

Relationship Between Technological Integration and Learners' Engagement in Agricultural Practicals in Public Junior Schools in Nyeri Central Sub-County, Kenya

Authors

Philip Mathai Ndiritu ⁽¹⁾; Lydia Kobiah ⁽²⁾; Mosonik Bornes ⁽³⁾

Main author's email: philipmathai8@gmail.com

(1.2.3) Kabarak University, Kenya.

Cite this article in APA

Ndiritu, P. M., Kobiah, L., & Bornes, M. (2026). Relationship between technological integration and learners' engagement in agricultural practicals in public junior schools in Nyeri Central Sub-County, Kenya. *Journal of pedagogy and curriculum*, 5(1), 62–73. <https://doi.org/10.51317/y5sp6q45>



A publication of Editon Consortium Publishing (online)

Article history

Received: 2026-08-01

Accepted: 2026-09-07

Published: 2026-10-05

Scan this QR to read the paper online



Copyright: ©2026 by the author(s). This article is an Open Access article distributed under the terms and conditions of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License (CC BY-NC-SA 4.0).



Abstract

This study assessed the relationship between technological integration and learners' engagement in agricultural practicals in Nyeri Central Sub-County, Kenya. An explanatory sequential mixed-methods design was employed, involving 343 Grade Eight learners, 112 School Agriculture Teachers, and 40 headteachers. Data were collected through questionnaires, interviews, and observation. Quantitative data were analysed using descriptive and inferential statistics in SPSS, while qualitative data were examined thematically. More than half of the headteachers, 52.8 per cent ($n = 19$), rated learners' engagement as moderate. Technology was reportedly used for agricultural instruction in 94.3 per cent ($n = 33$) of the schools, including digital resources such as videos and mobile applications, online search tools, and artificial intelligence. However, observations showed that agricultural applications or software were used to some extent in 68.4 per cent ($n = 228$) of cases, with only 21.1 per cent ($n = 70$) demonstrating effective use. Furthermore, only 50.5 per cent ($n = 53$) of teachers were experienced in using modern teaching methods. A statistically significant positive relationship was found between technological integration and learners' engagement, $r(40) = .751$, $p = .001$. The study concludes that effective technological integration is strongly associated with increased learner engagement in agricultural practicals. It recommends continuous teacher training on the effective integration of technology into practical agricultural instruction to enhance learner engagement.

Keywords: Agriculture, agricultural practicals, learner engagement, technological integration

1.0 INTRODUCTION

The effectiveness of agricultural education is increasingly undermined by low learner engagement in practical sessions. According to Cunningham et al. (2024), learners need to engage in agricultural practicals, as they enhance skill development through hands-on experience with essential techniques such as planting and weeding. It helps develop practical competencies needed for modern farming by enhancing problem-solving abilities through real-world application (Omagwa, 2022). Engagement in agricultural practicals is thus a crucial component of school curricula as it equips learners with practical skills and knowledge necessary for sustainable agricultural practices (Reschly & Christenson, 2022). In experiential learning theory, Kolb (1984) presents learning as an ongoing cycle that transforms experiences into new knowledge. This theory aligns with the hands-on nature of agricultural practicals and helps explain how learner engagement is fostered through direct experience. Therefore, effective implementation of agricultural practicals in schools can foster 21st-century skills such as learner engagement, critical thinking, and problem-solving, which are vital for addressing global food security challenges.

The instructional approaches for teaching Agriculture vary according to local priorities, educational systems, levels of technological advancement, and targeted learner populations across different areas. The integration of modern digital tools and technological systems forms the basis for technological integration in teaching and learning support. Studies show that access to modern agricultural technologies, for example, online learning resources for agricultural practicals, makes learning more engaging and relevant (Fan & Kang, 2025; Zenda & Dlamini, 2023). The integration of technology into agricultural education significantly influences learner engagement by enhancing interactivity, relevance, and skill development. Through this integration, learners became more involved, gaining practical ways to address agricultural problems in the field (Ma et al., 2024). This aligns with Bronfenbrenner's (1979) ecological Systems Theory, which posits that external influences, such as the use of technology, influence outcomes of processes such as agriculture instruction and engagement

