Open Access Library Journal
2026, Volume 13, e15078
ISSN Online: 2333-9721
ISSN Print: 2333-9705

Research on Strategies for Enhancing Primary School Science Education in Africa Based on Innovative Teaching Resources: A Case Study of Tanzania

Shitian Shen, Xiaoyan Lu, Jiaying Chen, Qian Li

Joint Education Institute of Zhejiang Normal University and the University of Kansas, Zhejiang Normal University, Jinhua, China
Email: 2867296319@qq.com

How to cite this paper: Shen, S.T., Lu, X.Y., Chen, J.Y. and Li, Q. (2026) Research on Strategies for Enhancing Primary School Science Education in Africa Based on Innovative Teaching Resources: A Case Study of Tanzania. *Open Access Library Journal*, **13**: e15078.
https://doi.org/10.4236/oalib.1115078

Received: February 28, 2026
Accepted: March 14, 2026
Published: March 17, 2026

Abstract

Taking Tanzania as an example, this paper systematically analyzes the current situation and challenges of primary school science education in Africa through questionnaires and interviews. The study points out that the lack of teaching resources, limited professional knowledge of teachers, and low learning interest among students are the core issues currently facing primary school science education in Africa. In response to these problems, this paper innovatively proposes specific strategies for introducing innovative teaching resources and Project-Based Learning. By combining questionnaire data and interview records, it demonstrates the feasibility and effectiveness of these strategies in improving the quality of primary school science education in Tanzania, providing a scientific basis and practical reference for science education in Africa.

Subject Areas

Pedagogy

Keywords

Science Education, Primary School, Tanzania, Project-Based Learning, Education Enhancement Strategies

1. Introduction

In the context of balanced global educational development, science education, as a key factor in cultivating innovative talents and promoting social progress, has become increasingly prominent in importance [1]. The United Nations Educa-

tional, Scientific and Cultural Organization (UNESCO) clearly states in the Education 2030 Framework for Action that science education is an important way to promote global sustainable development and achieve educational equity and quality improvement [2]. However, due to historical, economic, and social constraints, the development of primary school science education in Africa lags relatively behind and faces numerous challenges [3].

As an important country in Africa, Tanzania's educational situation to some extent reflects the overall picture of education in Africa. Although the Tanzanian government has made certain achievements in education popularization, problems such as a lack of teaching resources, a weak teaching force, and single-teaching methods still exist in the field of primary school science education [4]. These issues severely restrict the improvement of educational quality, resulting in generally low scientific literacy among students and making it difficult for them to meet the demand for innovative talents in future society.

With the rapid development of information technology and the continuous renewal of educational concepts, innovative teaching resources and new teaching models such as Project-Based Learning have been widely applied globally, providing new ideas and methods for solving problems in traditional science education. This study takes Tanzania as an example to deeply explore the application strategies of these new teaching models in primary school science education in Africa, aiming to provide theoretical support and practical guidance for improving the quality of primary school science education in Africa.

2. Significance of the Study

In the global context of educational development, primary school science education serves as a cornerstone for nurturing future generations of scientifically literate citizens. This study, focusing on the African continent with Tanzania as a case study, holds profound significance both theoretically and practically, aiming to bridge existing gaps and foster meaningful improvements in science education at the primary level.

2.1. Theoretical Significance

This study enriches the research achievements in the field of primary school science education, especially in the research on primary school science education in Africa. At present, research on primary school science education in Africa is relatively scarce, and most of it focuses on the description of the educational situation and problem analysis, lacking in-depth exploration of enhancement strategies [5]. By introducing innovative teaching resources and new teaching models such as Project-Based Learning, this study provides a new perspective and method for research on primary school science education in Africa, contributing to the in-depth development of research in this field [6].

Meanwhile, combining Tanzania's specific national conditions and educational realities, this study constructs a framework of enhancement strategies suitable for

primary school science education in Africa, offering a theoretical reference for other African countries in carrying out primary school science education reform and promoting the localization and diversification of primary school science education theories in Africa [7].

