

# Infrastructural Adequacy in Implementing Competence-Based Education (CBE) in Grade Four Agriculture: A Case of Public Primary Schools in Njoro Sub-County, Kenya

Alex O. Karani<sup>1\*</sup>

<sup>1</sup> Egerton University,

P.O Box 536, Egerton, Nakuru 20115, KENYA

\*Corresponding Author: [ongakialex@gmail.com](mailto:ongakialex@gmail.com)

DOI: <https://doi.org/10.30880/jstard.2025.07.01.001>

## Article Info

Received: 22 October 2024

Accepted: 17 February 2025

Available online: 26 June 2025

## Keywords

Infrastructural resources, adequacy, implementation of Competence Based Education (CBE), agriculture

## Abstract

This study examines the adequacy of institutional infrastructural resources for teaching competence-based grade four agriculture in public primary schools within Njoro Sub-County, Kenya. The key challenges identified include the lack of essential facilities such as laboratories, agriculture stores, workshops for tool repairs, and agriculture rooms/libraries. The study aimed to assess the availability of these resources and their impact on agricultural education. A descriptive survey design was employed, utilizing a questionnaire to collect data from 96 agriculture teachers across 96 schools. The findings highlight significant infrastructure gaps, particularly in school farms and water supply, which are critical for effective agricultural education. The study concludes that improving infrastructure, alongside regular teacher training and policy implementation, is crucial to enhance the quality of agricultural education and the socio-economic prospects of students.

## 1. Introduction

Education in Kenya has undergone several significant transformations aimed at addressing the evolving needs of the nation. The 7-4-2-3 system, established in 1964, was the first post-independence education framework, consisting of seven years of primary education, four years of secondary education, two years of pre-university education, and three years of university education (Owiti et al., 2024). This system, however, faced critiques due to its focus on theoretical learning, with little emphasis on practical skills and competencies necessary for societal and workforce success. As a response to the changing demands of the country and the global economy, the education system evolved again with the introduction of the 8-4-4 structure in 1985. This new framework introduced eight years of primary education, four years of secondary education, and four years of university education, aiming to balance academic knowledge with practical vocational training. However, the focus remained heavily on academic examinations, which continued to limit the development of practical, real-world skills (Nzoka, 2024). In 2017, Kenya transitioned to the Competency-Based Curriculum (CBC), which marked a major shift towards skills-based education. The CBC focuses on the acquisition of competencies and practical skills, such as problem-solving and critical thinking, to better prepare students for the workforce and higher education (Omariba & Barasa, 2024). This shift was driven by the realization that Kenya's education system needed to adapt to both local and global challenges, including technological advancement and the need for skilled workers in various sectors. The introduction of the CBC was further propelled by the need for an education system that could foster

creativity, collaboration, and adaptability, reflecting global educational trends that emphasize learner-centered approaches.

Competence-Based Education (CBE) is a curriculum framework emphasizing the acquisition of skills and competencies necessary for success in the workplace and society (Catacutan et al., 2023). In the context of agriculture education in Kenya's public primary schools, the implementation of CBE relies heavily on the availability and adequacy of infrastructure resources (Karani, 2023). Adequate infrastructure resources are essential for effective teaching and learning in any educational setting. In the case of CBE for agriculture, infrastructure encompasses various elements such as classrooms, laboratories, agricultural farms or gardens, tools, equipment, and internet connectivity (Ibrahim, 2023). These resources play a crucial role in facilitating hands-on learning experiences and practical application of agricultural concepts among students.

In Kenya, the successful implementation of CBE for agriculture in public primary schools is contingent upon the government's commitment to providing adequate infrastructure resources (Waruingi et al., 2022). However, some challenges hinder the attainment of this objective. Limited funding allocated to the education sector often leads to inadequate infrastructure development in schools, especially in rural areas where the majority of public primary schools are located (Shikalepo, 2020). As a result, many schools lack proper classrooms, laboratories, and agricultural facilities, thus compromising the quality of agricultural education delivered to students.

In addition, disparities in access to infrastructure resources between urban and rural schools exacerbate inequities in educational outcomes. Urban schools tend to have better-equipped facilities and resources compared to their rural counterparts, leading to disparities in the quality of education received by students from different regions (Milner & Lomotey, 2021). This inequality perpetuates the cycle of poverty and limits the opportunities for rural students to pursue careers in agriculture or related fields.

The availability of suitable classrooms and laboratories equipped with modern teaching aids is paramount for the effective delivery of CBE for agriculture (Othoo, 2018). Spacious classrooms are essential to accommodate practical demonstrations and group activities related to agricultural practices. Laboratories equipped with necessary tools and equipment enable students to conduct experiments and research, thereby enhancing their understanding of agricultural concepts (Oyewo et al., 2022). Moreover, modern teaching aids such as multimedia projectors and interactive whiteboards can make learning more engaging and interactive. The presence of agricultural farms or gardens within school premises provides students with practical exposure to farming techniques and practices. These farms serve as outdoor classrooms where students can apply theoretical knowledge acquired in the classroom to real-life agricultural activities (Farag et al., 2022). By actively participating in activities such as planting, nurturing, and harvesting crops, students develop practical skills and gain valuable hands-on experience in agriculture.

