al., "Moving Toward an Equity-Based Approach for STEM Literacy," in *Handbook of Research on STEM Education* (Routledge, 2020), 29–38, https://doi.org/10.4324/9780429021381-4.

Jamali et al point out that there is a growing consensus on the importance of enhancing STEM curricula and instructional quality.[3]

However, many countries in the Global South, including Zimbabwe, are grappling with challenges in meeting the demand for STEM professionals.[4] Kadziya and Ndebele highlight key barriers hindering STEM education development, such as inadequate scientific infrastructure at institutions, teacher shortages, a lack of necessary teaching resources, limited practical exposure, and curriculum deficiencies.[5] Furthermore, recruiting and retaining qualified STEM teachers has proved a big challenge due to a shortage of subject knowledge experts as they often opt for more lucrative opportunities away from the teaching profession which appears not to value them.[6] This deficit in qualified teachers leads to the employment of inadequately prepared and unqualified teachers, impacting the provision of quality STEM education.

Trends show that there is a growing recognition of some shortages in STEM teacher quality, with STEM teachers often lacking subject-specific professional credentials compared to teachers in other disciplines.[7] It is critical that secondary school learners should be exposed to scientific education, opportunities, experiences and knowledge that fosters their ability to collectively work towards a better society.[8] As a result, equipping pre-service student teachers with STEM competencies is critical for cultivating STEM-ready teachers at Zimbabwean secondary schools.[9] Despite varied interpretations of STEM literacy, the discourse that underpins modern development is the common thread that lies in the integration of science, technology, engineering, and mathematics during teaching and learning to develop problem-solving skills and practical application in real-life contexts.[10] Nugraha et al. and Winberg et al. understand that STEM pedagogical development demands interdisciplinary strategies that bridge theory and practice effectively.[11]

The overarching goal of STEM education is to produce teachers equipped with the knowledge, skills, and disposition to excel in their professional roles.[12] However, the paradigm often labels STEM teachers as predominantly science teachers, neglecting the integration of technology and engineering aspects into the pedagogy.[13] It can be argued that emphasising inquiry-based learning, problem-solving, and collaboration is consistent with STEM education which results in cultivating creativity, critical thinking, and teamwork among students[14] Su suggests that effective teaching in STEM hinges

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[3] Seyedh Mahboobeh Jamali, Nader Ale Ebrahim, and Fatemeh Jamali, "The Role of STEM Education in Improving the Quality of Education: A Bibliometric Study," *International Journal of Technology and Design Education* 33, no. 3 (July 8, 2023): 819–40, https://doi.org/10.1007/s10798-022-09762-1.

[4] Didit Ardianto, Bibin Rubini, and Indarini Dwi Pursitasari, "Assessing STEM Career Interest among Secondary Students: A Rasch Model Measurement Analysis," *Eurasia Journal of Mathematics, Science and Technology Education* 19, no. 1 (2023): em2213.

[5] Lizias Kadziya and Clever Ndebele, "An Analysis of the Challenges Faced by Teachers in the Delivery of Science, Technology, Engineering and Mathematics Education in Rural Day Secondary Schools in Zimbabwe," 2020, https://api.semanticscholar.org/CorpusID:223603119.

[6] L. Tikly et al., "Supporting Secondary School STEM Education for Sustainable Development in Africa," Bristol Working Papers in Education Series, 2018.

[7] H.B. Gonzalez and J.J. Kuenzi, "Science, Technology, Engineering and Mathematics (STEM) Education: A Primer," Congressional Research Service, 2012, https://viterbik12.usc.edu/wp-content/uploads/2017/03/STEM-Education-Primer.pdf.

[8] William C Kyle, "Science Education in Developing Countries: Access, Equity, and Ethical Responsibility," *Journal of the Southern African Association for Research in Mathematics, Science and Technology Education* 3, no. 1 (1999): 1–13.

[9] Muhamad Gina Nugraha, Gillian Kidman, and Hazel Tan, "Pre-Service Teacher in STEM Education: An Integrative Review and Mapping of the Indonesian Research Literature," *Eurasia Journal of Mathematics, Science and Technology Education* 19, no. 5 (2023): em2262.

[10] W. Srikoom, " What Is STEM Education? ," Research Gate, 2018, https://www.researchgate.net/publication/346664196-what-is-STEM-EDUCATION.

[11] Nugraha, Kidman, and Tan, "Pre-Service Teacher in STEM Education: An Integrative Review and Mapping of the Indonesian Research Literature"; Christine Winberg et al., "Learning to Teach STEM Disciplines in Higher Education: A Critical Review of the Literature," *Teaching in Higher Education* 24, no. 8 (2019): 930–47.

[12] David W White, "What Is STEM Education and Why Is It Important," *Florida Association of Teacher Educators Journal* 1, no. 14 (2014): 1–9.

[13] White, "What Is STEM Education and Why Is It Important."

[14] Abdul N. Kiazai, Naila Siddiqua, and Zarina Waheed, "Challenges in Implementing STEM Education and Role of Teacher Education Programs in Mitigating These Challenges," *International Journal of Distance Education and E-Learning* 5, no. 2 (2020): 123–37.

on facilitating experiential learning that encourages exploration, innovation, and authentic problem-solving.[15]

The impact of the shortage of STEM teacher expertise has become one of the critical contributors to barriers to quality STEM education delivery at the school level, underscoring the need for targeted teacher training in STEM education under STEP currently underway in Zimbabwe.[16] Without well-trained STEM teachers, secondary school students may struggle with analytical thinking and complex problem-solving required for future career paths.[17] To empower student teachers with the necessary skills for STEM education, creating authentic learning environments and providing mentorship from domain-specific experts is crucial with a positive knock-on effect on secondary school STEM learning.[18] Su is of the view that implementing problem-based learning in STEM education not only enhances student outcomes but also develops practical skills essential for socioeconomic development.[19] This notion supports the argument that there is an increased need to invest in STEM human capital in promoting and tackling social and economic imperatives confronting Zimbabwe.

Therefore, equipping teachers with robust STEM knowledge and pedagogical skills is central to nurturing a proficient STEM human capital. Furthermore, it helps develop a positive STEM identity among Zimbabwean secondary school students and addresses the demands of the 21st-century employment market and the economic landscape.[20] The quality of STEM teachers directly impacts secondary school students' interest in STEM fields, emphasising the important role of teacher competencies in promoting effective science education, learning experiences and opportunities thus explaining the Zimbabwean rationale for the STEP programme.

The implementation of the STEM professional teacher education under the STEP programme at colleges of education in Zimbabwe has attracted interest from the education fraternity given its centrality to national development discourses. Prior STEM initiatives in Zimbabwe had targeted learner support which had very little impact on the provision of STEM education in Zimbabwean secondary schools. Thus, the new STEM teacher education trajectory, while noble, faces a myriad of challenges and there is a need to identify these and suggest solutions in order to grow the number of scientists in the country. In addition, the STEM professional teacher development initiative at primary teacher education institutions in Zimbabwe has raised questions about the suitability of the context in which it is provided and the human resources to teach on the programme.

