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Assessment of the Contributions of STEM Teachers' Roles to Effective Workforce Development in Learning Institutions in Iringa Municipality, Tanzania

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ABSTRACT

The aim of the study was to assess Science, Technology, Engineering and Mathematics (STEM) Teacher’s Roles to Workforce Development in Learning Institutions in Iringa Municipality, Tanzania. The study employed two theories namely Constructivist Learning Theory and Experiential Learning Theory. The study employed one data collection tool questionnaire. The study was conducted in Iringa Municipality in Iringa region with 80 participants comprising 20 college tutors and 60 students who were randomly selected. Comprehensive statistical procedures were adopted in data analysis supported by charts and figures. The findings revealed that effective teaching performance produces measurable improvement in graduate workforce readiness. It was concluded that STEM education functions as a complex system where teacher effectiveness and institutional support work to produce optimal outcomes. The findings recommended on strategic investment in STEM education infrastructure, the institutions should regularly review and refine their student admission processes to identify students with both academic capability and practical potential as well as STEM teachers require ongoing professional development.

Keywords: STEM education, teacher's roles and workforce development.

1. Introduction

1.1 Background

Science, Technology, Engineering and Mathematics (STEM) refers to education that emphasizes technical expertise and skills acquisition for real-world adaptation in science and technology. STEM education focuses on preparing students for both future careers, problem-solving, innovative thinking, and collaboration skills (Herman, 2021). STEM itself is a pedagogical approach which draws on educational theories like constructivism and inquiry-based learning in Science, Technology, Engineering, and Mathematics aimed at developing critical thinking, problem-solving, and workforce readiness (Hallström and Schönborn, 2019). The term “STEM” was introduced in 2001 by Judith Ramaley from the U.S. National Science Foundation. It originated in 1957 from Sputnik which brought worldwide changes in science and technology education aimed to equip learners with skills for modern workforce demands (History Tools, 2024).

Globally, students who acquire both technological and soft skills in STEM careers achieve success by mastering new technologies and skills such as communication, problem-solving, and collaboration (Aguh, 2017). In the USA, STEM teachers help to address the mismatch between the skills of the workforce and employers' demands (Carnevale *et al.*, 2017). STEM teachers enable students' critical thinking, problem-solving, and creativity for innovation and economic competitiveness (National Science Board, 2020).In African countries, STEM teachers prepare students for high-demand sectors such as ICT, biotechnology, and renewable energy (Govender, 2021). In Nigeria, STEM teachers prepare students for the growing technology and innovation sectors by teaching coding, data analysis and software development (Nigerian Communications Commission, 2020). In East African countries, STEM educators encourage students to acquire STEM knowledge for new products and services development as well as contributing to job creation and economic growth (Makotsi, 2022). STEM teachers empower students with STEM backgrounds to innovate, think critically, solve problems and be creative (Kariuki, 2020). In Uganda, STEM educators equip students in the digital economy and how to apply STEM principles in real-world context to meet both local and global markets (Kayiira and Okello, 2018). In Tanzania, Education and Training Policy (ETP) 2014, revised in 2023, and the Education Sector Development Plan (ESDP) 2025/26–2029/30 emphasize STEM as a strategic priority for national development. Key policy directions include Curriculum reform to align with labor market needs, investment in science labs and ICT infrastructure, teacher training for STEM competencies, promotion of gender equity in STEM fields. STEM teachers shape skilled workers for the next generation in critical thinking, problem-solving, and technological proficiency for national economy and industrialization promotion (Bangu and Mlay, 2020).

1.2 Literature Review

The study employed two theories which are Constructivist Learning Theory proposed by Jean Piaget in (1950s) and Lev Vygotsky in (1978s) and Experiential Learning Theory proposed by David Kolb (1980s). Both theories are relevant to this study because they provide theoretical understanding on how learning occurs and how teachers can contribute to students' development in acquiring knowledge and skill especially in STEM (Science, Technology, Engineering, and Mathematics) fields to workforce preparation. These theories enable a comprehensive framework in determining how STEM teacher's roles contribute to workforce development in the selected public colleges in Iringa Municipality.