Additionally, internet connectivity plays a crucial role in supplementing traditional teaching methods with online resources and digital learning platforms (Matthew et al., 2018). Access to the internet allows students to conduct research, access educational materials, and participate in online discussions related to agriculture. Moreover, it enables teachers to access updated curriculum materials, instructional videos, and online courses, thereby enhancing the quality of agricultural education delivery (Ogola et al., 2017).

## 1.1 Statement of Problem

In Kenya, schools have historically faced challenges related to inadequate resources, a situation that has persisted from the 8-4-4 education system to the current Competency-Based Curriculum (CBC) framework. Under the 8-4-4 system, the focus was primarily on academic knowledge, with limited attention given to the practical and hands-on application of skills. This shift towards theoretical learning, coupled with resource constraints, hindered effective teaching and learning, especially in subjects like agriculture. In the transition to the CBC, which emphasizes the development of competencies and practical skills, the issue of resource inadequacy has become even more pronounced. The CBC aims to foster an education system that not only imparts knowledge but also prepares students for the challenges of the real world by focusing on skills, attitudes, and values. However, the successful implementation of this curriculum depends heavily on the availability of adequate infrastructure, such as classrooms, laboratories, teaching materials, and technology. In many schools, these resources are insufficient, leading to significant barriers in the effective delivery of Competency-Based Education. The lack of proper facilities, tools, and learning aids hampers both the teaching process and the assessment of student competencies. Teachers are often unable to provide hands-on experiences in subjects like agriculture, where practical application is critical for skill development. Consequently, this resource deficiency not only undermines the intended outcomes of the CBC but also creates a gap in the quality of education, affecting both student performance and future employability. Inadequate resources present a major challenge that needs to be addressed to ensure the successful implementation of the CBC and the development of competencies necessary for the modern workforce.

## 1.2 Research Objective

The study seeks to identify existing infrastructural gaps, examine their impact on teaching effectiveness, explore the perceptions of agriculture teachers, and propose measures to enhance these resources through community and stakeholder involvement.

## 1.3 Research Questions

- How do infrastructural deficiencies affect the delivery and effectiveness of Competence-Based Education in Grade Four Agriculture at public primary schools in Njoro Sub-County?
- What is the current state of infrastructural resources available in these schools for the implementation of CBE in Grade Four Agriculture?
- What are the perceptions of agriculture teachers regarding the adequacy and availability of infrastructural resources in their schools?
- What measures can be implemented to improve infrastructural resources for teaching agriculture in public primary schools in Njoro Sub-County?
- What role do local communities and stakeholders play in supporting the development and maintenance of infrastructural resources for agricultural education in public primary schools in Njoro Sub-County?

## 2. Review of Related Literature

The Sustainable Development Goal Four (SDG4) of the United Nations aims to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all by improving learners' literacy-numeracy, physical development, social-emotional development, and learning (Goyal et al., 2024). Globally, some countries have and are making changes in their education system to promote the achievement of SDG4 by adapting relevant education systems like CBE. Well-implemented CBE has been found to reduce poverty levels, create self-employment, improve food security and enable learners to develop positive attitudes towards vocational subjects in developing countries. UN countries that have successfully implemented CBE have improved the learning environment particularly laboratories, workshops, and the store for farm tools and equipment used in teaching vocational subjects. The learning environment for vocational subjects is beyond classrooms and books since successful schools have electricity, clean drinking water, laboratories, libraries, computers, and internet right from primary schools (Ndambuki et al., 2024).

Schools have different class structures ranging from iron-wall, and timber-wall classrooms to those made of bricks. However, the most important factor is the number of students a class can accommodate without learners struggling during the learning process. For instance, countries like Japan, South Korea, the USA, and Finland recommend a class to have between 20-30 students to ease the learning and teaching process (Kvamme, 2024). Effective teaching of agriculture subjects goes beyond classroom instruction (Diise et al., 2018). Therefore countries that have successful curricula implementation institutions have proven to have in place adequate laboratories, workshops, classrooms, equipment, physical facilities, and teaching aid (Nwuke & Nwanguma, 2024). The teaching of Agriculture requires learners to draw and carry out measurements within and outside the classroom and this requires learners to have a free space for these activities. In addition, learners carry out projects outside the classroom in either the farm, store, or laboratories. This learning activity needs students to be supplied with clean water for washing hands, and protective clothing like gloves, gumboots, and safety goggles during practicals to ensure students' health is not at risk.

A study on the factors impacting curriculum implementation and learners' performance in Agriculture science in South Africa indicated that lack or inadequate infrastructure affects curriculum implementation which later affects learners' competencies (Chauke & Kabiti, 2016). During the apartheid regime, schools meant for the Europeans were favored in terms of infrastructure unlike schools meant for Africans (Shepherd, 2016). This has made some provinces record high scores than others. The North-west province has always performed well in Agriculture subject recording (90.2%) efficiency while Limpopo province recorded 64% due to inadequate supply of infrastructures such as water, electricity, and farming space. To address the infrastructural challenge, the South African government has put into place room space (providing between 100m<sup>2</sup> and 120 m<sup>2</sup>) and garden grounds (4800 m<sup>2</sup>) for projects (Chauke & Kabiti, 2016).