In Kenya, agriculture and nutrition are learning areas anchored in the United Nations Sustainable Development Goals and the socio-economic pillar of Kenya Vision 2030, promoting health, hygiene, and food and nutrition security through education (Omagwa, 2022). Agricultural Curriculum Designs in junior schools are structured to engage learners in basic crop production practices, including land preparation, planting, and post-harvest handling, to equip learners with practical skills in soil and water conservation methods, including soil testing and erosion control and to engage learners in the application of modern agricultural technologies like greenhouse farming (KICD, 2024). However, the Ministry of Education's reports indicate that, while schools have formally introduced agriculture as a learning area under CBE, challenges persist in its effective delivery. KICD (2024) further acknowledges that many schools lack the foundational requirements for meaningful agricultural practical instruction. Although the existing literature has highlighted general challenges to CBE implementation in agricultural practicals, few studies have specifically explored learner engagement and how technology influences learner engagement in junior-level agricultural practicals. Schools may continue to invest in agricultural practicals without a clear understanding of the conditions that foster engagement. This study therefore sought to examine the relationship between technological integration and learners' engagement in agricultural practicals. The study hypothesised that there is no significant association between technological integration and learners' engagement in agricultural practicals.

2.0 LITERATURE REVIEW

The integration of modern digital tools combined with technological systems forms the basis of technological integration for teaching and learning support. The educational practice includes the use of computers, tablets, and agriculture-specific technologies, coupled with online platforms and devices to improve educational delivery and learner interaction (Manning et al., 2022). Educational technology integration in agriculture has entirely reshaped practical learning standards worldwide, thus influencing learner active participation. The adoption of smart technologies by Roy and Madhekar (2025) in Australian classrooms resulted in substantial improvements in learners' agricultural practical learning experiences. Learners became more interested in conducting soil analyses and managing crops by incorporating data-driven tools. Similarly, learners in Greig et al. (2024), a United States study, participated in simulated farm management and crop harvesting activities despite lacking physical access to a farm, thanks to Virtual Reality technology. Learners participated in virtual agricultural activities that improved their practical competencies and deepened their interest in agriculture. According to Fan and Kang (2025), in South Korea, learners who learned through agricultural technology platforms achieved higher academic marks and improved motivation levels. Learners benefited from using digital platforms because these tools enabled improved interaction with course materials and better engagement with practical farming techniques.

Similar findings have been documented across developing countries. The integration of GIS technology and agricultural management software into educational curricula has improved both learner engagement and participation in practical agricultural projects in South African educational institutions, according to Zenda and Dlamini (2023). The research revealed problems in teacher training and the need for ongoing professional growth. A study in Nigeria demonstrated that implementing mobile knowledge-sharing applications increased learner interest and improved outcomes in agricultural practices, according to Ik-Ugwoezuonu and Ezike (2024). Learners at Tanzanian secondary schools showed increased interest and engagement in agricultural practicals through the use of mobile phones and e-learning platforms (Nyangas, 2024). Locally, the integration of drones with GIS and GPS, along with AI, into Kenyan educational systems improved learners' critical thinking skills and developed their agripreneurial behaviour (Chirinda et al., 2024). Through this integration, learners became more engaged as they gained practical ways to address agricultural problems in the field. However, local studies were scarce, leaving a knowledge gap regarding the relationship between technological integration and learner engagement, which this study sought to address.

3.0 METHODOLOGY

An explanatory sequential mixed-methods design was employed, with the study initially collecting and analysing quantitative data before gathering qualitative data to elaborate on and contextualise the quantitative results (Venkatesh et al., 2024). The study was conducted in public junior schools in Nyeri Central Sub-County, Kenya. The target population comprised 2,404 Grade Eight learners (1,117 boys and 1,287 girls), 155 agriculture teachers, 45 headteachers, and one Curriculum Support Officer (CSO).

The sample comprised 343 Grade Eight learners, 112 agriculture teachers, and 40 headteachers. Slovin's formula, $n = N / [1 + N(e)^2]$, was applied to determine the required sample sizes for learners and teachers using a 5 per cent margin of error. Learners were selected using stratified random sampling to ensure proportional representation across schools, followed by simple random sampling to

select individual learners. Headteachers and the CSO were purposively selected because of their administrative and policy-related roles in the implementation of agricultural practical activities.