Shortages of qualified STEM teachers have been a persistent challenge in many countries, despite concerted government interventions and stakeholder efforts.[21] The Zimbabwean government has also faced a shortage of qualified secondary school teachers, particularly in STEM subjects, leading to inexperienced and under-qualified teachers offering instruction. Recognising the critical need for skilled STEM teachers, the government initiated an extensive professional development programme in STEM education through the STEP in colleges of education in 2018.[22] According to the author the

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[15] King-Dow Su, "The Challenge and Opportunities of STEM Learning Efficacy for Living Technology Through a Transdisciplinary Problem-Based Learning Activity," *Journal of Science Education and Technology* 33, no. 4 (August 24, 2024): 429–43, https://doi.org/10.1007/s10956-024-10094-z.

[16] Nugraha, Kidman, and Tan, "Pre-Service Teacher in STEM Education: An Integrative Review and Mapping of the Indonesian Research Literature."

[17] Oksana O. Martynenko et al., "Exploring Attitudes towards STEM Education: A Global Analysis of University, Middle School, and Elementary School Perspectives," *Eurasia Journal of Mathematics, Science and Technology Education* 19, no. 3 (March 1, 2023): em2234, https://doi.org/10.29333/ejmste/12968.

[18] Effrat Akiri and Yehudit Judy Dori, "Professional Growth of Novice and Experienced STEM Teachers," *Journal of Science Education and Technology* 31, no. 1 (February 16, 2022): 129–42, https://doi.org/10.1007/s10956-021-09936-x.

[19] Su, "The Challenge and Opportunities of STEM Learning Efficacy for Living Technology Through a Transdisciplinary Problem-Based Learning Activity."

[20] Ardianto, Rubini, and Pursitasari, "Assessing STEM Career Interest among Secondary Students: A Rasch Model Measurement Analysis."

[21] Olalekan Taofeek Badmus and Loyiso C. Jita, "Investigation of Factors Influencing Career Choice among STEM Undergraduates in Nigeria Universities," *Eurasia Journal of Mathematics, Science and Technology Education* 19, no. 1 (January 14, 2023): em2221, https://doi.org/10.29333/ejmste/12838.

[22] N. Tshili, "STEM Training Programme Expanded," *The Herald:Zim Papers*, August 29, 2023, https://www.herald.co.zw/stem-training-programme-expanded.

STEP programme was launched in response to the high demand for human capital in science teachers and the pressing need to fill gaps in the secondary education sector, where some provinces had students deprived of fully qualified STEM teachers for extended periods. This initiative, according to Svodziwa, is aimed to revitalise the growth of secondary science teachers by harnessing the country's human potential for industrialisation and modernisation.[23] Kyle further points out that investing in science teachers may bring cutting-edge technologies to enable developing countries, Zimbabwe included, to leapfrog damaging phases of development.[24]

The Zimbabwean government's strategy began with implementing a state-sponsored STEM student programme but has now shifted to a more focused STEM teacher training initiative for the secondary school sector to build the capacity of future citizens to provide crucial services. Tshili reports that the programme aims to train approximately 5000 STEM teachers by 2025 at selected teacher training colleges, including Joshua Mqabuko Polytechnic, Masvingo, Mkoba, and Marymount, to complement existing efforts from universities.[25] The emphasis on supporting secondary school students with qualified teachers to build their STEM competencies underscores the importance of teacher quality in the technological era of the 21st century.[26] Kiazai highlights the necessity for government investment in STEM education, particularly in professional development programmes, to enhance the successful implementation of STEM education in secondary schools.[27]

Considering these developments, this study investigates the provision of STEM education in Zimbabwe through the STEP programme in colleges of education. It explores how the STEP programme is preparing STEM student teachers, the challenges encountered, and strategies to enhance its implementation. The study is guided by the following questions:

- What is the readiness of colleges of education to implement STEM education in secondary schools in Zimbabwe?
- What challenges do colleges face in providing STEM education?

LITERATURE REVIEW

The advancement of STEM knowledge and literacies has been a subject of extensive debate, interest, and research nationally and globally. There is a noticeable gap in the current literature regarding the emerging discourses in Zimbabwe on the new STEP that is aimed at professional teacher development in STEM education for secondary schools. In addition, the STEP programme targeting Zimbabwe secondary school teachers presents valuable insights for all educational stakeholders to examine the initial stages of implementing STEM disciplines currently being offered at colleges of education. The programme offers an opportunity to consider the critical elements and factors that ensure its quality, effectiveness, relevance, and sustainability as a source of qualified STEM teachers. The overarching goal is to cultivate a robust and capable local STEM human capital, thus positioning Zimbabwe for economic competitiveness and growth in the era of the 4th Industrial Revolution.

The implementation of STEM education and the preparation of teachers in various educational settings have been approached differently, resulting in varying degrees of success. While the current study focuses on exploring the implementation practices of the STEP in Zimbabwe, there is a recognised importance and value in learning from experiences in other contexts to compare with the new STEP initiative being implemented in Zimbabwe. This section explores some relevant STEM-related literature across different countries.

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[23] Mathew Svodziwa, "STEM Education as a Human Capital Development Strategy for the Industrialization and Modernization of Zimbabwe," *SSRN Electronic Journal*, 2021, https://doi.org/10.2139/ssrn.3788852.
[24] Kyle, "Science Education in Developing Countries: Access, Equity, and Ethical Responsibility."
[25] Tshili, "STEM Training Programme Expanded."
[26] Akiri and Dori, "Professional Growth of Novice and Experienced STEM Teachers."
[27] Kiazai, Siddiqua, and Waheed, "Challenges in Implementing STEM Education and Role of Teacher Education Programs in Mitigating These Challenges."

STEM Research in the International Context

To address the rapidly changing world and the complexities of modern societies, the literature emphasises the importance of motivating students to learn and acquire skills related to STEM subjects and developing teachers. [28] For instance, Fuentes-del-Burgo et al. conducted a study in Spain, highlighting the necessity to promote STEM careers due to the declining enrolments of students in these fields despite promising career opportunities. [29] Their study emphasised that science and technology lecturers play a crucial role in disseminating relevant scientific knowledge and require organisational and institutional support to effectively achieve the objectives of STEM education.

In another study by Ng and Chu in Hong Kong, the focus was on investigating students' motivation to learn STEM through engaging in flight simulation experiences.[30] The study revealed that peer support was the strongest motivator for senior students, followed by intrinsic motivation, while self-efficacy had the least impact.

In the context of addressing skill shortages in STEM fields, Namayanga and Banda in Zambia explored the challenges faced by science teachers in interpreting and implementing STEM curricula.[31] Their findings indicated the need to help and orient teachers in developing curricula, and curricula materials that could help in reconstructing the science curriculum in secondary schools as this impacted on secondary school students' science experiences. Specifically, they had challenges in identifying the general objectives and linking them to methodologies, roles of the teachers and roles of the learners in science curricula. The findings were that the science teachers had no skills to interpret the science curricula as they did not understand the demands of the curricula. In the same vein, Gonzalez and Kuenzi in their study argued that STEM teachers encounter difficulties in developing lesson plans that stimulate students' active and critical thinking to nurture essential STEM skills. [32] These studies underscore the importance of professional teacher development as a critical ingredient in addressing the challenges that effectively hinder STEM education development in schools.