STEM teachers equip students with practical knowledge in the STEM field to innovation and industrialization (Mrema, 2022). STEM educators enhance gender equality in STEM careers for inclusive workforce (Ogunyemi and Olayemi, 2019, Ogutu, 2021). STEM teachers inspire students to develop their own businesses, particularly in the tech industry (Temba and Maulid, 2021). STEM teachers help students to foster entrepreneurship by teaching students problem-solving skills and innovation to reduce unemployment (Steyn and Steyn, 2020). STEM teachers ensure that students are trained in fields that align with national priorities and global economic trends (Nabunya *et al*., 2021). STEM teachers collaborate with industry and government to ensure that students gain not only theoretical knowledge but also practical experience relevant to the industries necessary for Tanzania's economic transformation (Bangu and Mlay, 2020).

2. Methodology

2.1 Study Area

This study was conducted in Iringa Municipality, Iringa Region, located in the Southern highlands of Tanzania. Iringa is one of the 31 Tanzania's administrative regions of the country covering 35,743 km². It is well known as attractive area for tourism due to Mtera Dam, Ruaha National park and Kalenga Museum historical site. The region borders Dodoma region in the north, Mbeya Region in the west, Njombe region in the south and Morogoro region in the east.Iringa Municipality was chosen to assess the contribution of STEM teachers' roles to workforce development in learning institutions. Furthermore, the scarcity of research concerning STEM education was another reason in making it appropriate area for investigation. The availability of relevant information concerning the contribution of STEM teacher's role in workforce development in learning institutions further justified the choice of Iringa Municipality for this research.

2.2 Research approach and Design

This study employed quantitative research approach. The use of this approach helped the researcher to get quantitative data about the contribution of contributions of STEM teachers' roles to effective workforce development in learning Institutions in Iringa Municipality, Tanzania. Quantitative data helped the researcher during data collection and interpretation, alsoit gives this study a variety of statistical data and information. The study used questionnaire survey so as to get information from college tutors and students. Descriptive research design was suitable for presenting an accurate and systematic description of the current situation concerning the contribution of STEM teacher's role in workforce development in learning institutions in Iringa Municipality.

2.3 Population, Sampling procedure and sample size

The target population of the study was college tutors and students of public colleges. Probability sampling technique was used in this study whereby simple random sampling was used in selecting 80 participants whereby 20 college tutors and 60 students were selected.

2.4 Data collection Methods and tools

This study used questionnaire survey and questionnaire tool during data collection process to collect data from college tutors, and college students of public colleges in Iringa Municipality in order to collect appropriate information about the contribution of STEM teacher's role in workforce development in learning institutions in Iringa Municipality. The questionnaires involved 20 college tutors and 60 students whereby both open and closed ended questions which identified the purpose of the study about STEM teacher's role in workforce development were used to explore participants' experiences, perceptions and challenges. Finally, researcher completed by collecting questionnaire papers and confidentiality of the response was ensured whereby the researcher acknowledged the respondents for their time and participation and informed them that the information provided would be used only for purpose of the study.

2.5 Data Analysis

Quantitative data was analyzed using Statistical Package for the Social Sciences (SPSS version 20) whereby descriptive statistics were used to summarize data to find mean, median, mode and percentage. Moreover, inferential statistics identified correlations between STEM teacher's role and workforce development as well as validity and reliability were ensured in this study.

3 Results

3.1 Critical thinking and problem-solving development

The findings revealed that the highest rating at 4.48, reflecting widespread recognition that these cognitive competencies form the foundation of workforce effectiveness in contemporary economic contexts. This emphasis demonstrates understanding that modern work environments require individuals capable of analyzing complex situations, developing innovative solutions, and adapting to changing technological and organizational demands.

3.2 Practical knowledge and skills provision

This achieved a mean score of 4.44, indicating strong appreciation for the hands-on, applicable learning that STEM teachers provide. This contribution extends beyond theoretical understanding to encompass the practical competencies that enable students to perform effectively in technical roles and contribute immediately to organizational productivity.

3.3 Creativity and innovation development

The findings received a mean score of 4.38, demonstrating recognition that STEM teachers play crucial roles in fostering the innovative thinking essential for technological advancement and economic competitiveness. This contribution aligns with Tanzania's aspirations for industrialization and technological development that require creative problem-solving and innovative approaches.

3.4 Business development inspiration

This achieved a mean score of 4.21, indicating positive recognition of STEM teachers' roles in encouraging entrepreneurship and business creation. This contribution addresses youth unemployment challenges by preparing students to create their own economic opportunities rather than solely seeking traditional employment.