Data were collected using structured questionnaires, interviews, and observation schedules. Questionnaires administered to agriculture teachers and headteachers collected quantitative data on school infrastructure, teacher competency, technological integration, administrative support, and learners' engagement in agricultural practicals. Interviews with headteachers and the CSO provided qualitative information on administrative and school-based factors influencing learners' engagement, while observations of agricultural practical sessions, school farms, and related facilities provided information on the availability and adequacy of learning resources. Supervisors and education specialists at Kabarak University reviewed the research instruments to establish content validity. Before the main study, the research instruments were piloted with 50 participants from four public junior schools in Tetu Sub-County to assess their clarity and reliability. The split-half technique was used to evaluate instrument reliability, and the Spearman-Brown formula produced a coefficient of 0.77, indicating acceptable internal consistency (Coe et al., 2025).

Quantitative data were analysed using the Statistical Package for the Social Sciences (SPSS) Version 29. Descriptive statistics, including frequencies and percentages, summarised the data, while Pearson product-moment correlation examined the relationship between technological integration and learners' engagement in agricultural practicals at the 95 per cent confidence level. Qualitative interview data were analysed thematically and presented narratively. Integrating quantitative and qualitative findings enabled the study to provide both statistical evidence and contextual explanations of the factors influencing learners' engagement.

The Institutional Scientific and Ethics Review Committee (ISERC) of Kabarak University granted ethical approval, and the National Commission for Science, Technology and Innovation (NACOSTI) granted research authorisation. The researchers also obtained permission from the relevant education authorities and participating schools. The researchers obtained informed consent from adult participants, while learner participation required school authorisation and child assent. Participation was undertaken on a voluntary basis, and participants were explicitly advised that they could leave the study at any time without penalty. The study maintained confidentiality and anonymity throughout, and securely stored collected data, accessible only to authorised researchers.

4.0 RESULTS AND DISCUSSION

The study gathered data from 477 respondents out of a possible 496, representing a response rate of 96.5 per cent (see Table 1).

Table 1: Response Rate

Population	Sample size	Respondents	Response rate (%)
CSO	1	1	100.0
Headteachers	40	36	90.0
Teachers	112	106	94.6
Learners	343	334	97.4
Total	496	477	96.2

Learners' Engagement in Agricultural Practicals

Head teachers in the study were asked to rate learners' engagement in agricultural practicals at their schools. As shown in Table 2, most respondents (52.8%, n=19) rated learners' engagement as moderate.

Table 2: Head Teachers' Rating of Learners' Engagement

		Frequency	Percent
	Low	4	11.1
	Moderate	19	52.8
	High	13	36.1
	Total	36	100.0

In an interview, headteachers were asked to indicate how the agricultural curriculum aligns with the local agricultural context in Nyeri Central Sub-County. The headteachers indicated that *"The curriculum is designed to align with local practices in Nyeri Central Sub-County like Coffee farming, production of fodder crops and livestock rearing."* They also mentioned that the curriculum *"puts emphasis on improving agricultural productivity."* However, some schools face challenges in practical implementation due to insufficient involvement in school farm projects. When asked about the criteria used to assess the quality of agricultural practicals, the headteachers indicated that they evaluate *"whether learners are able to answer oral questions concerning the project they have carried out,"* as well as *"whether learners can state the steps followed while carrying out the project and arranged in the correct order."* They also emphasised the importance of "safety standards" and *"industrial relevance"*, ensuring practicals are connected to real-world challenges.

On determining whether agricultural practicals effectively enhance learners' knowledge and skills, the headteachers indicated that they assess *"whether learners can handle and manipulate tools, materials, and equipment used in the practicals effectively."* They also emphasised the use of *"tests after completing practical lessons"* and *"skill demonstrations"* to measure improvement in knowledge and skills. Regarding the frequency of school inspections to ensure proper implementation of agricultural practicals, the headteachers indicated that assessments are typically conducted *"once or twice every year by officers from the Ministry of Education."* They check various aspects, such as *"whether the school land is well utilised"*, and assess *"whether other infrastructure in the school compounds are supporting proper implementation of agricultural practicals."*

Teachers in the study were also asked to rate learners' engagement in agricultural practicals at their schools. The results show that 50.9 per cent (n=54) of the respondents indicated moderate, while 41.5 per cent indicated high.