Learning is a process and not an outcome (Hodges, 2012). Therefore, the calm environment in modern classrooms with proper air ventilation, classroom furniture, perimeter wall, and floor surface that is free from clouds of dust have been confirmed to contribute to learners' competencies (Hodges, 2012). In Zambia, for a school to be allowed to offer agriculture it must put into place agricultural land, physical facilities, and laboratories for

conducting experiments (Chauke & Kabiti, 2016). Availability, access, and utilization of infrastructures in teaching vocational subjects are directly proportional to learners' competencies at primary, secondary, and tertiary levels and in the labor industry (Nuraeni & Suwadji, 2020).

### 2.1 Underpinning Theory

The theoretical framework underpinning this study is grounded on Human Capital Theory and the Social Constructionist Theory. Human Capital Theory, proposed by Schultz (1961), suggests that investments in education and training contribute to the development of human capital, ultimately enhancing individuals' productivity and economic outcomes (Jules et al., 2021). In the context of this study, infrastructure resources serve as investments in education, providing the necessary physical and technological support for students to acquire the skills and competencies essential for success in agriculture through Competence-Based Education (CBE). Adequate infrastructure, such as well-equipped classrooms, laboratories, and agricultural facilities, creates an environment conducive to effective teaching and learning experiences, enabling students to develop the practical skills needed for agricultural practice. (Olasumbo, 2020) Additionally, modern teaching aids and internet connectivity enhance access to educational materials and facilitate interactive learning, aligning with the principles of CBE.

In addition, the Social Constructionist Theory, posits that knowledge and meaning are constructed through social interactions and experiences (Longhofer & Winchester, 2023). In the context of agriculture education, infrastructure resources play a vital role in shaping the learning environment and facilitating collaborative learning among students. Agricultural farms or gardens within school premises provide opportunities for hands-on experience and practical application of agricultural concepts, fostering the construction of knowledge through experiential learning. Infrastructure resources also enable students to interact with peers and teachers, engaging in discussions, group activities, and cooperative learning experiences (Ng et al., 2022). Through these social interactions, students share ideas, exchange perspectives, and collectively construct knowledge relevant to agricultural practices. Additionally, infrastructure resources facilitate access to external resources and expertise, such as visits to agricultural institutions and community farms, enriching students' learning experiences and broadening their understanding of agricultural concepts.

### 2.2 Conceptual Framework

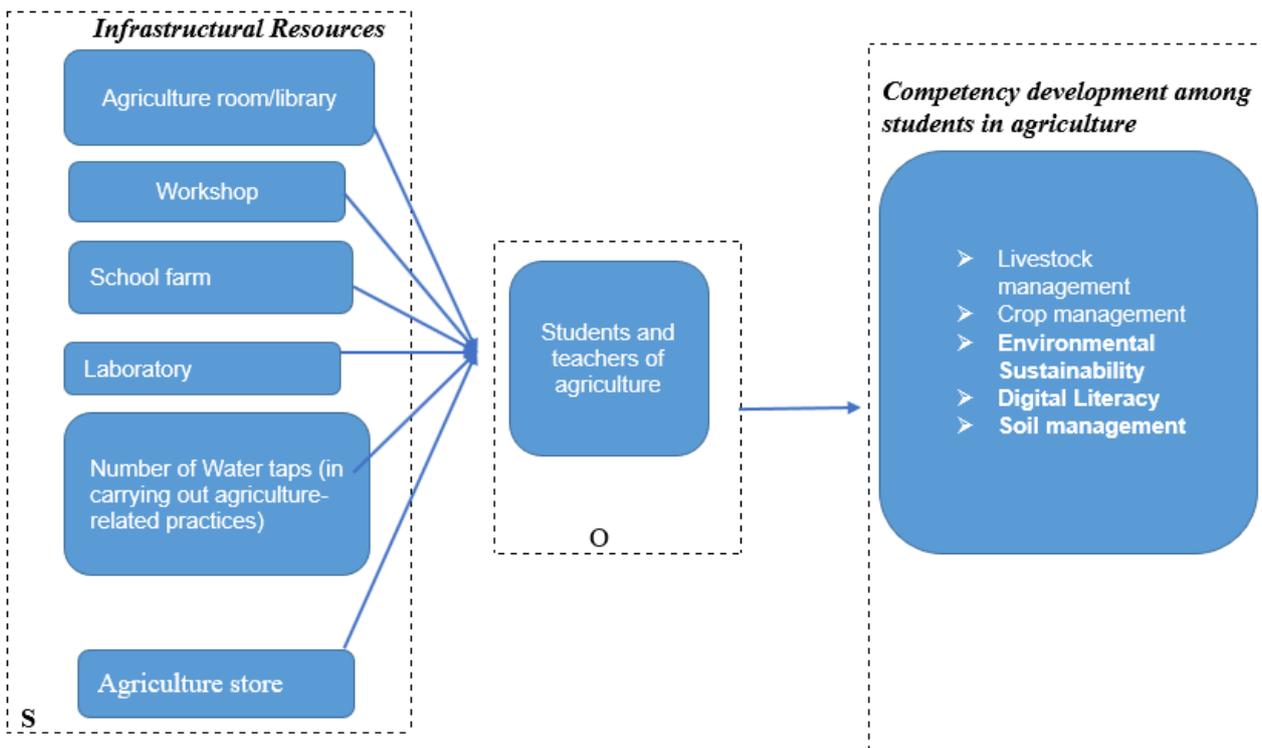


Fig. 1 Presents the conceptual framework, which depicts the relationship between the study variables

The conceptual framework for this study utilizes the SOR (Stimulus-Organism-Response) model to examine how infrastructure resources (stimulus) influence competency development among students and teachers of agriculture (organisms), ultimately leading to specific outcomes related to agricultural education.

