OPEN ACCESS

Int. J. Agr. Ext. 14 (02) 2026.203-215. DOI:-10.33687/ijae.014.02.6275

Check for updates

Available Online at EScience Press

International Journal of Agricultural Extension

ISSN: 2311-6110 (Online), 2311-8547 (Print)

https://esciencepress.net/journals/IJAE

EFFECT OF OBSERVATIONAL ASSESSMENT ON GRADE 9 LEARNERS' PROBLEM-SOLVING COMPETENCY IN FOOD PRODUCTION PROCESSES: EVIDENCE FROM A COMPETENCY-BASED EDUCATION CONTEXT IN KENYA

[a]Alex Karani, [b]Miriam Kyule, [c]Joel Ng'eno

[a] *Department of Agricultural Education and Extension, Egerton University, Njoro, Kenya.*

[b] *Department of Curriculum, Instruction and Educational Management, Egerton University, Njoro, Kenya.*

ARTICLE INFO

Article History

Received: June 11, 2026

Revised: August 04, 2026

Accepted: August 22, 2026

Keywords

Authentic assessment

Competency-based education

Education for Sustainable Development

Observational assessment;

Problem-solving competency

Sustainable agriculture

ABSTRACT

The study examined the effect of structured field-based observational assessment on Grade 9 learners' problem-solving competency in food production processes. A quasi-experimental Solomon Four-Group design was used with 335 learners from four public secondary schools in Njoro Sub-County, Kenya. All groups participated in practical food-production activities aligned with the Grade 9 Agriculture Curriculum Design, while experimental groups received structured field-based observational assessment over 16 weeks and control groups received conventional assessment. The intervention required learners to observe actual agricultural conditions, identify food-production problems, interpret evidence, and propose appropriate management responses using predetermined criteria. A standardized pictorial skill test was administered as the common pretest and posttest outcome measure, covering soil conservation, water management, and pest and disease control. One-way ANOVA showed a statistically significant difference in competency scores across the four groups, $F(3, 331) = 52.473$, $p < .001$, $\eta^2 = .322$. Tukey HSD comparisons showed that both experimental groups scored significantly higher than both control groups, while the two control groups did not differ significantly. The findings demonstrate that structured field-based observational assessment was associated with higher problem-solving competency and support its integration into competency-based agricultural education.

Corresponding Author: Alex Karani

Email: ongakialex@gmail.com

INTRODUCTION

Authentic assessment has become central in contemporary education systems as a strategy for promoting meaningful learning, skills development, and the application of knowledge in real-life contexts (Salinas-Navarro and Vilalta-Perdomo, 2025). Unlike traditional assessment approaches that emphasize recall of information, authentic assessment focuses on learners' ability to apply knowledge in practical situations. This shift aligns with Sustainable Development Goal 4 (Quality Education), which emphasizes the need for education systems that develop relevant skills for work, life, and sustainable development (United Nations Educational, Scientific and Cultural Organization [UNESCO], 2024).

Sustainability has become a critical global concern in the 21st century, particularly with projections indicating that the world population will rise to about 9.7 billion by the year 2050 with sub-Saharan region expected to double their population, increasing pressure on food systems, natural resources, and agricultural productivity (United Nations, 2023). This situation requires education systems to prepare learners who can understand and respond to complex environmental and food production challenges. Schools therefore play an important role in training and assessing learners in ways that develop problem-solving, critical thinking, and practical competencies that support sustainable food production and responsible resource use (Karani et al., 2024). In this context, assessment is not only a measurement tool but also a mechanism for shaping the skills needed to address real-world sustainability challenges.