Table 3: School Agriculture Teachers Responses on Learners' Engagement

		Frequency	Percent
	Low	4	3.8
	Moderate	54	50.9
	High	44	41.5
	Total	102	96.2

A majority, 75.4 per cent (n=252) of learners strongly agreed that they actively participate in assigned tasks. Regarding collaboration, most learners, 71.9 per cent (n=240), agreed that they work in groups during practicals, with 19.5 per cent (n=65) agreeing, and 6.0 per cent (n=20) remaining uncertain.

Table 4: Learners' Responses on Engagement

	Strongly Agree	Agree	Uncertain	Disagree	Strongly disagree
Learners actively participate in assigned tasks	75.4%	13.5%	4.2%	3.6%	3.3%
Learners collaborate and work in groups during practicals	71.9%	19.5%	6.0%	0.9%	1.8%
Learners show enthusiasm and concentration in agricultural tasks	55.4%	28.7%	11.1%	3.0%	1.8%

The majority, 68.4 per cent (n=228) of students, were observed to always participate actively. Regarding asking relevant questions, the majority, 57.9 per cent (n=193), always did so. Regarding collaboration, 68.4 per cent (n=228) of students were observed to collaborate effectively. Finally, regarding enthusiasm and interest, the majority, 78.9 per cent (n=264) of students always showed enthusiasm.

Table 5: Observation Results for Active Participation

	Rarely	Sometimes	Often	Always
Students actively participating	0.0%	5.3%	26.3%	68.4%
Asking relevant questions	5.3%	0.0%	36.8%	57.9%
Following instructions	0.0%	0.0%	26.3%	73.7%
Collaborating effectively	5.3%	0.0%	26.3%	68.4%
Showing enthusiasm/interest	0.0%	5.3%	15.8%	78.9%

The vast majority, 89.5 per cent (n=299) of students were observed to handle tools properly; 89.5 per cent (n=299) consistently followed safety procedures; and 78.9 per cent (n=264) demonstrated evident skills, while 21.1 per cent (n=70) showed only partial evidence.

Table 6: Observation Results for Skill Development Observable

	Partially Evident	Evident
Proper tool handling	10.5%	89.5%
Following safety procedures	10.5%	89.5%
Problem-solving abilities	21.1%	78.9%
Application of theoretical knowledge	22.2%	77.8%
Peer teaching/support	33.3%	66.7%

The majority, 68.4 per cent (n=228) of students were frequently observed to be on-task; 78.9 per cent (n=264) were frequently observed to handle materials carefully; 68.4 per cent (n=228) were frequently observed to take initiative; and 63.2 per cent (n=211) were observed to show persistence when facing challenges.

Table 7: Observation Results for Student Behaviors

	Rarely Observed	Sometimes Observed	Frequently Observed
On-task behavior	0.0%	31.6%	68.4%
Respectful interaction with peers	0.0%	10.5%	89.5%
Care for equipment and materials	10.5%	10.5%	78.9%
Initiative in learning	5.3%	26.3%	68.4%
Persistence when facing challenges	0.0%	36.8%	63.2%

The CSO was asked to indicate the criteria used to assess the quality of agricultural practicals in schools. The CSO indicated that assessment is based on *"learners' responses to assessment items" and "observation schedules."* Regarding the effectiveness of agricultural practicals in enhancing learners' knowledge and skills, the CSO noted that they assess this through *"the use of questionnaires" and "learners' project assignments."* The CSO also shared that schools undergo inspections or assessments *"not less than once a term and as many times depending on need"* to ensure the proper implementation of agricultural practicals. Additionally, the CSO explained that the agricultural curriculum in Nyeri Central Sub-County is structured according to the national curriculum, which is *"CBE,"* and that customisation is done at the sub-county level to *"reflect learners familiar environment."*

Technological Integration

The vast majority, 94.3 per cent (n=33) of the headteachers confirmed that their schools used digital tools or technology in teaching agricultural subjects; 59.4 per cent (n=19) incorporated technology frequently in agricultural practical lessons. In comparison, 88.6 per cent (n=31) of headteachers reported that learners used technology, such as online resources or agricultural software, to support their learning, while 11.4 per cent (n=4) indicated that this was not the case.