**Stimulus (S):** The stimulus in this framework consists of various infrastructure resources available in public primary schools, including workshops for repairing agriculture tools, school farms, computer/tablet rooms/stores, laboratories for practical work, the number of water taps available for agriculture-related practices, and agriculture stores. These infrastructure resources serve as environmental stimuli that provide essential support and facilities for teaching and learning agricultural concepts and practices.

**Organism (O):** The organisms in this framework represent students and teachers of agriculture who interact with the infrastructure resources provided in the school environment. Students engage in practical activities, experimental research, and learning experiences facilitated by these infrastructure resources, while teachers utilize them to deliver educational content and enhance teaching effectiveness in agriculture.

**Response (R):** The response in this framework refers to competency development among students in agriculture, which encompasses various areas such as livestock management, crop management, environmental sustainability, digital literacy, and soil management. Competency development occurs as a result of the interaction between students, teachers, and the infrastructure resources provided. For example, access to workshops for repairing agriculture tools allows students to gain practical skills in livestock management and crop management, while laboratories facilitate hands-on learning experiences in soil management and environmental sustainability. Additionally, the availability of computer/tablet rooms/stores enhances students' digital literacy skills, enabling them to access educational resources and information related to agriculture.

### 3. Research Methodology

#### 3.1 Research Design

This study employed a descriptive survey design, which is effective for gathering detailed information about the current status of a phenomenon without manipulating the study variables (Siedlecki, 2020). This design was chosen to assess the adequacy of infrastructural resources for teaching competence-based Grade Four agriculture in public primary schools in Njoro Sub-County, Kenya. The descriptive survey design allows for a comprehensive understanding of the existing conditions and facilitates the collection of quantitative data on infrastructural adequacy.

#### 3.2 Research Respondents

The respondents of the study were 96 teachers of agriculture from 96 public primary schools in Njoro Sub-County. Purposive sampling was employed to select one agriculture teacher from each school. In cases where a school had multiple eligible teachers, simple random sampling was utilized to select one teacher. Njoro Sub-County was chosen due to its proximity to agricultural learning institutions and numerous farming activities, making it an ideal location for assessing institutional readiness for teaching agriculture.

#### 3.3 Research Instrument

The primary data collection instrument was a questionnaire designed to assess the adequacy of institutional infrastructural resources for teaching competence-based Grade Four agriculture. The questionnaire included items on various infrastructural elements such as classrooms, laboratories, workshops, agricultural farms, and water supply. A pilot study was conducted in Molo Sub-County to determine the reliability of the questionnaire, yielding a Cronbach's alpha coefficient of 0.743, indicating satisfactory internal consistency.

#### 3.4 Data Analysis

This study utilized the Statistical Package for the Social Sciences (SPSS) version 25 for data analysis. Descriptive statistics, including frequencies and percentages, were employed to summarize the current state of infrastructural resources in public primary schools for teaching competence-based Grade Four agriculture. Cronbach's alpha was applied to determine the reliability and internal consistency of the questionnaire used for data collection. These statistical tools provided a comprehensive understanding of the infrastructural adequacy and its impact on agricultural education in the study area.

## 4. Results and Discussion

### 4.1 Institutional Infrastructural Resources for Teaching Competence-Based Grade Four Agriculture

The number of structures in schools meant for teaching and learning agriculture informed the adequacy of the infrastructural resources. The findings were recorded in Table 7 where 0=absent/ not available. 1= (1/4 hectare for land,/one room buildings/ one tap for water). 2= (1/2 hectare for land/ two rooms for buildings/ two taps of water). 3= (one hectare of land /three rooms for buildings / three taps of water). 4= (more than 1-hectare piece of land,/More than 3 rooms/ more than three taps of water).

**Table 1** *Infrastructural resources for teaching competence-based Grade Four agriculture*

| Resource   | Percentage |       |       |       |       |
|--|------------|-------|-------|-------|-------|
|  | 0          | 1     | 2     | 3     | 4     |
| Agriculture room/library   | 94.8%      | 5.2%  | -     | -     | -     |
| Workshop for repairing agriculture tools                             | 96.9%      | 3.1%  | -     | -     | -     |
| School farm  | 5.2%       | 54.2% | 31.2% | 9.4%  |       |
| Computer/tablets room/store  | 6.3%       | 93.8% | -     | -     | -     |
| Laboratory for carrying out practical                                | 100%       | -     | -     | -     | -     |
| Number of Water taps (in carrying out agriculture-related practices) | -          | 15.6% | 29.2% | 38.5% | 16.7% |
| Agriculture store  | 83.3%      | 16.7% | -     | -     | -     |