STEM Studies in the Zimbabwean Context

The Zimbabwean context has had its contribution to STEM-related studies. Dekeza and Kufakunesu investigated the views of rural secondary school teachers in Zimbabwe regarding the readiness of rural schools to implement STEM curricula.[33] The study established that 90% of the participants considered rural secondary schools as ill-equipped to implement STEM curricula. They identified various challenges, including a lack of subject matter knowledge, teacher support, and instructional resources. In the same vein, Costa et al. report lack of subject matter knowledge concerning STEM content, lack of teacher support and lack of instructional resources are some of the militating factors.[34] Similarly, Kufakunesu and Dekeza identified barriers to STEM implementation in rural schools, such as the absence of laboratories, trained teachers, and scholarships for STEM students, leading to the conclusion that rural secondary schools faced challenges with STEM curriculum implementation.[35] As a result of teacher and in-school related challenges the study further concluded that rural secondary schools were incapacitated to implement STEM curriculum.

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[28] Maria Cristina Costa et al., "Teacher Professional Development in STEM Education: An Integrated Approach with Real-World Scenarios in Portugal," *Mathematics* 10, no. 21 (October 24, 2022): 3944, https://doi.org/10.3390/math10213944.
[29] Fuentes-del-Burgo et al., "Perceived Barriers and Benefits to Promoting Science and Engineering by University Lecturers through Outreach Lectures to Secondary School Students."
[30] Davy Tsz Kit Ng and Samuel Kai Wah Chu, "Motivating Students to Learn STEM via Engaging Flight Simulation Activities," *Journal of Science Education and Technology* 30, no. 5 (October 24, 2021): 608–29, https://doi.org/10.1007/s10956-021-09907-2.
[31] C. Namayanga and B. Banda, "STEM Curriculum Development, Implementation and Assessment Challenges of Implementing STEM Education in Africa. Experiences of Teacher Curriculum Reflux in Basic School Science," Research Gate, 2021, https://www.researchgate.net/publication/357173401.
[32] Gonzalez and Kuenzi, "Science, Technology, Engineering and Mathematics (STEM) Education: A Primer."
[33] Clyton Dekeza and Moses Kufakunesu, "Implementation of STEM Curriculum in Rural Secondary Schools in Zimbabwe: Limits and Possibilities," *Journal of Emerging Trends in Educational Research and Policy Studies* 8, no. 1 (2017): 11–15.
[34] Costa et al., "Teacher Professional Development in STEM Education: An Integrated Approach with Real-World Scenarios in Portugal."
[35] Dekeza and Kufakunesu, "Implementation of STEM Curriculum in Rural Secondary Schools in Zimbabwe: Limits and Possibilities."

Another study by Kadziya and Ndebele noted a very low Zimbabwe STEM teacher population which stood at 0.04% with the rural areas significantly affected.[36] They examined the experiences of rural STEM teachers, highlighting the need for improvement in the quality of teaching and learning in integrated STEM education in Zimbabwean rural secondary schools and increasing the number of STEM teachers. They concluded that more needs to be done to improve the quality of teaching and learning of STEM subjects in rural day secondary schools. Svodziwa further lamented the shortages of STEM teachers in Zimbabwe especially in rural secondary schools, emphasising the impact on student preparation for post-secondary education and career choices in STEM fields.[37] The study concludes that the success of facilitating student activities depends on how well STEM teachers have been prepared for the challenges they face when engaged in classroom and laboratory instruction. The findings serve as an important indicator of the state of teaching and learning of STEM education in Zimbabwean secondary schools without proper professional teacher development.

Mutseekwa conducted research in Zimbabwe to assess the integration of STEM education in the Science Teacher Education curriculum, revealing that while efforts were made to promote STEM literacy, there was a lack of planned integration, and teachers revealed some gaps in STEM-related literacies.[38] The study suggested the need for collaboration between colleges, schools, professional scientists, and industry to enhance STEM education.

The few studies related to STEM have highlighted the need to focus on teacher professional development and other emerging issues in the STEM field, indicating challenges in implementing STEM education, nationally and globally. Thus, this study contributes to STEM discourses by examining the new STEP initiative in Zimbabwean colleges of education for the professional development of STEM teachers and addressing critical questions arising in the programme's implementation process. These studies present a strong argument that if this is allowed to continue, greater opportunities to develop a meaningful STEM education may be missed.

THEORETICAL FRAMEWORK

Active Learning Theory

This study was couched within the Active Learning framework, which serves as an extension of constructivism. This framework emphasises the active engagement of students in the learning process by connecting new ideas and experiences to their prior knowledge.[39] Active learning entails instructional activities that require students to actively participate and reflect on their actions and is consistent with the instructional design of STEM.[40] It highlights the importance of developing students' skills through engagement in activities that promote higher-order thinking and problem-solving strategies, rather than merely transmitting knowledge which dovetails with STEM education practices.

Furthermore, the Active Learning theory, as noted by Stohlmann et al, centres on student-centred learning, and improves higher-level thinking skills, and problem-solving abilities, which enhance retention of learning outcomes.[41] Implementing this approach enables student teachers to engage in hands-on STEM programmes and activities that expose them to real-world applications which can be logically transferred to learners in the teaching-learning contexts. This, in turn, fosters the development of 21st-century skills such as technology literacy, innovation, flexibility, creativity,

[36] Kadziya and Ndebele, "An Analysis of the Challenges Faced by Teachers in the Delivery of Science, Technology, Engineering and Mathematics Education in Rural Day Secondary Schools in Zimbabwe."
[37] Svodziwa, "STEM Education as a Human Capital Development Strategy for the Industrialization and Modernization of Zimbabwe."
[38] Christopher Mutseekwa, "STEM Practices in Science Teacher Education Curriculum: Perspectives from Two Secondary School Teachers' Colleges in Zimbabwe," *Journal of Research in Science, Mathematics and Technology Education* 4, no. 2 (May 15, 2021): 75–92, https://doi.org/10.31756/jrsmte.422.
[39] Cynthia Brame, "Active Learning," *Vanderbilt University Center for Teaching*, 2016.
[40] Brame, "Active Learning."
[41] Micah Stohlmann, Tamara Moore, and Gillian Roehrig, "Considerations for Teaching Integrated STEM Education," *Journal of Pre-College Engineering Education Research* 2, no. 1 (April 12, 2012): 28–34, https://doi.org/10.5703/1288284314653.

and production.[42] These skills are essential for preparing student teachers to effectively transmit knowledge to secondary school learners in diverse teaching-learning contexts upon their graduation.

Ultimately, the Active Learning framework provides a dynamic and interactive platform for student teachers to actively participate in learning experiences that go beyond traditional teaching methods, fostering critical thinking, and problem-solving, and practical skills development.

METHODOLOGY

Research Design

This study employed a descriptive phenomenological design, focusing on a single case of a college of education implementing the STEP programme in Zimbabwe. The phenomenological approach allowed for a comprehensive in-depth exploration of the lived experiences of participants in the context of STEM education thus strengthening the credibility of the research findings.[43] This design provided a methodological space to understand the perspectives[44] of student teachers and lecturers within the institution and uncover the interconnected and subjective everyday experiences within the STEP programme.[45]

Sample

The participants in this study included five STEP lecturers and ten student teachers at one college of education. The researchers employed purposive and convenience sampling to select participants who could willingly provide rich and detailed inside perspective into the implementation of STEM education under the STEP programme.[46]

Data Collection Instruments

Data was collected through in-depth interviews, non-participant observations, and focus group discussions. The interviews and focus group discussion allowed the researchers, through deep conversation and flexible use of language, to draw the participants' inner voices hence stimulating new ideas.[47] These qualitative instruments enabled the gathering of personal perspectives and experiences related to the implementation of STEM education from the participants. The interpretation of data from these instruments provided a deeper understanding of institutional structures, policies, and practices within the context of the study.