Table 8: Head Teachers on Technological Integration

		n	%
Does the school use digital tools or technology in teaching agricultural subjects?	Yes	33	94.3%
	No	2	5.7%
How often do you incorporate technology (e.g., computers, internet, mobile apps) in agricultural practical lessons?	Occasionally	7	21.9%
	Frequently	19	59.4%
	Always	6	18.8%
Do learners use technology (e.g., online resources, agricultural software) to support their learning in agriculture?	Yes	31	88.6%
	No	4	11.4%
I use digital resources in teaching agricultural practicals.	Yes	33	94.3%
	No	2	5.7%

Headteachers were asked how integrating technology could improve the quality and delivery of agricultural education in their schools. The headteachers indicated that *"the learners can be able to explore the wide scope of agriculture and appreciate career progression in agriculture."* They also mentioned that technology would allow learners to *"learn modern methods of adding value to farm produce,"* making the learning process easier as students would be able to *"access the internet on their own."* Additionally, they noted that technology would expose learners to *"modern farming techniques,"* enhance their *"knowledge and attitude,"* and help them *"interact with the internet" to find the meanings of agricultural terms.* The headteachers also highlighted the role of technology in *"data collection";* providing *"interactive learning tools";* and offering *"fast and efficient communication."*

The majority, 72.6 per cent (n=77) of teachers confirmed that their schools used digital tools or technology to teach agricultural subjects, with 82.8 per cent (n=82) indicating that students used technology, such as online resources or agricultural software, to support their learning. In comparison, 17.2 per cent (n=17) reported that students did not. Furthermore, 90.4 per cent (n=94) of teachers personally used digital resources in teaching agricultural practicals, while 9.6 per cent (n=10) did not.

Table 9: School Agriculture Teachers on Technological Integration

		n	%
Does the school use digital tools or technology in teaching agricultural subjects?	Yes	77	72.6%
	No	29	27.4%
How often do you incorporate technology (e.g., computers, internet, mobile apps) in agricultural practical lessons?	Never	4	3.8%
	Occasionally	53	50.5%
	Frequently	40	38.1%
	Always	8	7.6%
Do learners use technology (e.g., online resources, agricultural software) to support their learning in agriculture?	Yes	82	82.8%
	No	17	17.2%
I use digital resources in teaching agricultural practicals.	Yes	94	90.4%
	No	10	9.6%

The majority of learners, 76.6 per cent (n=256), strongly agreed that they showed interest when technology was used, with 14.4 per cent (n=48) agreeing. Additionally, 75.7 per cent (n=253) of learners strongly agreed that technology improved their understanding of tasks, while 19.2 per cent (n=64) agreed.

Table 10: Technological Integration

	Strongly Agree	Agree	Uncertain	Disagree	Strongly disagree
Teacher uses visual aids/technology (charts, videos, etc.) during practicals	30.5%	31.4%	14.7%	13.8%	9.6%
Learners show interest when technology is used	76.6%	14.4%	4.8%	3.3%	0.9%
Technology improves learner understanding of tasks	75.7%	19.2%	4.2%	0.0%	0.9%

Digital learning resources were used effectively in 57.9 per cent (n=193) of cases, and agricultural apps or software were used somewhat in 68.4 per cent (n=228) of cases. Regarding recording and documentation tools, 63.2 per cent (n=211) of the observed sessions used them effectively, while communication platforms were used effectively in 63.2 per cent (n=211) of sessions.

Table 11: Observation Results for Technology Use in Agricultural Practical

	Not used	Used somewhat	Used effectively
Digital learning resources	0.0%	42.1%	57.9%
Agricultural apps/software	10.5%	68.4%	21.1%
Recording/documentation tools	10.5%	26.3%	63.2%
Communication platforms	5.3%	31.6%	63.2%
Online research resources	0.0%	42.1%	57.9%

The CSO was asked to indicate their opinion on how integrating technology could improve the quality and delivery of agricultural education in the Sub-County. The CSO indicated that *"technology is a factor to consider for effective education drive."*

Association of Technological Integration with Learners' Engagement

There was a significant positive correlation between technological integration and learners' engagement ($r(40) = .751$, $p = .001$) using Pearson's correlation. These results indicate that integrating technology is strongly associated with increased learners' engagement in agricultural practicals. The study's hypothesis is therefore rejected, and the study concludes that there is a significant relationship between technological integration and learners' engagement in agricultural practicals.