In reference to Table 1, none of the schools had a laboratory for carrying agriculture-related practicals, 83.3% of schools had no store for agriculture, 96.9% of schools had no workshop for maintenance of farm tools and equipment, 94.8% of schools had no agriculture room/library. In addition, 5.2% and 6.3% of schools lacked school farms and computer stores respectively. The majority of the schools that had a school farm it was 1/4 a hectare. The possible reason for most schools missing infrastructure could be because inadequacy of some teaching and learning resources. For instance, some teachers of agriculture reported they relied upon farm tools from parents thus; they had no reason of having an agriculture store and workshop. Other teachers indicated that the school had financial challenges in establishing some infrastructures. Quality and sustainable education is one of the ways the Kenyan government projects to achieve industrialization by the year 2030 (Musyimi et al., 2018). However, a study conducted by Nyambura (2018) on evaluating the underlying factors behind poor performance of science subject in Nairobi county revealed that more than half of the schools were missing science room for demonstrations or carrying experiments. In addition, none of the school had a lab equipment for conducting practical activities something that was observed to hinder realization of industrialization in Kenya as teachers opted for theoretical teaching of vocational subjects. Inadequacy and absence of infrastructure has a negative influence on students' innovative and problem solving skills. In Finland, pupils of between ages of 3-6 are oriented in joining science clubs where their teacher guides them on various scientific activities they are expected to do in the laboratories. At this level, the students do not conduct any practical activity but they observe and make reports. However, between 10-20 years they are allowed to conduct lab experiments, practicals and write reports. During school holidays, students camp for one week where they do lab practicals and experiments every day between 9 am to 3pm with varied hours per practical depending on the age and grade of the students Petäjistö & Putila (2016). The rigorous exposure to laboratory and library rooms for students has made students in Finland perform well in international exams and innovation programs Afridi (2021). Given that all schools had no laboratory for students to carry out some practical and experiment activities, the grade Four agriculture students may miss problem solving and critical thinking competencies since they are grounded on hands on activities. In Finland and Netherlands, primary school teachers have kept generating new technology, innovation and invention due to frequent interaction with laboratories where they do practicals and experiments in their teaching subjects (Niemi et al., 2016).

The study findings, at least 96.9% of schools had no workshop/ room for repair of tools and equipment. The workshops are essential facilities for repair, maintenance and replacement of malfunctioning tools Qi et al. (2018). The absence of workshops is likely to make teachers shift from practical teaching to theoretical teaching due to inability of schools to repair hands on tools and equipment something that may compromise learner's competences. A study conducted in Netherlands on learning room management and associated challenges indicated that the presence of workshops and science rooms in school was not enough for practical instruction. It was observed that students felt uncomfortable during practical sessions the workshops due to poor ventilation and noise pollution. However, a recommendation was made that every workshop to have student friendly headphones and proper ventilation (Bluyssen et al., 2020). This implies that for proper implementation of CBE in Kenya there is need to establish workshops, which are well ventilated and equipped with student friendly soundproof. In addition, lack of laboratory in schools may hinder scientific skills of the teachers since they will have no exposure to practicals, which enables them to generate new skills.

A study conducted by Fan et al.(2022) on use of ICT among Chinese and Singapore students indicated that a single computer room was sufficient in serving entire school when the lessons are well scheduled to avoid collision. At least 93.8% of schools had computer room /computer store. Existence of a single computer room per school indicates that there is safety of tablets and computers used for teaching and learning. The students whose schools had computer rooms were found to be more ICT competent in hardware and software utilization as opposed to their colleagues whose schools had no computer rooms/computer labs. In addition, students' whose schools had computer labs were found to be more active on mobile phones since their teachers used the mobile phones in sending assignments. Given that 6.3% of schools had no computer resource room, students from these schools may not compete favorably in the job industry in relation to utilization of ICT resources.

At least 40.6 % of schools had about  $\frac{1}{2}$  a hectare piece of land for carrying out agricultural activities. Additionally, about 52.4% of schools had  $\frac{1}{4}$  a hectare piece of land. An ideal school farm should have four main sections namely commercial section, museum section, project section and demonstration (Aboelmakarem et al., 2021). Agriculture is a compulsory subject in Kenya' middle schools. Given that, most schools have inadequate land; students across the grades may not get an opportunity to learn practical agriculture in the four sections of the school farm since  $\frac{1}{4}$  hectare is too small. The crop produce from the schools farms and the farm tools needs to be stored. However, about 83.3% of schools did not have agriculture storage facilities. According to Saduak et al.(2019) practical teaching of agriculture is a challenge in most Kenyan schools due the lack of essential infrastructure as agriculture stores something that has made school incur many expenses in replacing lost tools and equipment due to improper storage. Therefore lack of agriculture store poses a challenge to primary schools in Njoro because they may not be able to store farm produce and related farm tools.

The study observed that only 16.7% of schools had adequate water supply. Given that a school has only 3 taps of water, it is an indicator of at most 3 water containers or water tanks. Therefore, the water available may not sustain agricultural activities like students washing themselves after farm activities. The findings of this study coincide with study by Rob et al. (2021) on delivery of safe and clean water in Kenya's primary schools. The findings indicated that about 71% of schools stored water in plastic water tanks and only 13% of schools could store water for more than 2 months as majority of schools shifted to vendors to supply water and other schools asked students to bring water to school. The implication of water inadequacy is that students may not conduct rigorous agriculture activities, which may require washing of farm tools and equipment. Therefore, lack of water may result to theoretical teaching of agriculture.