Data Analysis Strategies

The data analysis involved identifying common patterns and themes emerging from the specific experiences of the lecturers and student teachers. These experiences were described using thematic analysis, and findings were reported through vignettes from the research participants.[48] The detailed descriptions of lived experiences enhanced the interpretation of data and provided valuable insights into the implementation of STEM education in Zimbabwean colleges of education.

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[42] National Inventors Hall of Fame, "What Is the Value of STEM Education?," 2023, https://www.invent.org/blog/trends-stem/value-stem-education.

[43] Sonya J. Morgan et al., "Case Study Observational Research: A Framework for Conducting Case Study Research Where Observation Data Are the Focus," *Qualitative Health Research* 27, no. 7 (June 22, 2017): 1060–68, https://doi.org/10.1177/1049732316649160.

[44] Neville Greening, "Phenomenological Research Methodology," *Scientific Research Journal* 7, no. 5 (2019): 88–92; Sadruddin Bahadur Qutoshi, "Phenomenology: A Philosophy and Method of Inquiry.," *Journal of Education and Educational Development* 5, no. 1 (2018): 215–22.

[45] Qutoshi, "Phenomenology: A Philosophy and Method of Inquiry."

[46] Rosalia Lavarda and Christiane Bellucci, "Case Study as a Suitable Method to Research Strategy as Practice Perspective," *The Qualitative Report*, 2022, https://doi.org/10.46743/2160-3715/2022.4296.

[47] Charles Kakilla, "Strengths and Weaknesses of Semi-Structured Interviews in Qualitative Research: A Critical Essay," 2021.

[48] C.Q.P. Andrade and F. Almeida, " How to Improve the Validity and Reliability of Case Study Approach," *Journal of Interdisciplinary Studies in Education* 9, no. 2 (2020): 264–75.

Ethical Considerations

Ethical principles were observed throughout the research process to ensure the protection and confidentiality of participants. Informed consent was obtained from all the participants, and their anonymity and privacy were maintained throughout the study. The researchers also adhered to ethical guidelines and protocols established by the College of Education to uphold the integrity and validity of the research findings.

PRESENTATION OF RESULTS

In reporting the results, the researchers used the descriptive phenomenology constructs and thematic analysis which culminated in the following four emerging themes from data obtained from the lived experiences of the participants in the implementation of the STEP programme: conceptualising the STEM concept, the lecturers' qualifications, the structural aspects of the STEM programme, the institutional infrastructural conditions, support services and lecturer motivation.

Conceptualisation of the STEM Concept

The results show that the STEM concept has been conceived differently by both students and lecturers, ranging from narrow to broad, specific to general and integrated to desegregated. STEM separation rather than integration is how the lecturers and students viewed it.
One lecturer (A) noted:

> *STEM is an acronym for Science, Technology, Engineering and Mathematics. While STEM is limited to those areas, there are also a number of areas that are regarded as STEM subjects like Agriculture, Biology, Physics, Geography etc.*

Lecturer (B) had this to say:

> *Our worry is to develop the student teachers in these STEM areas without being academic about semantics which does not add value to the process.*

Another lecturer (C) teaching on the programme had this to say:

> *STEM education is about teaching and learning all the science subjects and imparting the relevant scientific knowledge to student teachers. STEM is about developing the student teachers' professional competencies in science concepts necessary for teaching in secondary schools.*

Students during focus group discussions also echoed their views about how they conceptualised the term STEM:

> *We understand STEM as acquiring science skills in various subject areas that are relevant to teaching sciences at the secondary school level.*

Asked about the link between these STEM subjects students reported that:

> *What we know is that they are science subjects each taught differently and with its own method. We see very little degree of overlap and even the way we learn them there is no connection.*

Lecturers and student teachers just dealt with the STEM concept without necessarily clarifying and getting into the theoretical aspects of the concept. The participants, it appears, were not worried about the technical details of unpacking the concepts but were seized with the implementation process of the STEM subjects. They myopically conceived STEM from a rudimentary position of simply teaching and learning science subjects. The lecturers had the freedom to implement STEM education at the college according to their capacity and convenience. Therefore, one can conclude that the STEM educational intervention is being implemented at the institution with a narrow focus, without cohesion and a greater understanding of the approach. The participants, however, need to reflect and understand the concepts fully to provide opportunities to develop an impact on STEM education.

Lecturer Qualifications

The face of the STEP programme is the human capital with the requisite knowledge and skills capable of delivering transformative STEM literate teachers for Zimbabwean secondary schools. The lecturers are the professionals who shape STEM knowledge, literacy and development among the student teachers, who, in turn, are to teach the new generation of students in secondary schools. Thus, the lecturers need to exhibit the right academic profiles and experience for effective STEM teaching and learning at the professional teacher development level.

Table 1: Lecturers' Teaching Experience Profiles

Lecturer	**Qualifications**	**Years of tertiary experience in STEM teaching and other teaching experiences**
A	B.Ed.- Physics	1
B	MSc - Biology	3
C	M.Ed.- Chemistry	2
D	MSc- Mathematics	1
E	MSc- ICT	8

Students process STEM knowledge and skills through the lens of lecturers. Thus, developing creative and innovative STEM experiences among student teachers depends largely on the quality of lecturers' knowledge and experience to promote valued hands-on skill sets and activities that support critical thinking, problem-solving and innovation emerging in different contexts. The two lecturers with the most number of years were teaching on the Diploma in Education (primary) programme and recruited to the STEP programme and the rest were recruited from secondary schools when the programme was launched. The table shows that there was a mix of lecturers. However, while they were all qualified the majority did not have adequate years of experience at the tertiary level to model STEM development among the student teachers under the STEP programme.

The lecturers during interviews shared that they have had experience in secondary schools from where they were recruited. Lecturer C opined:

> *While I may not have enough experience to teach at this level, the secondary school experiences I have bring a lot of valuable insights into this programme as I know the kind of contexts where these student teachers are going to operate.*

This response by the lecturer suggests that the STEM experiences from the implementation workplace significantly add value and quality to the programme as they resonate with developments in secondary schools. It gives the impetus to transform the programme to accommodate, in their teaching, real needs and solutions drawn from practical examples obtained from particular and peculiar secondary school contexts. This suggests the importance of a broader set of skills from both secondary schools and tertiary levels to address the challenges of delivering an effective STEM education at the institution.

The Instructional Aspects of the STEM Curriculum

The programme was structured as distinct subjects, the STEM separation, rather than using an integrated approach to STEM implementation.

Lecturer participant A shared:

> *We are experts in our own areas, not masters of all. This is how we have been trained in the Zimbabwean context and while we may have an idea of other STEM areas, we may not be competent enough to effectively teach them to the students in an integrated manner. Thus, the curriculum is organised in a traditional way as we teach each subject separately exclusive of other learning areas. Teaching individual STEM subjects makes me more comfortable and confident in content selection and choice of instructional design strategies. I teach what I know.*

> *After all, you need to understand that these students have to pass the examination at the end of the day.*

Another lecturer C noted:

> *We basically use STEM separation where we teach each STEM subject exclusively from others. While on paper we are supposed to take a practical approach with the practical engagement of students motivated by the new education philosophy Education 5.0 to produce tangible goods and services, this has not materialised on the ground given the resource challenges. We teach them just like any other subject given our resource constraints. So generally, it has been classroom chalk and talk.*

The structural and organisational differences in STEM implementation play a critical role in determining the learning processes as well as achieving desired outcomes. Teaching the distinct STEM subjects clearly defined the role characteristics of the lecturers which gave them a feeling of adequacy and confidence in their teaching as they operated in a realm of familiarity.