Table 12: Association of Technological Integration with Learners' Engagement

	Value	Asymp. Std. Error ^a	Approx. T ^b	Approx. Sig.
Interval by Interval Pearson's R	.751	.145	4.406	.001 ^c
Ordinal by Ordinal Spearman Correlation	.751	.145	4.406	.001 ^c
N of Valid Cases	40			
a. Not assuming the null hypothesis.				
b. Using the asymptotic standard error assuming the null hypothesis.				
c. Based on normal approximation.				

Discussion

These results indicate that integrating technology is strongly associated with increased learners' engagement in agricultural practicals. The respondents acknowledged the positive impact of technology on engagement. Teachers reported using digital resources such as videos, mobile apps, and online research tools to enhance practical lessons. At the same time, learners expressed greater interest and understanding when these tools were integrated into their learning. Furthermore, the provision of classroom technology, such as Wi-Fi and digital devices, was seen as crucial for promoting interactive, modern learning methods. The results of this study align with those of Fan & Kang (2025), who found that learners who used agricultural technology platforms achieved better academic outcomes and showed increased motivation. Similarly, Pulley et al. (2025) demonstrated that the use of virtual reality (VR) technology in agricultural education led to significant improvements in learner engagement and skill development, further supporting the idea that technological integration enhances agricultural education. Elsewhere, Zenda and Dlamini (2023) noted that integrating GIS and agricultural management software in South African educational settings increased learner participation and engagement in agricultural projects.

5.0 CONCLUSION AND RECOMMENDATIONS

Conclusion: The influence of technological integration on learners' engagement in agricultural practicals is positive and significant. The integration of technology, comprising digital learning tools and online resources, was strongly associated with increased learners' engagement in agricultural practicals. Increased learner engagement aligns with experiential learning theory, which holds that meaningful learning occurs when learners are actively involved in experiential activities rather than through passive classroom instruction. The findings also align with ecological systems theory, which argues that learners' development and behaviour are influenced by interactions within their surrounding environments and systems.

Recommendations: Agricultural practical lessons should therefore incorporate learner-centred digital approaches to strengthen practical understanding and sustain learner engagement. Schools should be enabled to increase investment in technological infrastructure to support agricultural practicals. To this end, teachers ought to be continuously trained on the effective integration of technology into practical agricultural instruction to improve learner engagement. The Ministry of Education ought to increase school allocations to enable the upgrading of technological infrastructure. There is a need for teacher training programs focused on modern agricultural practices and innovative teaching methods to equip teachers with the knowledge and skills required to engage students effectively. The national assembly should also introduce policies that mandate the provision of digital infrastructure and ensure consistent internet access in schools.

6.0 REFERENCES

1. Bronfenbrenner, U. (1979). *The ecology of human development: Experiments by nature and design*. Harvard University Press.
2. Chirinda, N., Abdulkader, B., Hjortsø, C. N., Aitelkadi, K., Salako, K. V., Taarji, N., Mhada, M., Lamdaghi, Z., Romanova, G., Assogbadjo, A. E., Chadare, F. J., Saidi, M., Sassi, M., Mugonola, B., Gogo, E. O., Ssekandi, J., Okalany, E., Egeru, A., Mshenga, P. M., & Chfadi, T. (2024). Perspectives on the integration of agri-entrepreneurship in tertiary agricultural education in Africa: Insights from