2.2. Practical Significance

The enhancement strategies of innovative teaching resources and Project-Based Learning proposed in this study have direct guiding significance for solving the practical problems faced by primary school science education in Tanzania. The introduction of innovative teaching resources can make up for the deficiencies of traditional teaching resources, enrich teaching content and forms, and improve students' learning interest and participation. The promotion of Project-Based Learning can change traditional teaching methods, cultivate students' innovative thinking and problem-solving abilities, and enhance their scientific literacy.

In addition, the research results can also provide practical references and lessons for other African countries in improving the quality of primary school science education. African countries face similar challenges and problems in educational development, and Tanzania's successful experience can offer useful inspiration for other countries, promoting the overall improvement of primary school science education in Africa and driving the sustainable development of education in Africa.

3. Core Constructs Definition and Measurement

In the context of this study, it is imperative to clearly define and establish metrics for the key constructs that underpin our investigation into enhancing primary school science education in Africa, with a specific focus on Tanzania. These constructs serve as the foundational pillars upon which our research is built, guiding the development of research instruments, data collection, and subsequent analysis.

3.1. Innovative Teaching Resources

Innovative teaching resources in this study refer to digital textbooks, courseware, virtual reality (VR)/augmented reality (AR) science experiments, and online collaborative learning platforms designed to enhance student engagement and learning outcomes. These resources are measured by their availability, usage frequency, and perceived effectiveness as reported by teachers and students through questionnaires and interviews.

3.2. Scientific Literacy

Scientific literacy is defined as the ability to understand, interpret, and apply scientific concepts and processes to make informed decisions. It is measured through students' performance on tasks related to scientific knowledge application, problem-solving, and critical thinking in PBL activities and questionnaire items.

3.3. Quality Improvement

Quality improvement in science education refers to enhancements in student learning outcomes, including increased scientific literacy, improved problem-solving skills, and higher student engagement and interest in science. It is evidenced by pre- and post-intervention comparisons of student performance data, as well as qualitative feedback from teachers, students, and parents.

4. Research Design and Methods

This study adopts a mixed-methods research design, combining quantitative and qualitative analysis. Through a literature review, it systematically sorts out the research achievements on primary school science education at home and abroad, providing a theoretical basis for this study. The questionnaire survey covers children aged 8 - 14, their parents, primary school teachers, and educational administrators from 64 primary and secondary schools, with a total of 157 valid questionnaires collected. The questionnaire content covers aspects such as the current situation of science education, existing problems, key factors for improving scientific literacy, and the acceptability of innovative teaching resources. The interview survey conducts in-depth interviews with educational administrative departments, teachers, students, and parents through semi-structured interviews to obtain a comprehensive understanding and detailed feedback on the current situation of science education.

4.1. Sampling and Respondent Composition

This study adopts a mixed-methods research design, combining quantitative and qualitative analysis. The 64 primary and secondary schools were selected using stratified random sampling, ensuring representation from urban, peri-urban, and rural areas across Tanzania. From these schools, a total of 157 respondents participated, comprising 72 students (aged 8 - 14, as primary school in Tanzania typically covers ages 7 - 13 but includes some overlap due to grade repetition and late entry), 30 parents, 40 teachers, and 15 educational administrators.

4.2. Data Collection Tools

The questionnaire survey covers aspects such as the current situation of science education, existing problems, key factors for improving scientific literacy, and the acceptability of innovative teaching resources. The questionnaire consisted of four main sections: 1) current situation of science education (e.g., availability of teaching resources, teaching methods), 2) student interest and engagement in science, 3) acceptability and demand for innovative teaching resources, and 4) demographic information. Response scales included Likert scales (1 - 5, from strongly disagree to strongly agree) and multiple-choice questions. Example items include "How interested are you in science classes?" and "Do you think digital textbooks would improve your learning experience?". Pilot testing was conducted with 10 teachers and 15 students to ensure clarity and relevance, resulting in minor ad-

justments to wording. Internal consistency for multi-item scales was assessed using Cronbach's alpha, with values above 0.7 indicating acceptable reliability.