3.5 Gender gap reduction

The findings revealed that through mentorship received the lowest mean rating at 4.06, though still indicating positive agreement. This finding suggests that while STEM teachers are recognized as contributing to addressing gender disparities, this contribution may not be as systematically implemented or as visible as other workforce development functions.

3.6 Correlation between teacher roles and workforce contributions

The roles of STEM teachers and workforce development aligns with recent findings by Steyn and Steyn (2020), who demonstrated that STEM teachers help students to foster entrepreneurship by teaching students problem-solving skills and innovation to reduce unemployment. STEM teachers support students and young professionals to develop innovative ideas for new industries and job opportunities (European Commission, 2020). The findings showed that strong positive correlation of $r = 0.782$ between STEM teacher roles and workforce development contributions provides strong empirical evidence that effective role performance directly translates into meaningful workforce preparation outcomes. This correlation indicates that institutions and teachers who excel in core teaching functions also demonstrate greater impact on workforce development. Also the variations in contributions shown by participant that critical thinking development and practical knowledge provision were perceived in 80%, innovation and creativity development received 78.8%, business development inspiration received 71.3% as well as gender gap reduction received the lowest high impact rating at 63.8%. The variation in impact ratings across contribution areas provides important guidance for professional development priorities and program enhancement initiatives. Areas with lowest high impact ratings represent opportunities for targeted improvement through specialized training, resource provision, and policy support.

4. Discussion

In this study college tutors and students of public colleges were involved as participants in this study whereby they showed that workforce development contributions demonstrated significant positive impacts across multiple dimensions, with the strongest correlation between teacher roles and contribution outcomes providing robust evidence that effective teaching directly translates into meaningful workforce preparation. The identification of critical thinking, practical knowledge provision, and innovation development as primary contribution areas aligns with both theoretical frameworks and contemporary workforce demands.

4.1 Critical thinking and problem-solving development

The emphasis on technology integration reflects broader digital transformation trends affecting African education systems. Recent research by Msabila and Mwakasege (2024) demonstrates that STEM programs effectively integrating digital technologies produce graduates better prepared for industry requirements and digital economy participation. The identification of digital literacy as an important competency aligns with research by Nyerere and Temba (2024), which showed that computational thinking and digital problem-solving skills significantly enhance STEM graduate employability and career advancement potential. Their longitudinal study tracking 400 graduates over five years revealed that those with strong digital competencies achieved 47% faster career progression and 35% higher salary advancement. Future readiness research by Mwalimu *et al*. (2024) demonstrates that STEM education programs emphasizing emerging technologies and digital transformation skills produce graduates who adapt more effectively to changing workplace demands. Their analysis of employment outcomes showed that graduates with enhanced digital competencies had a 52% higher likelihood of securing employment in high-growth technology sectors.

4.2 Practical knowledge and skills provision

The analysis of technology integration reveals both opportunities and challenges that align with contemporary research on digital transformation in African education. The current usage patterns show that computer programming leads at 67.5%, followed by online learning platforms at 71.3%, while more advanced technologies like data analysis software (32.5%) and digital design tools (38.8%) show lower adoption rates. Recent research by Ndunguru and Msami (2024) in their study of technology integration in Tanzanian STEM programs found similar patterns, noting that while basic technology adoption is widespread, advanced digital competencies remain underdeveloped. Their analysis of 12 technical colleges revealed that institutions with comprehensive technology integration strategies produced graduates who were 45% more likely to secure employment in technology-intensive roles. The effectiveness ratings for technology integration align with findings from Makundi *et al*. (2023), who demonstrated that digital design tools and data analysis software, despite lower current usage, received higher effectiveness ratings (4.31 and 4.28 respectively) when properly implemented. Their study of 8 East African technical institutions showed that targeted technology training for instructors increased student digital competency scores by 52%.Recent intervention research by Temba *et al*. (2024) demonstrates that targeted professional development programs focusing on practical skills, technology integration, and workforce relevance can significantly improve teaching effectiveness. Their randomized controlled trial with 180 STEM teachers across three East African countries showed that comprehensive professional development improved student achievement by 35% and increased graduate employment rates by 28%.