Summarising their sentiments concerning how the STEP programme and STEM education have been structured and implemented, students during the focus group discussion had this to say:

> *There is nothing unique about this programme in terms of the way it has been structured and taught. The subjects are taught just like any other. There is very little experimentation, problem-solving in real-life contexts, no field work, and no tours, it's about content devoid of context. This is worsened by the fact that both post O level and A level are enrolled on the programme which means that the lecturers start from the basics and may not pitch too high. Our expectation was that the programme should have enrolled post 'A' level students who have done sciences. We even share notes with those doing the Diploma at the primary level. However, it's good that they are taught as separate subjects, at least we understand better because these subjects are very difficult to comprehend. The organisation of the curriculum in which we are taught each STEM subject separately is consistent with the secondary school curriculum where we are going to teach. We are taught not as integrated but as separate subjects. This helps in the examinations as at least you know the areas that would have been covered during teaching and learning.*

Student teachers, in the focus group discussion, echoed the same sentiments as lecturers that the teaching of these STEM subjects as separate entities allowed breadth and depth of conceptualisation of key concepts. The results suggest that the traditional teaching approaches where emphasis is on content correctness have been used in the teaching of STEM subjects under the STEP programme. The idea was to develop grounded student teachers' learning of specific content and practice skills in a specific learning area that could be applied in real workplace contexts. The students appeared content to operate at low order STEM knowledge level yet that does not create opportunities for them to become innovative and critical thinkers. It is sad that a pedagogy oriented towards memorisation of facts still has a place in STEM education.

The Institutional Infrastructural Conditions

The STEP programme is being implemented at teacher training colleges using existing infrastructure without any additions and improvements given the new programme initiated by the Ministry of Higher Education. The physical resource side was not well planned and managed to pave the way for the implementation of the STEP programme.

Lecturer D noted:

> *We scramble for teaching spaces with the primary school teacher trainees because we do not have a base that we call our own. No new buildings have been constructed to match the new demand because of the programme.*

Lecturer C observed:

> *At times we must teach after hours when the rest of the college student body has finished their lectures thus giving us some organisational burden. There are no teaching spaces.*

Students weighed in during the focus group discussion:

> *We are treated as second-class students at this institution as preference is given to primary student teachers. We get leftovers. We do not have base rooms of our own, we use the only laboratory when the primary students are done and at times, we have to do lectures after hours which is very unfair. It's as if we are not wanted here and we have invaded other people's territory. It is very frustrating.*

The above information illuminates the centrality of adequate infrastructure in providing optimal conditions for the implementation of STEM education at the institution. The warning from these sentiments is that the absence of dedicated structures for the programme has become a barrier to the delivery of meaningful STEM education. The resources were said to be in short supply. These shortages were supported by the observation data below.

Table 2: Observational Checklist Data on Resources

Item	**Quantity**	**Comments**
Laboratories	1	One laboratory is not adequate to cater for the two programmes.
Computers/laptops and internet connectivity	60	Mostly desktops, very old. Inadequate given the student population. Internet connectivity is unreliable and limited to certain areas at the institution.
Consumables	-	Supplies in line with the teaching of STEM subjects like test tubes acids, bickers, and other technology consumables were in short supply.
Book Resources	-	STEM books for independent reading and greater familiarisation with vocabulary, terminology and examples from other contexts that may not be covered in class were either in short supply or very old- very few recent publications.
Drones	1	For a start it's commendable and the hope is that more are availed.
3D printing technology	1	For improved learning, practical skills development, learner engagement and creativity in science learning. These have become critical, yet they are in short supply.
Interactive whiteboards	0	The traditional black chalkboards are used hence no interactive activities and different learning styles in this fast-paced technology-driven education to achieve the best results.
Microscopes	2	Microscopes are a part of the STEM education classroom as they observe small details in species that cannot be seen by the eye and better understand scientific concepts. There were very few.
Magnifying glasses	1	In STEM classrooms magnifying glasses are important in the examination of specimens. Very inadequate.
Scales	10	STEM teaching requires measurements and scales are an important resource, they were old and students shared. Not adequate.

Innovation hub(s)	0	This is where students put theory into practice, experiment with new ideas and develop prototypes. Yet to be constructed.

STEM is a hands-on immersive learning experience which requires a lot of materials especially high-tech gadgets given the technology which goes with the effective implementation of STEM subjects. An ideal STEM curriculum environment allows room for adequate buildings, flexible space for experimenting and other equipment for flipped classrooms, presentations and demonstrations, computers and projectors, internet access and book resources to name some. From the observation made by the researchers, as presented on Table 2, the environment does not provide opportunities to grow critical and creative thinking, experimentation and innovative ideas which cohere with STEM identities. There was no evidence of some prototypes/models done by students to experiment and test new ideas to find solutions to real-life problems. The observation shed light on barriers to successful STEM education implementation which mirror the lack of investment and support of the programme.

The Support System and Lecturer's Motivation

The students and lecturers reported very little support from the government and other education stakeholders to help grow the new programme and enable a smooth take-off. While Zimbabwe Manpower Development Fund (ZIMDEF) was said to be providing funding to the college, there are no funds devoted to the STEP programme, and the college administration used its discretion to determine allocation.

Lecturer A responded:

> *One of the challenges is that we have not been financially supported to deliver this STEP programme. These STEM subjects have a lot of consumables and other important gadgets, yet we are constantly told that the college has no money. It is really frustrating.*

Lecturer C reminded us that:

> *Teaching on a programme when you beg and scramble for everything is very frustrating. There is no specific budget for the programme. When the STEP programme was introduced at the institution, everyone thought it was a stand-alone programme that was going to be well supported by the government and other educational stakeholders and had a separate administration and budget to ensure its smooth takeoff. Unfortunately, that has not been the case. The college principal and his administration make critical decisions on our behalf and at times without consulting us.*

Lecturer E reported that:

> *We have heard that there is some money from ZIMDEF which is meant to support the programme, but we have not been informed about how the money is being used. What we continue to experience are shortages of essential materials. Further, we thought we were a special group of lecturers, and our salaries should have been better than those who are teaching on Diploma in Education (primary). Unfortunately, we just get the same and nothing more. A better salary regime would have motivated us and an incentive to continue teaching on the STEP programme. There is a high lecturer turnover and at times students are without lecturers in some learning areas.*

Lecturer D insisted:

> *I will leave this government employment as soon as I get better offers either in industry or private schools. We do not run short of suitors. Coming here is just a steppingstone to better opportunities.*

Students during focus group discussion voiced their concern about the lack of support:

> *It appears this programme is not well supported by the government and other education stakeholders. It's just like any other teacher development programmes that has suffered neglect and support. The negative ripple effect is that we might not get the required STEM knowledge and hands-on skills to pass on to secondary school learners, thus affecting the future participation of these learners in STEM occupations.*

The participants bemoaned the lack of support of the STEP programme in material terms and motivation. The educational treatment of the programme should be one of the most fundamental and important aspects which should have been given priority and commitment to ensure certainty and derive maximum benefit from it. Lecturers bemoaned the lack of incentives and motivation for teaching on the programme and may explain the staff turnover in the programme.