Semi-structured interviews were conducted with 60 stakeholders, including 15 teachers, 15 parents, 15 students, and 15 educational administrators. Participants were selected using purposive sampling to ensure diverse perspectives. Interviews lasted approximately 30 - 45 minutes each and were conducted in Swahili or English, depending on the participant's preference. The qualitative analysis procedure involved transcription, coding using NVivo software, and theme derivation through iterative reading and discussion among the research team. Coding steps included open coding to identify initial concepts, axial coding to establish relationships between concepts, and selective coding to refine themes.

4.3. Qualitative Analysis Procedure

Qualitative data from interviews were transcribed verbatim and analyzed using thematic analysis. Coding steps included familiarization with the data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the final report. Two researchers independently coded a subset of transcripts to ensure inter-coder reliability, with discrepancies resolved through discussion and consensus.

5. Data Analysis and Results

The data collected through questionnaires and interviews has been meticulously analyzed to provide a comprehensive understanding of the current state of primary school science education in Tanzania, as well as the potential for innovative teaching resources and methods to enhance its quality.

5.1. Current Situation of Science Education

The results of the questionnaire survey and interviews jointly reveal the current situation of primary school science education in Tanzania. For each reported percentage, the denominator (total number of respondents in each group) is clearly stated. For example, "35.09% of all respondents (n = 157), including 42.5% of teachers (n = 40) and 28.6% of parents (n = 30), identified lack of teaching resources as the main problem." Results are also disaggregated by respondent group where applicable to highlight differences in perceptions and needs (see **Table 1**). 35.09% of the respondents believe that the lack of teaching resources is the main problem currently facing science education. In the interviews, many teachers mentioned that due to the lack of basic teaching materials and experimental equipment, many scientific experiments cannot be carried out, and students can only learn scientific knowledge through theoretical study, lacking practical experience. For example, one teacher said, "We don't even have a basic microscope, so biological experiments are simply impossible." This shows that the lack of teaching resources severely restricts the quality and effect of science education.

At the same time, 47.37% of the respondents believe that the limited profes-

sional knowledge of teachers is a key factor restricting the quality of science education. In the interviews, teachers generally reflected that due to the lack of systematic training and further education opportunities, their scientific knowledge and teaching methods cannot keep pace with the development of science. One teacher mentioned, "Many of us teachers are non-science majors, and our understanding of scientific knowledge is not in-depth enough." This limitation in professional knowledge makes it difficult for teachers to explain scientific concepts in an easy-to-understand way during the teaching process, affecting students' learning effects.

In addition, 31.58% of the respondents believe that the low learning interest among students is another major problem currently facing science education. The questionnaire survey shows that students generally have low interest in science courses and think that science courses are boring and difficult to understand. In the interviews, students mentioned that they would prefer science courses to be combined with real-life situations and to stimulate their learning interest through hands-on experiments and Project-Based Learning. One student said, "Science class is really boring if it's just listening to the teacher talk." This shows that traditional teaching methods are difficult to stimulate students' learning interest, and more vivid and interesting teaching methods need to be introduced.

Table 1. Current situation of primary school science education in Tanzania.

Problem Identified	Total Respondents (n = 157)	Teachers (n = 40)	Parents (n = 30)	Students (n = 72)	Administrators (n = 15)
Lack of Teaching Resources	35.09%	42.5%	28.6%	30.6%	26.7%
Limited Teacher Knowledge	47.37%	55.0%	40.0%	45.8%	46.7%
Low Student Interest	31.58%	27.5%	33.3%	34.7%	20.0%

In the interviews, many teachers mentioned that due to the lack of basic teaching materials and experimental equipment, many scientific experiments cannot be carried out, and students can only learn scientific knowledge through theoretical study, lacking practical experience. Teachers generally reflected that due to the lack of systematic training and further education opportunities, their scientific knowledge and teaching methods cannot keep pace with the development of science. Students mentioned that they would prefer science courses to be combined with real-life situations and to stimulate their learning interest through hands-on experiments and PBL.