Within authentic assessment methods, Observational Assessment (OA) has gained importance as a practical approach for evaluating learners' competencies in real or realistic learning environments (Chan, 2023). OA is a learner-centered assessment method in which students are evaluated based on their ability to observe, interpret, and respond to visible conditions in their learning environment. In agricultural education, this involves learners examining field-based situations such as crop growth, soil conditions, pest presence, and water management practices. Learners are then required to interpret what they observe, identify problems, and propose appropriate solutions. Teachers assess learners based on how accurately and effectively they make sense of these observations and apply them to problem-solving situations (Dignath and Veenman, 2021). In this study, observational assessment was operationalized specifically to a structured field-based assessment procedure rather than learning through observation alone. During the assessment, learners examined actual crop-production conditions in the field and were required to identify observable conditions affecting crop production, interpret the evidence, identify the underlying problem, and propose an appropriate management response. The evidence considered included observable soil and plant conditions and other field indicators relevant to water management, soil conservation, and pest and disease control. The teacher observed and judged learners' responses and problem-solving performance against predetermined assessment criteria focusing on the accuracy of observation, interpretation of the observed condition, identification of the problem, and appropriateness of the proposed management response. This procedure is consistent with observational assessment, which involves systematic observation of learners' behaviours or performance using predefined assessment criteria, checklists, or rating systems to support the evaluation of demonstrated competencies (Lee et al., 2024).

Evidence shows that observation-based learning approaches improve learners' cognitive and practical competencies. For example, learners engaged in structured observation activities demonstrate improved analytical thinking, communication skills, and problem-solving ability (Eleni et al., 2021). Similarly, Fahmi et al. (2021)'s study found that when learners observe scientific phenomena and respond to guided tasks, their ability to interpret situations and apply knowledge to solve problems improves significantly. These findings indicate that learning through observation strengthens the connection between theory and practice. Despite its importance, the implementation of observational and authentic assessment approaches remains uneven in many education systems. Studies in different contexts have reported challenges such as inadequate teacher preparation, large class sizes, limited resources, and concerns about subjectivity in assessment (Adewusi et al., 2023; Issa et al., 2024; Kigwilu and Mokoro, 2022). These challenges limit the consistent use of OA in classrooms and reduce its effectiveness in developing practical competencies.

In Kenya, the Competency-Based Education (CBE) emphasizes the use of assessment methods that evaluate learners' ability to apply knowledge in real contexts. The Kenya Institute of Curriculum Development (KICD, 2024) states that teachers are expected to assess learners through practical tasks while observing their performance and reasoning processes. In agriculture, particularly in food production processes, learners are expected to engage in hands-on activities and demonstrate problem-solving based on field observations (KICD, 2024). However, despite this policy direction, evidence from a 2024 study by the African Population and Health Research Center (APHRC) and the Ministry of Education indicates that 80% of teachers in both CBC and non-CBC grades reported using county, sub-county, and zonal-level tests, commonly referred to as local joint tests. The same study reported that 70% of teachers in CBC grades used these local joint tests, despite concerns regarding their use under the CBC framework (APHRC, 2024). Further studies in Kenya indicate that challenges such as limited teacher training, inadequate instructional resources, and overcrowded classrooms continue to hinder effective implementation of observational assessment (Karani, 2025; Kikwei,

2023; Okutu and Nyambane, 2024). As a result, learners may not fully develop the practical problem-solving competencies required for sustainable agricultural production.
Against this background, there is a need for empirical evidence on the effect of observational assessment on learners' problem-solving competencies in agricultural education, particularly within practical food production contexts. This study therefore examines the effect of observational assessment on students' problem-solving competency in sustainable food production processes among Grade 9 learners in Njoro Sub County, Kenya. Specifically, it determines whether there is a measurable difference in problem-solving performance between learners assessed using observational assessment and those assessed using conventional methods. The study contributes to evidence on how assessment practices can support the development of sustainability-oriented competencies in agricultural education.

Study Objective

The study aimed to establish the effect of observational assessment method on students' acquisition of problem-solving competency in food production processes.

Study Hypothesis

H01: There is no statistically significant difference in problem-solving competency in food production processes among learners across the four Solomon Four-Group conditions.