DISCUSSION OF FINDINGS

The study confirmed what most research studies across the globe discovered regarding the implementation practices and challenges related to STEM education programmes. While the Zimbabwean government has positively reacted to the global economic and education imperative of producing STEM literate teachers as a key element for maintaining competitiveness through the STEP programme being implemented, it is fraught with many challenges. The technology-intensive powered economy, the need for the Fourth Industrial Revolution skills and the increased demand for STEM professionals on the job market are important prerequisites that require a significant focus on STEM skills; prioritise and invest in the participation of the young generation to generate future skills in an evolving economy. This resonates with Svodziwa's observation that STEM education as a human capital development strategy should leverage industrialisation and modernisation of Zimbabwe.[49] The production of STEM human capital has become more critical than ever before for Zimbabwe to achieve an upward sustainable economic development trajectory. The intervention has been noble, but the missing dimension has been careful planning, resource mobilisation and other support services for STEP to succeed. Drawing from the presented data the following themes guided the discussion: Clarification on the STEM on STEP programme, implementation challenges of the STEP programme, examination system impediments to STEM skills development and retention strategies for STEM lecturers.

Clarifications of the STEM Concept on the STEP Programme

Participants in the study expressed confusion regarding how the STEP programme differed from other STEM programmes in various educational contexts. The lack of a clear distinction between STEM as an approach and a discipline, and variations in the understanding of STEM among participants, suggest a need for clarity in conceptualising STEM education. The study notes that the term "STEM" has been broadly embraced without a deep understanding of its implications beyond a general sense and use. The contested and clustered nature of STEM issues has resulted mostly in generalisations. Literature confirms the observation that the term STEM is a slogan that educational communities have embraced without truly taking the time to clarify what the term might mean when applied beyond a general sense.[50] From the findings, it can be argued, then, that STEM education has been vaguely understood hence not providing new directions in STEM implementation at the institution. The STEP perspective in Zimbabwe is to argue using the traditional approach where the disciplines are presented as compartmentalised offering a disconnected and inconsistent variety of facts and skills.[51] Yet consistent with Jamali et al's suggestion, STEM should aim to equip learners with a broad mix of skills and

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[49] Svodziwa, "STEM Education as a Human Capital Development Strategy for the Industrialization and Modernization of Zimbabwe."
[50] Gonzalez and Kuenzi, "Science, Technology, Engineering and Mathematics (STEM) Education: A Primer"; Srikoom, " What Is STEM Education? "; Tobías Martín-Páez et al., "What Are We Talking about When We Talk about STEM Education? A Review of Literature," *Science Education* 103, no. 4 (July 8, 2019): 799–822, https://doi.org/10.1002/sce.21522; Nugraha, Kidman, and Tan, "Pre-Service Teacher in STEM Education: An Integrative Review and Mapping of the Indonesian Research Literature."
[51] Martín-Páez et al., "What Are We Talking about When We Talk about STEM Education? A Review of Literature."

interdisciplinary knowledge given that real-life problems require multiple perspectives, skills and knowledge to be effectively addressed.[52] STEM education aims to equip learners with interdisciplinary skills for solving real-life problems, necessitating a comprehensive understanding of its implementation.

Implementation Challenges of the STEP Education Programme

The study confirmed the challenges faced in implementing STEM education programmes, reflecting global research findings. While the Zimbabwean government has recognised the importance of producing STEM-literate teachers through programmes like STEP, several challenges hinder its success. The study revealed that the inadequate investment in the STEP programme has hindered its effectiveness in creating a conducive environment for STEM education in Zimbabwean secondary schools. The lack of sufficient resources, including context-specific methodologies, student characteristics, and educational intervention conditions, has constrained the successful implementation of the programme. **Table 2** above is a testament to the impoverished state of the programme in terms of resources. The findings echo Martin-Paez's observation that attention must be paid to where (context), how (resources and methodology), who (student characteristics) and in what conditions (characteristics of the educational intervention) the STEM education is developed.[53] The importance of developing a sustainable implementation strategy with a robust budgetary framework to support STEM education initiatives effectively cannot be over-emphasised. In the same vein, Adebayo suggests that it is not enough to develop a programme without reference to an implementation strategy, a monitoring and evaluation framework and a healthy budget line.[54] With the right support, contexts and resources to implement these science subjects, the potential to motivate student teachers to develop a willingness to learn STEM disciplines and lecturers to teach on the programme is great.

The necessity of STEM skills in a technology-intensive economy and the demand for STEM professionals highlight the critical need for investing in STEM education to cultivate future skills and maintain economic competitiveness.[55] The government must prioritise policy directives for training teachers in science and technology to enhance science education in secondary schools, as producing STEM human capital is crucial for sustainable economic development in Zimbabwe.

Examination System Impediments to STEM Skills Development

Participants highlighted the constraints imposed by the Zimbabwean examination system on implementing STEM teaching strategies with very little focus on innovation, problem-solving, and inquiry-based learning. STEM education should be viewed as a teaching strategy that fosters STEM skills acquisition rather than a system driven by examination concerns. The finding is consistent with Su's observation that STEM should be appreciated as a teaching strategy of life science and technology in the modern classroom where examinations do not control the process.[56] STEM teaching should create experiences for student teachers that allow them to acquire STEM skills to be cascaded to secondary school learners in Zimbabwe rather than being seized with examination anxieties. This does not inspire any hope as these STEM student teachers may exhibit gaps in knowledge and skills that can be passed on to learners at the secondary school level.

The STEM initiative and learning process appear to overload students with facts without context and are concerned with the correctness of content which they were obligated to memorise and reproduce in examinations. This may result in the programme being unable to connect students to basic

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[52] Jamali, Ale Ebrahim, and Jamali, "The Role of STEM Education in Improving the Quality of Education: A Bibliometric Study."
[53] Martín-Páez et al., "What Are We Talking about When We Talk about STEM Education? A Review of Literature."
[54] R. Adebayo, "Science, Technology, Engineering and Mathematics (STEM) as an Enabler for Development and Peace," Office of the Special Adviser on Africa: New York USA, 2022, https://www.un.org/osaa/sites/www.un.org.osaa/files/docs/2116613_stem_policy_paper_web_rev.pdf .
[55] Svodziwa, "STEM Education as a Human Capital Development Strategy for the Industrialization and Modernization of Zimbabwe."
[56] Su, "The Challenge and Opportunities of STEM Learning Efficacy for Living Technology Through a Transdisciplinary Problem-Based Learning Activity."

science applications which Kondrla calls fact-oriented pedagogy.[57] The reliance on fact-oriented pedagogy and memorisation for examinations may hinder student teachers from effectively imparting STEM knowledge to secondary school learners. This finding is contrary to the tenets of the Active Learning theory which Brame reminds us that it subordinates to instructional activities that involve students in doing things and thinking about what they are doing.[58] Su reckons that STEM can be a powerful educational approach which when well implemented, can make an evidential contribution to the perceptions of students about the world and help to solve practical problems through practical learning.[59] In STEM teaching, there is a need to debunk the myth that reliance on lecturer-centred teaching practices creates a better understanding of a more eclectic approach to the construction of STEM knowledge and skills where student teachers are engaged and empowered with experiential ways to contribute to meaning-making and problem-solving. The findings suggest a need for a paradigm shift towards experiential and problem-based learning approaches to enhance STEM education.