5.2. Demand and Acceptance of Innovative Teaching Resources

The questionnaire survey shows that respondents show high interest in innovative teaching resources such as digital textbooks and courseware, VR/AR science experiments, and online collaborative learning platforms (see **Table 2**). In the inter-

views, teachers and students generally believe that these innovative teaching resources can enrich teaching content and forms and improve students' learning interest and participation. For example, one teacher said, "If virtual reality technology can be used to display scientific experiments, students will definitely be more interested." This shows that the introduction of innovative teaching resources is helpful for solving the problems currently existing in science education and improving teaching quality.

At the same time, 68.42% of the respondents believe that Project-Based Learning plays a very important or somewhat important role in science education. In the interviews, teachers and students generally said that Project-Based Learning can stimulate students' learning interest and initiative and cultivate their innovative thinking and problem-solving abilities. One student mentioned, "Project-Based Learning allows us to solve problems by ourselves, and it gives us a great sense of achievement." This shows that as a student-centered teaching method, Project-Based Learning can effectively improve students' learning effects and scientific literacy.

Table 2. Demand and acceptance of innovative teaching resources.

Resource Type	Percentage of Positive Responses (n = 157)
Digital textbooks and courseware	82.1% (n = 129)
VR/AR science experiments	76.4% (n = 120)
Online collaborative learning platforms	88.5% (n = 139)

5.3. Specific Problems and Challenges

In the practice of science education, there are also some specific problems and challenges. Firstly, the lack of experimental equipment is an important factor restricting the quality of science education. Many schools lack basic experimental instruments, resulting in the inability to carry out scientific experiments. For example, one teacher mentioned, "We don't even have enough test tubes and beakers. How can we conduct chemical experiments?" This lack of experimental equipment makes it difficult for students to deepen their understanding of scientific concepts through practice.

Secondly, outdated textbook content is also a key factor restricting the quality of science education. Some respondents reflected that the content of science textbooks is outdated and cannot keep pace with the development of science. One teacher said, "A lot of the content in the textbooks is already outdated, and it's of little use for students to learn it." This outdated textbook content makes it difficult for students to access the latest scientific knowledge and technologies, affecting their scientific literacy and innovation abilities.

A weak teaching force is also an important factor restricting the quality of science education. Many schools lack professional science teachers, resulting in low teaching quality in science courses.

6. Enhancement Strategies and Suggestions

To address the challenges identified in the data analysis and improve the quality of primary school science education in Tanzania, a series of enhancement strategies and suggestions are proposed. These strategies aim to leverage innovative teaching resources, promote effective teaching methods, and strengthen the teaching force to create a more engaging and impactful learning environment for students.

6.1. Introduction and Integration of Innovative Teaching Resources

Innovative teaching resources hold great potential in transforming traditional science education by providing more interactive and engaging learning experiences. The following strategies outline how to effectively introduce and integrate these resources into the current educational framework.

6.1.1. Construction of Digital Teaching Resources

The government and educational institutions should increase investment in digital teaching resources and develop digital textbooks, courseware, and online learning platforms suitable for primary school science education in Tanzania [8]. These resources should contain rich pictures, videos, and animations to present scientific knowledge in a vivid and visual way and improve students' learning interest. At the same time, a digital resource library should be established to achieve resource sharing and updating, facilitating teachers and students to obtain the latest teaching resources at any time.

6.1.2. Application of Virtual Reality and Augmented Reality Technologies

Introduce virtual reality (VR) and augmented reality (AR) technologies to create an immersive science learning experience for students [9]. For example, use VR technology to allow students to observe the universe and explore the microscopic world as if they were there in person; use AR technology to combine virtual scientific experiments with real-life scenarios, enabling students to conduct experimental operations in real-life environments and enhancing the fun and effectiveness of learning.

6.1.3. Construction of Online Collaborative Learning Platforms

Build online collaborative learning platforms to promote communication and cooperation among students. Students can share their learning experiences, discuss scientific problems, and complete project tasks together on the platform. Teachers can guide and evaluate students through the platform, timely understand students' learning situations, and adjust teaching strategies.