## 5. Conclusion

The findings of this study highlight significant gaps in the availability and adequacy of infrastructural resources for teaching Agriculture in public primary schools . Across various categories of infrastructural resources such as agriculture rooms/libraries, workshops for repairing agriculture tools, school farms, computer/tablets rooms/stores, and water taps, a large proportion of schools were found to lack essential facilities. The absence or inadequacy of these resources poses challenges to the effective implementation of Competence-Based Education (CBE) in agriculture, limiting students' opportunities for hands-on learning, practical activities, and experimental research.

## 6. Recommendations

There is a crucial need for infrastructure improvement, with the government and relevant stakeholders urged to prioritize the provision of essential resources like laboratories, agriculture stores, workshops, and adequate water supply in public primary schools. This entails allocating sufficient funds for infrastructure development and maintenance to ensure conducive learning environments for students. Teacher training programs should be implemented to enhance educators' competencies in utilizing available resources effectively and integrating

practical teaching methods into the curriculum, emphasizing experiential learning approaches and modern teaching aids. community engagement is vital, necessitating collaboration with local stakeholders to mobilize support for infrastructure projects, fundraising, and resource mobilization. Additionally, strict policy implementation is essential, with clear guidelines established to ensure equitable distribution of resources across schools and regions, addressing disparities and promoting inclusivity. Continuous research and monitoring efforts are crucial to assess the impact of infrastructure improvements on educational outcomes and student performance in agriculture, including regular evaluations of infrastructure projects and initiatives.

## Acknowledgement

I would like to express my deepest gratitude to Dr. Miriam Kyule from the Department of Agricultural Education and Extension, Dr. Joel Ng'eno from the Department of Curriculum, Instruction and Education Management, and Prof. John Mironga from the Department of Geography for their unwavering support and mentorship throughout my Master's program. Their guidance has been invaluable in shaping the direction of this research and in fostering my academic growth.

## Conflict of Interest

Author declare that there is no conflict of interests regarding the publication of the paper.

## Author Contribution

*The author confirms sole responsibility for the following: study conception and design, data collection, analysis and interpretation of results, and manuscript preparation.*

## References

- Aboelmakarem, A., Badawi, S., Lalli, G., & Kamareddine, M. (2021). *School Farms: Feeding and Educating Children* (1st ed.). Routledge. <https://doi.org/10.4324/9781003176558>
- Afridi, T. (2021). "DIGITAL LEARNING AS EDUCATION INNOVATION AT UNIVERSITIES". *Psychology and Education Journal*, 58(1), 5273–5289. <https://doi.org/10.17762/pae.v58i1.2083>
- Bluyssen, P. M., Kim, D. H., Eijkelenboom, A., & Ortiz-Sanchez, M. (2020). Workshop with 335 primary school children in The Netherlands: What is needed to improve the IEQ in their classrooms? *Building and Environment*, 168, 106486. <https://doi.org/10.1016/j.buildenv.2019.106486>
- Catacutan, A., Kilag, O. K., Felix Diano, J., Tiongzon, B., Malbas, M., & Abendan, C. F. (2023). Competence-Based Curriculum Development in a Globalized Education Landscape. *Excellencia: International Multi-Disciplinary Journal of Education* (2994-9521), 1(4), Article 4.
- Chauke, P. K., & Kabiti, H. M. (2016). Teachers' Perceptions on Agricultural Science Curriculum Evolvment, Infrastructure Provision and Quality Enhancement in Limpopo Province, South Africa. 9.
- Diise, A. I., Zakaria, H., & Mohammed, A. A. (2018). Challenges of teaching and learning of agricultural practical skills: The case of deploying project method of teaching among students of Awe Senior High School in the Upper East Region, Ghana. *International Journal of Agricultural Education and Extension*. 2018a, 4(2), 167-179.
- Fan, L., Luo, J., Xie, S., Zhu, F., & Li, S. (2022). Chinese students' access, use and perceptions of ICTs in learning mathematics: Findings from an investigation of Shanghai secondary schools. *ZDM – Mathematics Education*, 54(3), 611–624. <https://doi.org/10.1007/s11858-022-01363-5>
- Farag, A. A., Badawi, S., Lalli, G., & Kamareddine, M. (Eds.). (2022). *School farms: Feeding and educating children*. Routledge Taylor & Francis Group.
- Goyal, A., Kumar, P., & Shalini. (2024). Quality Education: A Key Component of the United Nations Sustainable Development Goals (SDGs). In W. Leal Filho, S. Kautish, T. Wall, S. Rewhorn, & S. K. Paul (Eds.), *Digital Technologies to Implement the UN Sustainable Development Goals* (pp. 127–151). Springer Nature Switzerland. [https://doi.org/10.1007/978-3-031-68427-2\\_7](https://doi.org/10.1007/978-3-031-68427-2_7)
- Hodges, p. (2012). Differences In The Quality Of Jamaican Primary School Facilities Are Correlated To Differences In The Performance Of The Schools In The Grade Six Achievement Tests.
- Ibrahim, Y. (2023). Relevance of School Facilities and Infrastructure towards Implementing Education Policies. *Journal of Social Transformation and Regional Development*, 5(2), Article 2.