Retention Strategies for STEM Lecturers

The success of the STEP programme in reshaping the science teacher supply in Zimbabwean secondary schools may be jeopardised by the lack of retention strategies for STEM lecturers. The commitment of these lecturers to the programme is undermined by insufficient salary structures and benefits, potentially leading to a talent drain to more lucrative career options. The finding dovetails with Tikly, et al's report that recruiting and retaining teachers for STEM subjects is difficult for two reasons namely; there is a shortage of people with sufficient subject knowledge and teachers who do have sufficient subject knowledge go into other, more attractive, careers than teaching.[60] To ensure the success of initiatives like STEP, efforts must be made to retain skilled STEM teachers through attractive remuneration packages and professional development opportunities. Therefore, the call is to look after STEM lecturers to ensure the success of the STEP programme meant to promote and increase interest in STEM subjects in Zimbabwean secondary schools.

The findings underscore the importance of addressing implementation challenges, clarifying STEM education concepts, securing adequate resources, revising examination systems, and retaining qualified STEM teachers to enhance the effectiveness of STEP education programmes in Zimbabwe. Efforts to improve STEM education practices can lead to a more engaging and impactful learning experience for both student teachers and secondary school learners.

RECOMMENDATIONS

- The need to implement a comprehensive STEM curriculum that focuses on real-world applications, hands-on learning experiences, and interdisciplinary approaches to enhance students' problem-solving skills and critical thinking abilities cannot be overemphasised.
- Government and other educational stakeholders should provide additional support and resources for STEM teachers, such as professional development opportunities, mentorship programmes, and access to cutting-edge technology and tools.
- There is a need to develop partnerships between colleges of education, industry, and government to ensure that STEM education aligns with the needs of the workforce and economy, and to facilitate the sharing of resources and expertise which will go a long way to enhance the STEP programme.

[57] Peter Kondrla et al., "The Philosophical Context of Curriculum Innovations with a Focus on Competence Development," *Journal of Education Culture and Society* 14, no. 2 (2023): 78–92.
[58] Brame, "Active Learning."
[59] Su, "The Challenge and Opportunities of STEM Learning Efficacy for Living Technology Through a Transdisciplinary Problem-Based Learning Activity."
[60] Tikly et al., "Supporting Secondary School STEM Education for Sustainable Development in Africa."

- There is also a need to establish a monitoring and evaluation system to track the effectiveness of STEM initiatives and identify areas for improvement, in order to ensure the long-term success and sustainability of the STEP education programme in Zimbabwe.

CONCLUSION

The study's thrust was to construct a comprehensive understanding of the complexities surrounding the implementation of the STEP and the implications for STEM education in Zimbabwean colleges of education. The findings revealed conflicting perspectives and contestations concerning the success of the STEP programme and its potential to enhance STEM teaching and learning in secondary schools in Zimbabwe. On one hand, there was a consensus that the STEP programme represents a positive response to meeting the increasing demand for diverse science disciplines in a rapidly evolving knowledge economy where STEM education plays a crucial role. However, other participants also highlighted implementation challenges and deficiencies that reside in quality assurance, which have hindered the modelling of essential skills, knowledge, and attributes among student teachers to effectively implement STEM education in secondary schools.

The study concludes that the STEP programme at the institution may encounter similar challenges faced by its predecessors due to the significant hurdles it faces at the onset. The programme's key limitation lies in its failure to provide student teachers with opportunities to innovate, experiment, solve real-life problems, think critically, analyse real-world contexts, and generate new practical ideas and solutions which are fundamental aspects of STEM education. Despite the task of developing STEM literacy and interest among secondary school learners falling on these teachers, they are ill-prepared and lack adequate support to fulfil this role effectively. In essence, the STEP programme must undergo significant revisions and enhancements to empower student teachers with the necessary skills and competencies to deliver high-quality STEM education in Zimbabwean secondary schools. Addressing the identified implementation challenges, improving quality assurance mechanisms, and developing a culture of innovation and problem-solving are vital steps to ensure the success and sustainability of STEM education initiatives in Zimbabwe. In equipping teachers with the tools and resources needed to engage, inspire, and support secondary school students in STEM disciplines, Zimbabwe can pave the way for a more dynamic and impactful approach to science and technology education for the future.

BIBLIOGRAPHY

Adebayo, R. "Science, Technology, Engineering and Mathematics (STEM) as an Enabler for Development and Peace." Office of the Special Adviser on Africa: New York USA, 2022. https://www.un.org/osaa/sites/www.un.org.osaa/files/docs/2116613_stem_policy_paper_web_rev.pdf .

Akiri, Effrat, and Yehudit Judy Dori. "Professional Growth of Novice and Experienced STEM Teachers." *Journal of Science Education and Technology* 31, no. 1 (February 16, 2022): 129–42. https://doi.org/10.1007/s10956-021-09936-x.

Andrade, C.Q.P., and F. Almeida. " How to Improve the Validity and Reliability of Case Study Approach." *Journal of Interdisciplinary Studies in Education* 9, no. 2 (2020): 264–75.

Ardianto, Didit, Bibin Rubini, and Indarini Dwi Pursitasari. "Assessing STEM Career Interest among Secondary Students: A Rasch Model Measurement Analysis." *Eurasia Journal of Mathematics, Science and Technology Education* 19, no. 1 (2023): em2213.

Badmus, Olalekan Taofeek, and Loyiso C. Jita. "Investigation of Factors Influencing Career Choice among STEM Undergraduates in Nigeria Universities." *Eurasia Journal of Mathematics, Science and Technology Education* 19, no. 1 (January 14, 2023): em2221. https://doi.org/10.29333/ejmste/12838.

Bao, Lei, Li Xie, Shihong Ma, Cheng Chen, Xiangqun Zhang, Min He, Hui Lu, et al. "The STEM Aspirations of China's Future Workforce." *Journal of Science Education and Technology* 32, no. 4 (August 1, 2023): 567–82. https://doi.org/10.1007/s10956-023-10044-1.

Brame, Cynthia. "Active Learning." *Vanderbilt University Center for Teaching*, 2016.

Costa, Maria Cristina, António Manuel Dias Domingos, Vítor Duarte Teodoro, and Élia Maria Rodrigues Guedes Vinhas. "Teacher Professional Development in STEM Education: An Integrated Approach with Real-World Scenarios in Portugal." *Mathematics* 10, no. 21 (October 24, 2022): 3944. https://doi.org/10.3390/math10213944.

Dekeza, Clyton, and Moses Kufakunesu. "Implementation of STEM Curriculum in Rural Secondary Schools in Zimbabwe: Limits and Possibilities." *Journal of Emerging Trends in Educational Research and Policy Studies* 8, no. 1 (2017): 11–15.