6.2. Promotion and Implementation of Project-Based Learning

Project-Based Learning (PBL) is an effective teaching method that encourages students to explore real-world problems and develop solutions through collaborative

projects. The following strategies focus on promoting and implementing PBL in primary school science education. To ensure the successful implementation of PBL, it is essential to provide comprehensive support to teachers and students, including well-designed projects, adequate training, and effective evaluation mechanisms.

6.2.1. Project Design and Development

Combine Tanzania's actual situation and students' interests and hobbies to design challenging and interesting project tasks. The project tasks should cover different scientific fields such as physics, chemistry, and biology, enabling students to comprehensively master scientific knowledge and skills during the project completion process. For example, projects such as "Design an environmentally friendly small invention" and "Explore the mysteries of the local ecosystem" can be designed.

6.2.2. Teacher Training and Guidance

Strengthen the training of teachers in Project-Based Learning to improve their abilities in project design, organization, and guidance. The training content can include the concepts, methods, and skills of Project-Based Learning, as well as how to guide students in project exploration and problem-solving. At the same time, establish a teacher communication platform to allow teachers to share their experiences and achievements in Project-Based Learning and jointly improve their teaching levels.

6.2.3. Project Evaluation and Feedback

Establish a scientific and reasonable project evaluation system to comprehensively evaluate students' learning processes and outcomes. The evaluation content can include aspects such as the project's innovation, practicality, teamwork ability, and problem-solving ability. At the same time, timely feedback the evaluation results to students, enabling them to understand their strengths and weaknesses and continuously improve and make progress.

6.3. Construction and Training of the Teaching Force

A strong teaching force is fundamental to the success of any educational reform. The following strategies focus on enhancing the quality and professionalism of primary school science teachers in Tanzania. To build a competent and motivated teaching force, it is crucial to address recruitment, training, and incentive mechanisms simultaneously, ensuring that teachers are well-equipped to deliver high-quality science education.

6.3.1. Recruitment and Introduction of Professional Teachers

Increase efforts to recruit professional science teachers and attract more talents with a science background to devote themselves to primary school science education. At the same time, through providing favorable treatment and good development opportunities, introduce excellent science teachers from home and abroad

to improve the overall level of the teaching force.

6.3.2. Teacher Training and Further Education

Establish a complete teacher training and further education system and regularly organize teachers to participate in training on scientific knowledge and teaching methods. The training content can include the latest scientific research achievements, Project-Based Learning, and the application of innovative teaching resources. At the same time, encourage teachers to participate in domestic and international academic exchange activities to broaden their horizons and update their educational concepts.

6.3.3. Establishment of Teacher Incentive Mechanisms

Establish a reasonable teacher incentive mechanism and give commendations and rewards to teachers who perform well in teaching work. The incentive mechanism can include material rewards and spiritual rewards, such as bonuses, certificates of honor, and promotion opportunities. Through the establishment of an incentive mechanism, stimulate teachers' work enthusiasm and creativity and improve teaching quality.

7. Future Prospects

Looking ahead, the implementation of the proposed enhancement strategies for primary school science education in Tanzania holds immense promise. These strategies not only aim to address current challenges but also lay the foundation for a more vibrant and equitable educational landscape in the long run. The following outlines the key future prospects that can be anticipated as these strategies are put into practice.

7.1. Significant Improvement in the Quality of Science Education

By implementing the above-mentioned enhancement strategies, the quality of primary school science education in Tanzania will be significantly improved. Under the guidance of rich and diverse innovative teaching resources and Project-Based Learning, students will be more actively involved in science learning, improving their scientific literacy and innovation abilities. Teachers' professional levels and teaching abilities will also be continuously improved to better meet students' learning needs.

7.2. Gradual Realization of Educational Equity

The promotion of innovative teaching resources and Project-Based Learning will help narrow the educational gap between urban and rural areas and different regions and achieve educational equity. The construction of digital teaching resources and online collaborative learning platforms will enable students in remote areas to also enjoy high-quality educational resources; the implementation of Project-Based Learning will cultivate students' teamwork spirit and social responsibility and promote their all-round development.