- Jules, T. D., Thomas, M. A. M., & Shields, R. (2021). *The Bloomsbury Handbook of Theory in Comparative and International Education*. 1–512.
- Karani, A. (2023). Sustainability Plans for Resources Meant For Teaching Vocational Agriculture for Competence-Based Grade Four Agriculture in Public Primary Schools Njoro Sub-County. *International Journal of Education, Technology and Science*, 3(2), Article 2.
- Kvamme, E. (2024). A Comparative Analysis of Special Education Development in South Korea and Norway: A Literature Review [Master's Thesis, Høgskulen på Vestlandet]. <https://hvlopen.brage.unit.no/hvlopen-xmlui/handle/11250/3154476>
- Longhofer, W., & Winchester, D. (Eds.). (2023). *Social theory re-wired: New connections to classical and contemporary perspectives* (3rd edition). Routledge.
- Matthew, U., Kazaure, J., & Okafor, N. (2018). Contemporary Development in E-Learning Education, Cloud Computing Technology & Internet of Things. *EAI Endorsed Transactions on Cloud Systems*, 169173. <https://doi.org/10.4108/eai.31-3-2021.169173>
- Milner, H. R., & Lomotey, K. (Eds.). (2021). *Handbook of urban education* (Second edition). Routledge.
- Musyimi, C. M., Malechwanz, J., & Luo, H. (2018). The Belt and Road Initiative and Technical and Vocational Education and Training (TVET) in Kenya: The Kenya-China TVET Project. *Frontiers of Education in China*, 13(3), 346–374. <https://doi.org/10.1007/s11516-018-0017-x>
- Ndambuki, R., Robert, R. O., & Karani, A. (2024). AN INVESTIGATION OF THE TEACHER PREPAREDNESS IN THE IMPLEMENTATION OF THE COMPETENCE-BASED AGRICULTURE SUBJECT CURRICULUM AT JUNIOR SECONDARY SCHOOLS IN KENYA. *International Journal of Education, Technology and Science*, 4(2), 1873–1892.
- Ng, P. M. L., Chan, J. K. Y., & Lit, K. K. (2022). Student learning performance in online collaborative learning. *Education and Information Technologies*, 27(6), 8129–8145. <https://doi.org/10.1007/s10639-022-10923-x>
- Niemi, H., Toom, A., & Kallioniemi, A. (Eds.). (2016). Science at Finnish Compulsory School. In *Miracle of Education* (pp. 125–144). SensePublishers. [https://doi.org/10.1007/978-94-6300-776-4\\_9](https://doi.org/10.1007/978-94-6300-776-4_9)
- Nuraeni, Y., & Suwadji, Y. T. (2020). Strategy for Enhancing Quality of Labor through Technical Vocational Education & Training Faces Industry 4.0 Challenges. In *International Conference on Elementary Education* (Vol. 2, No. 1, pp. 1255-1272).
- Nwuke, T. J., & Nwanguma, T. K. (2024). Provision and Utilization of Physical Resources for Effective Teaching and Learning Effectiveness in Public Universities in Rivers State. [https://www.researchgate.net/profile/Thankgod-James-Nwuke/publication/378736003\\_Provision\\_and\\_Utilization\\_of\\_Physical\\_Resources\\_for\\_Effective\\_Teaching\\_and\\_Learning\\_Effectiveness\\_in\\_Public\\_Universities\\_in\\_Rivers\\_State/links/65e7209fc3b52a117016277d/Provision-and-Utilization-of-Physical-Resources-for-Effective-Teaching-and-Learning-Effectiveness-in-Public-Universities-in-Rivers-State.pdf](https://www.researchgate.net/profile/Thankgod-James-Nwuke/publication/378736003_Provision_and_Utilization_of_Physical_Resources_for_Effective_Teaching_and_Learning_Effectiveness_in_Public_Universities_in_Rivers_State/links/65e7209fc3b52a117016277d/Provision-and-Utilization-of-Physical-Resources-for-Effective-Teaching-and-Learning-Effectiveness-in-Public-Universities-in-Rivers-State.pdf)
- Nyambura, K. S. (2018). Factors Affecting Science Subject Performance in Public Primary Schools in Westlands Sub-County, Nairobi County. 100.
- Nzoka, F. K. (2024). Reforming Education in Kenya for Global Competitiveness: A Case of Competency Based Curriculum. *European Journal of Contemporary Education and E-Learning*, 2(3), 141–150.
- Olasumbo, A., & Grace. (2020). Professionalism, School Facilities, and Students' Cognitive Performance in Science in Oyo State, Nigeria. *Teacher Education and Curriculum Studies*, 5(3), 94. <https://doi.org/10.11648/j.tecs.20200503.17>
- Omae, N. S., Onderi, H., & Mwebi Benard. (2017). Quality Implications Of Learning Infrastructure On Performance In Secondary Education: A Small Scale Study Of A County In Kenya. <https://doi.org/10.5281/ZENODO.344956>
- Omariba, A., & Barasa, D. W. (2024). Navigating Leadership and Management Challenges in the Transition to Competency-Based Curriculum in Junior Secondary Education Subtheme: Education Leadership and Management. <http://41.89.243.34:8080/xmlui/handle/123456789/6500>
- Othoo, H. A. (2018). Selected educational resources as determinants of academic performance in public secondary schools in Kuria East and Kuria West sub-counties, Kenya [Thesis, Maseno University]. <https://repository.maseno.ac.ke/handle/123456789/875>