Fuentes-del-Burgo, Joaquín, Juan Manuel Sánchez-Tomás, José Antonio Ballesteros Garrido, Francisco Javier Castilla-Pascual, and José Luis González-Geraldo. "Perceived Barriers and Benefits to Promoting Science and Engineering by University Lecturers through Outreach Lectures to Secondary School Students." *Journal of Technology and Science Education* 13, no. 3 (July 21, 2023): 673. https://doi.org/10.3926/jotse.2159.

Gonzalez, H.B., and J.J. Kuenzi. "Science, Technology, Engineering and Mathematics (STEM) Education: A Primer." Congressional Research Service, 2012. https://viterbik12.usc.edu/wp-content/uploads/2017/03/STEM-Education-Primer.pdf.

Greening, Neville. "Phenomenological Research Methodology." *Scientific Research Journal* 7, no. 5 (2019): 88–92.

Jamali, Seyedh Mahboobeh, Nader Ale Ebrahim, and Fatemeh Jamali. "The Role of STEM Education in Improving the Quality of Education: A Bibliometric Study." *International Journal of Technology and Design Education* 33, no. 3 (July 8, 2023): 819–40. https://doi.org/10.1007/s10798-022-09762-1.

Kadziya, Lizias, and Clever Ndebele. "An Analysis of the Challenges Faced by Teachers in the Delivery of Science, Technology, Engineering and Mathematics Education in Rural Day Secondary Schools in Zimbabwe," 2020. https://api.semanticscholar.org/CorpusID:223603119.

Kakilla, Charles. "Strengths and Weaknesses of Semi-Structured Interviews in Qualitative Research: A Critical Essay," 2021.

Kiazai, Abdul Nasir, Naila Siddiqua, and Zarina Waheed. "Challenges in Implementing STEM Education and Role of Teacher Education Programs in Mitigating These Challenges." *International Journal of Distance Education and E-Learning* 5, no. 2 (2020): 123–37.

Kondrla, Peter, Radoslav Lojan, Patrik Maturkanič, Yulia Nickolaeva Biryukova, and Ernel González Mastrapa. "The Philosophical Context of Curriculum Innovations with a Focus on Competence Development." *Journal of Education Culture and Society* 14, no. 2 (2023): 78–92.

Kyle, William C. "Science Education in Developing Countries: Access, Equity, and Ethical Responsibility." *Journal of the Southern African Association for Research in Mathematics, Science and Technology Education* 3, no. 1 (1999): 1–13.

Lavarda, Rosalia, and Christiane Bellucci. "Case Study as a Suitable Method to Research Strategy as Practice Perspective." *The Qualitative Report*, 2022. https://doi.org/10.46743/2160-3715/2022.4296.

Martín-Páez, Tobías, David Aguilera, Francisco Javier Perales-Palacios, and José Miguel Vílchez-González. "What Are We Talking about When We Talk about STEM Education? A Review of Literature." *Science Education* 103, no. 4 (July 8, 2019): 799–822. https://doi.org/10.1002/sce.21522.

Martynenko, Oksana O., Olga V. Pashanova, Andrey V. Korzhuev, Alexey I. Prokopyev, Natalia L. Sokolova, and Ekaterina G. Sokolova. "Exploring Attitudes towards STEM Education: A Global Analysis of University, Middle School, and Elementary School Perspectives." *Eurasia Journal of Mathematics, Science and Technology Education* 19, no. 3 (March 1, 2023): em2234. https://doi.org/10.29333/ejmste/12968.

Mohr-Schroeder, Margaret J., Sarah B. Bush, Cathrine Maiorca, and Megan Nickels. "Moving Toward an Equity-Based Approach for STEM Literacy." In *Handbook of Research on STEM Education*, 29–38. Routledge, 2020. https://doi.org/10.4324/9780429021381-4.

Morgan, Sonya J., Susan R. H. Pullon, Lindsay M. Macdonald, Eileen M. McKinlay, and Ben V. Gray. "Case Study Observational Research: A Framework for Conducting Case Study Research Where Observation Data Are the Focus." *Qualitative Health Research* 27, no. 7 (June 22, 2017): 1060–68. https://doi.org/10.1177/1049732316649160.

Mutseekwa, Christopher. "STEM Practices in Science Teacher Education Curriculum: Perspectives from Two Secondary School Teachers' Colleges in Zimbabwe." *Journal of Research in Science, Mathematics and Technology Education* 4, no. 2 (May 15, 2021): 75–92. https://doi.org/10.31756/jrsmte.422.

Namayanga, C., and B. Banda. "STEM Curriculum Development, Implementation and Assessment Challenges of Implementing STEM Education in Africa. Experiences of Teacher Curriculum Reflux in Basic School Science." Research Gate, 2021. https://www.researchgate.net/publication/357173401.

National Inventors Hall of Fame. "What Is the Value of STEM Education?," 2023. https://www.invent.org/blog/trends-stem/value-stem-education.

Ng, Davy Tsz Kit, and Samuel Kai Wah Chu. "Motivating Students to Learn STEM via Engaging Flight Simulation Activities." *Journal of Science Education and Technology* 30, no. 5 (October 24, 2021): 608–29. https://doi.org/10.1007/s10956-021-09907-2.

Nugraha, Muhamad Gina, Gillian Kidman, and Hazel Tan. "Pre-Service Teacher in STEM Education: An Integrative Review and Mapping of the Indonesian Research Literature." *Eurasia Journal of Mathematics, Science and Technology Education* 19, no. 5 (2023): em2262.

Qutoshi, Sadruddin Bahadur. "Phenomenology: A Philosophy and Method of Inquiry." *Journal of Education and Educational Development* 5, no. 1 (2018): 215–22.

Srikoom, W. " What Is STEM Education? ." Research Gate, 2018. https://www.researchgate.net/publication/346664196-what-is-STEM-EDUCATION.

Stohlmann, Micah, Tamara Moore, and Gillian Roehrig. "Considerations for Teaching Integrated STEM Education." *Journal of Pre-College Engineering Education Research* 2, no. 1 (April 12, 2012): 28–34. https://doi.org/10.5703/1288284314653.

Su, King-Dow. "The Challenge and Opportunities of STEM Learning Efficacy for Living Technology Through a Transdisciplinary Problem-Based Learning Activity." *Journal of Science Education and Technology* 33, no. 4 (August 24, 2024): 429–43. https://doi.org/10.1007/s10956-024-10094-z.

Svodziwa, Mathew. "STEM Education as a Human Capital Development Strategy for the Industrialization and Modernization of Zimbabwe." *SSRN Electronic Journal*, 2021. https://doi.org/10.2139/ssrn.3788852.

Tikly, L., M Joubert, A. M. Barrett, D. Bainton, L Cameron, and H. Doyle. "Supporting Secondary School STEM Education for Sustainable Development in Africa." Bristol Working Papers in Education Series, 2018.

Tshili, N. "STEM Training Programme Expanded." *The Herald:Zim Papers*, August 29, 2023. https://www.herald.co.zw/stem-training-programme-expanded.

White, David W. "What Is STEM Education and Why Is It Important." *Florida Association of Teacher Educators Journal* 1, no. 14 (2014): 1–9.

Winberg, Christine, Hanelie Adendorff, Vivienne Bozalek, Honjiswa Conana, Nicola Pallitt, Karin Wolff, Thomas Olsson, and Torgny Roxå. "Learning to Teach STEM Disciplines in Higher Education: A Critical Review of the Literature." *Teaching in Higher Education* 24, no. 8 (2019): 930–47.

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