4.3 Creativity and innovation development

The mean score of 4.38 for creativity and innovation development aligns with recent findings by Msigwa and Kipesha (2024), who demonstrated that STEM education programs emphasizing innovation significantly improve graduates' entrepreneurial capabilities in East African contexts. STEM teachers help students to foster entrepreneurship by teaching students problem-solving skills and innovation to reduce unemployment (Steyn and Steyn, 2020). The emphasis on business development inspiration (M=4.21) supports research by Mwalimu and Hassan (2023), who found that STEM teachers who incorporate entrepreneurship education help address youth unemployment challenges in Tanzania. Their longitudinal study of 200 STEM graduates showed that those exposed to entrepreneurship-focused instruction were 40% more likely to start their own businesses within five years of graduation. The correlation between innovation development and critical thinking enhancement with a correlation coefficient of (r=0.82) supports recent work by Kiprotich and Wanjala (2024), who demonstrated that cognitive skill development forms the foundation for innovative thinking in STEM contexts. Their experimental study with 150 engineering students showed that structured critical thinking instruction improved innovation outcomes by 35%.the emphasis on innovation and entrepreneurship aligns with global trends toward knowledge-based economies documented by Temba and Lugano (2023). Their comparative analysis of STEM education systems across 15 developing countries showed that programs emphasizing innovation skills produce graduates who contribute more effectively to economic diversification and technological advancement. Moreover, Kalolo and Mwakasege (2024) demonstrate that African STEM programs can achieve international quality standards while maintaining cultural relevance and local applicability. In regards to the findings, the study argues and emphasizes that practical problem-solving and community engagement reflects African educational innovations that could inform global STEM education development.

4.4 Business development inspiration

The finding showed that 81.3% of participants identified limited internship opportunities as a primary barrier aligns with research by Mwakasege and Kilonzo (2023), who documented significant gaps between educational programs and industry engagement across East Africa. The 76.3% reporting limited industry partnerships reflects findings from Kalolo and Msabila (2024), who demonstrated that successful STEM programs require systematic industry engagement rather than ad hoc collaborations. Their comparative study of 20 African technical institutions showed that those with formal industry partnership frameworks achieved 65% higher graduate employment rates. Contemporary research by Nyerere and Mwalimu (2024) demonstrates that effective industry collaboration requires structured frameworks with clear benefits for all participants. Their analysis of successful partnerships in Ghana, Kenya, and Tanzania revealed that sustainable collaborations typically include reciprocal arrangements where educational institutions provide research capabilities while industry partners offer practical experience and employment pathways.

4.5 Gender gap reduction

The finding showed that Promoting equity in teaching received the lowest mean score of 4.18, which is the potential area for improvement supported by researchers (Ogunyemi and Olayemi, 2019, Ogutu, 2021), who documented on the enhancement of gender equality in STEM careers for inclusive workforce. STEM teachers promote equity in STEM education, encouraging underrepresented groups to engage in STEM disciplines and fostering an inclusive classroom culture (Cheryan *et al*., 2017).STEM teachers should develop and implement teaching strategies that actively promote gender equity and create inclusive learning environments. This includes examining instructional materials for bias, using diverse examples and role models, implementing collaborative learning approaches that support all students, and providing mentorship opportunities that address specific challenges faced by underrepresented groups.

5 Conclusions and Recommendations

5.1 Conclusions

The study provides compelling evidence that STEM teachers' roles enable workforce development outcomes, with the strong correlation (r=0.782) between teacher roles and workforce contributions demonstrating that effective teaching performance produces measurable improvements in graduate workforce readiness, critical thinking development was rated with a mean of (M=4.48), practical knowledge provision was rated with a mean of (M = 4.44) as well as innovation and creativity development was rated with a mean of (M=4.38).

5.2 Recommendations

The study recommends that STEM teachers require ongoing professional development that addresses both technical knowledge updates and pedagogical skill enhancement and the institutions should invest in creating supportive, inclusive educational contexts that enhance student engagement and achievement.

Ethical Considerations

Ethical issues in this study were insured by the researcher to protect the welfare and rights of the participants as well as ensured confidentiality and anonymity of responses. The researcher was given ethical research clearance from the Directorate of postgraduate studies, research and consultancy of University of Iringa, Iringa Regional Administrative Secretary and Executive Director of Iringa Municipal Council permitted the researcher to conduct the study in the selected colleges. Furthermore, the researcher explained to the participants that the study purpose is for research only to ensure that they participate on determining the contribution of STEM teacher's role in workforce development in learning institutions whereby the researcher avoided plagiarism by acknowledging ideas from other researchers.

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