- Owiti, G., Juma, F., & Ronoh, T. (2024). The Place of Utilitarianism in Promoting Education in Public Universities in Kenya: A Philosophical Analysis. *Egerton Journal of Humanities, Social Sciences & Education*, 13(1–196), 148–160.
- Oyewo, O. A., Ramaila, S., & Mavuru, L. (2022). Harnessing Project-Based Learning to Enhance STEM Students' Critical Thinking Skills Using Water Treatment Activity. *Education Sciences*, 12(11), 780. <https://doi.org/10.3390/educsci12110780>
- Petäjistö, S., & Putila, P. (2016). STEAM-activities for Pupils and Schools in Finland. 7.
- Qi, Q., Tao, F., Zuo, Y., & Zhao, D. (2018). Digital Twin Service towards Smart Manufacturing. *Procedia CIRP*, 72, 237–242. <https://doi.org/10.1016/j.procir.2018.03.103>
- Rob, Katuva, J., Nyaga, C., Koehler, J., Charles, K., Nowicki, S., Dyer, E., Olago, D., Tanui, F., & Trevett, A. (2021). Delivering safely-managed water to schools in Kenya. *Smith School of Enterprise and the Environment, University of Oxford*.
- Saduak, W., Pounsuk, P., Phonpakdee, R., & Deeying, S. (2019). School Agricultural Learning Center for Sustainable Agricultural Learning. *Journal for the Education of Gifted Young Scientists*, 7(3), 389–407. <https://doi.org/10.17478/jegys.582993>
- Shepherd, D. L. (2016). The open door of learning–Access restricted: School effectiveness and efficiency across the South African education system (Doctoral dissertation, Stellenbosch: Stellenbosch University).
- Shikalepo, E. E. (2020). Challenges Facing Teaching at Rural Schools: A Review of Related Literature. [https://d1wqtxts1xzle7.cloudfront.net/63487885/Challenges\\_Facing\\_Teaching\\_at\\_Rural\\_Schools20200531-17223-d5g6c-libre.pdf?1590995398=&response-content-disposition=inline%3B+filename%3DChallenges\\_Facing\\_Teaching\\_at\\_Rural\\_Scho.pdf&Expires=1715686361&Signature=IDcqUuMIbbU2NPMjNjjYrLw7gRQhTROSjyOs15P~rdTiLejc31MgOzGN~VU~nzldpg311Q0Nsp-lyIXrLGduhBqgLpCj84e1TMgbUVZlfbD9aCDDgmgNQiEXYydvnnR8zCj28LWgmoq2TZG1gBTH~Ng5NAIgtUiKWVmz16M6Hg-9xabk9l42Q6RcFargxfbm2VIPR76gMy2TswCHUq3NUtE4kGvzvMpfofhstfa5IZ0lcYdh5RzkqZmRmN9XnPuFze13oSDGMLsBjzFGQccNHPF9~04-aJA-kOBd1E5Jx-YGjSNLHEuTAAVZZLaC4MJQksdYUwamZ3f1jvT43A &Key-Pair-Id=APKAJLOHF5GGSLRBV4ZA](https://d1wqtxts1xzle7.cloudfront.net/63487885/Challenges_Facing_Teaching_at_Rural_Schools20200531-17223-d5g6c-libre.pdf?1590995398=&response-content-disposition=inline%3B+filename%3DChallenges_Facing_Teaching_at_Rural_Scho.pdf&Expires=1715686361&Signature=IDcqUuMIbbU2NPMjNjjYrLw7gRQhTROSjyOs15P~rdTiLejc31MgOzGN~VU~nzldpg311Q0Nsp-lyIXrLGduhBqgLpCj84e1TMgbUVZlfbD9aCDDgmgNQiEXYydvnnR8zCj28LWgmoq2TZG1gBTH~Ng5NAIgtUiKWVmz16M6Hg-9xabk9l42Q6RcFargxfbm2VIPR76gMy2TswCHUq3NUtE4kGvzvMpfofhstfa5IZ0lcYdh5RzkqZmRmN9XnPuFze13oSDGMLsBjzFGQccNHPF9~04-aJA-kOBd1E5Jx-YGjSNLHEuTAAVZZLaC4MJQksdYUwamZ3f1jvT43A &Key-Pair-Id=APKAJLOHF5GGSLRBV4ZA)
- Siedlecki, S. L. (2020). Understanding descriptive research designs and methods. *Clinical Nurse Specialist*, 34(1), 8–12.
- Waruingi, A. W., Mbogo, P. R., & Mambo, D. A. (2022). Assessment of Challenges Faced by Principals in the Implementation of the Competency-Based Curriculum in Public Primary Schools in Kenya: A Case of Kiambu County. *Journal of Education*, 2(2), Article 2.