- the AgriENGAGE project. *Frontiers in Sustainable Food Systems*, 8, Article 1348167. <https://doi.org/10.3389/fsufs.2024.1348167>
3. Coe, R., Waring, M., Hedges, L. V., & Day Ashley, L. (Eds.). (2025). *Research methods and methodologies in education* (4th ed.). SAGE Publications.
 4. Cunningham, K., Gorman, M., & Maher, J. (2024). Enhancing academic student engagement in vocational agricultural education: Why course design matters. *Journal of Vocational Education & Training*, 76(3), 724–746. <https://doi.org/10.1080/13636820.2022.2079093>
 5. Fan, Q., & Kang, Y. (2025). Building a village education community: A case study of a small agricultural high school in South Korea. *Sustainability*, 17(24), Article 11217. <https://doi.org/10.3390/su172411217>
 6. Greig, J. A., Colclasure, B., Rampold, S., Ruth, T., & Granberry, T. (2024). Enhancing agricultural education through virtual reality: Facilitation, application, reflection, and measurement in the classroom. *Advancements in Agricultural Development*, 5(2), 64–80. <https://doi.org/10.37433/aad.v5i2.353>
 7. Ik-Ugwoezuonu, L., & Ezike, C. (2024). Assessing the effectiveness of mobile apps in enhancing agricultural extension services delivery in Nigeria. *African Journal of Sustainable Agricultural Development*, 5(2), 13–31. <https://www.openjournals.ijaar.org/index.php/ajsad/article/download/555/752/1737>
 8. Karani, A. O., Kyule, M. N., & Mironga, J. (2021). Teaching competence-based agriculture subject in primary schools in Kenya: A review of institutional preparedness. *International Journal of Education, Technology and Science*, 1(1), 14–30. <https://globets.org/journal/index.php/IJETS/article/view/5>
 9. Kenya Institute of Curriculum Development. (2019). *Basic education curriculum framework*. <https://kicd.ac.ke/curriculum-reform/basic-education-curriculum-framework/>
 10. Kenya Institute of Curriculum Development. (2024a). *Grade 7 curriculum design: Agriculture and nutrition*.
 11. Kenya Institute of Curriculum Development. (2024b). *Grade 8 curriculum design: Agriculture and nutrition*.
 12. Kenya Institute of Curriculum Development. (2024c). *Grade 9 curriculum design: Agriculture and nutrition*.
 13. Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development*. Prentice-Hall.
 14. Ma, S., Adeyemi, A. E., Xu, Z., & Wang, Q. (2024). Effects of educational technology on students' academic achievement in agricultural education: A meta-analysis. *Journal of Agricultural Education*, 65(4), 42–66. <https://doi.org/10.5032/jae.v65i4.2458>
 15. Manning, J. K., Cosby, A., Power, D., Fogarty, E. S., & Harreveld, B. (2022). A systematic review of the emergence and utilisation of agricultural technologies into the classroom. *Agriculture*, 12(6), Article 818. <https://doi.org/10.3390/agriculture12060818>
 16. Nyangas, J. A. (2024). Teachers' pedagogical skills and students' attitudes towards technology-enhanced teaching and learning in Morogoro secondary schools, Tanzania. *International Journal of Education Humanities and Social Science*, 7(2), 222–230. <https://doi.org/10.54922/IJEHSS.2024.0674>
 17. Omagwa, K. E. (2022). *Influence of practical approaches of teaching agriculture on academic performance in high schools in Kisii County, Kenya* [Doctoral dissertation, Kisii University].

18. Pulley, J., Claflin, K., & Thompson, A. (2025). A review of virtual reality applications in agriculture education and recommendations for future research. *Journal of Agricultural Education*, 66(3), Article 15. <https://doi.org/10.5032/jae.v66i3.3195>
19. Reschly, A. L., & Christenson, S. L. (2022). Jingle-jangle revisited: History and further evolution of the student engagement construct. In A. L. Reschly & S. L. Christenson (Eds.), *Handbook of research on student engagement* (2nd ed., pp. 3–24). Springer. https://doi.org/10.1007/978-3-031-07853-8_2
20. Roy, M., & Medhekar, A. (2025). Transforming smart farming for sustainability through agri-tech innovations: Insights from the Australian agricultural landscape. *Farming System*, 3(4), Article 100165. <https://doi.org/10.1016/j.farsys.2025.100165>
21. Venkatesh, V., Brown, S., & Sullivan, Y. (2023). *Conducting mixed-methods research: From classical social sciences to the age of big data and analytics*. Virginia Tech Publishing. <https://doi.org/10.21061/conducting-mixed-methods-research>
22. Zenda, R., & Dlamini, R. (2023). Examining factors that influence teachers to adopt information and communication technology in rural secondary schools: An empirical study. *Education and Information Technologies*, 28(1), 815–832. <https://doi.org/10.1007/s10639-022-11198-y>