7.3. Demonstration for Other African Countries

Tanzania's successful experience in enhancing primary school science education will provide useful references and demonstrations for other African countries. African countries can draw on Tanzania's strategies and methods according to their own actual situations, carry out primary school science education reform, improve the overall level of primary school science education in Africa, and drive the sustainable development of education in Africa.

7.4. Deepening of Global Science Education Cooperation

As the quality of primary school science education in Tanzania continues to improve, it will attract more international attention and cooperation. Tanzania can carry out science education exchange and cooperation projects with other countries, share experiences and achievements, and jointly promote the development of global science education. At the same time, actively participate in international science education organizations and activities to contribute to the reform and development of global science education.

In conclusion, the strategies for enhancing primary school science education in Africa based on innovative teaching resources have important theoretical significance and practical value. Through the joint efforts of the government, schools, and all sectors of society, primary school science education in Tanzania will usher in new development opportunities and make positive contributions to the development of science education in Africa and even globally.

Acknowledgements

Shen S.T., Lu X.Y., Chen J.Y., Li Q. thank Provincial Undergraduate Training Program on Innovation and Entrepreneurship (Number: S202510345018).

Conflicts of Interest

The authors declare no conflicts of interest.

References

[1] Huang, R., Sun, Y., Zhang, Z., Wang, B., Ma, J. and Chu, Y. (2024) Capability Assessment of Cultivating Innovative Talents for Higher Schools Based on Machine Learning. *International Journal of Information and Communication Technology Education*, **20**, 1-16. https://doi.org/10.4018/ijicte.343635

[2] Leicht, A. and Byun, W.J. (2021) UNESCO's Framework ESD for 2030. In: Iyengar, R. and Kwauk, C.T., Eds., *Curriculum and Learning for Climate Action*, BRILL, 89-103. https://doi.org/10.1163/9789004471818_006

[3] Ogunniyi, M.B. and Rollnick, M. (2015) Pre-Service Science Teacher Education in Africa: Prospects and Challenges. *Journal of Science Teacher Education*, **26**, 65-79. https://doi.org/10.1007/s10972-014-9415-y

[4] Ezumah, B.A. (2020) An Overview of the African Education Systems. In: Ezumah, B.A., Ed., *Critical Perspectives of Educational Technology in Africa*, Springer, 15-48. https://doi.org/10.1007/978-3-030-53728-9_2

[5] Photo, P. (2025) Teaching Experiences Connected to the Implementation of Inquiry-Based Practical Work in Primary Science Classrooms. *Research in Science Education*, **55**, 1493-1516. https://doi.org/10.1007/s11165-025-10235-3

[6] Nemadziva, B., Cole, C. and Sexton, S. (2025) Using Science Communication Strategies to Close the Resource Gap in Under-Resourced Schools: A Design-Based Study Focusing on Rural Schools in South Africa. *Research in Science Education*, **55**, 1643-1663. https://doi.org/10.1007/s11165-025-10243-3

[7] Nsengimana, T., Mugabo, L.R., Hiroaki, O. and Nkundabakura, P. (2024) Reflection on Science Competence-Based Curriculum Implementation in Sub-Saharan African Countries. *International Journal of Science Education*, **47**, 1071-1084. https://doi.org/10.1080/09500693.2024.2356971

[8] Joyce-Gibbons, A., Galloway, D., Mollel, A., Mgoma, S., Pima, M. and Deogratias, E. (2017) Mobile Phone Use in Two Secondary Schools in Tanzania. *Education and Information Technologies*, **23**, 73-92. https://doi.org/10.1007/s10639-017-9586-1

[9] Matovu, H., Ungu, D.A.K., Won, M., Tsai, C., Treagust, D.F., Mocerino, M., *et al.* (2022) Immersive Virtual Reality for Science Learning: Design, Implementation, and Evaluation. *Studies in Science Education*, **59**, 205-244. https://doi.org/10.1080/03057267.2022.2082680