Theoretical Framework

This study is grounded in Constructivist Learning Theory and Situated Learning Theory, which explain how learners develop problem-solving competencies through observational assessment within sustainable food production contexts. Constructivist Learning Theory posits that learners actively construct knowledge through interaction with their environment. Learning occurs when individuals engage in meaningful tasks that require interpretation, analysis, and application of knowledge (Murray, 2024).. In observational assessment, learners engage with real agricultural conditions such as soil status, crop performance, and pest presence. These observations enable learners to interpret field situations, diagnose production challenges, and propose solutions that reflect sustainable agricultural practices, such as soil conservation, efficient water use, and environmentally appropriate pest management. Situated Learning Theory emphasizes that learning is context-dependent and occurs most effectively in authentic environments (Cho et al., 2024). Observational assessment reflects this principle by placing learners in real or simulated agricultural settings where sustainability-related challenges emerge naturally. Through engagement with these contexts, learners develop competencies that are directly applicable to sustainable food production systems, including resource management and environmentally responsible decision-making. Together, these theories support observational assessment as an approach that integrates learning and assessment while promoting the development of problem-solving competencies relevant to sustainability in agriculture.

METHODOLOGY

Research Design

The study adopted a quasi-experimental design based on the Solomon four non equivalent control group design. This design was appropriate because intact Grade 9 classes were used, making random assignment of individual learners impractical in school settings (Chebii et al., 2018). Naturally formed classes were therefore maintained to preserve ecological validity. The design controls for pretest sensitization while strengthening internal validity by addressing threats such as history, maturation and testing effects. The design structure is presented in Table 1.

Table 1. Solomon four-group design.

Group	Pretest	Intervention	Post test
E1	O1	X	O2
E2	—	X	O3
C1	O4	—	O5
C2	—	—	O6

Source: Nair and Mathew (2021)

Legend
E1 – Experimental group with both pretest and intervention
E2 – Experimental group with intervention only, no pretest
C1 – Control group with pretest but no intervention
C2 – Control group with neither pretest nor intervention
O – Observation (test or measurement)
X – Intervention (treatment or experimental condition)
▬ Not applicable or not conducted

Study Area and Population

The target population comprised all Grade 9 agriculture learners in the 96 junior secondary schools within Njoro Sub-County. According to the Njoro Sub-County Education Office, the total number of learners in this category is 8,347. These learners are distributed across Njoro, Nessuit, Lare, Mauche, Mau Narok and Kihingo wards, representing diverse learning contexts within the sub-county. Grade 9 learners were selected because they have foundational agricultural knowledge suitable for assessing problem-solving competencies in food production processes and are distributed across varied school environments that support meaningful evaluation of agricultural learning outcomes.

Sampling Procedure and Sample Size

A multistage cluster sampling technique was used. Wards were treated as clusters, from which four were selected to ensure variation in ecological and school characteristics. One school was randomly selected from each ward and assigned to the Solomon four groups. The minimum sample size was 172 learners based on class size estimates, however the final sample consisted of 335 learners drawn from intact classes. The four selected schools were assigned to the experimental pretested (E1), experimental non-pretested (E2), control pretested (C1), and control non-pretested (C2) conditions. The use of intact classes preserved the existing school and class structures during the study. Since one school represented each Solomon condition, the school and teacher characteristics were inherently associated with the respective treatment condition; this was considered in the interpretation of the findings. This increased sample size improved statistical power and reduced sampling error associated with cluster designs.

Instrumentation and Intervention

Data were collected using a structured skill test aligned to the Grade 9 agriculture curriculum. The instrument measured learners' ability to interpret agricultural situations, identify food production problems, analyze causes, and propose appropriate management practices. The standardized skill test was administered as a common pretest and posttest measure and was distinct from the field-based observational assessment used as the intervention. The pictorial items required learners to examine represented agricultural situations using observable features, interpret the evidence presented, identify problems, explain their consequences, and propose appropriate management responses.

Prior to assessment, learners engaged in practical agricultural activities including land preparation, planting, watering, weeding, soil conservation and crop monitoring. Learners in both the experimental and control groups participated in practical food-production activities in accordance with the prescribed Grade 9 Agriculture Curriculum Design. Thus, the curriculum content and practical learning activities were common across the four groups, while the distinguishing feature was the assessment approach used during the intervention.

Before commencement of the intervention, teachers in the experimental schools were retooled on the implementation of the structured field-based observational assessment approach. The retooling focused on procedures for engaging learners in observing actual agricultural conditions, interpreting observable evidence, identifying food-production problems, and making appropriate management decisions using predetermined assessment criteria. This preparation was intended to strengthen consistency in implementation of the intervention and enhance internal validity.

The intervention was implemented over two school terms, covering a total of 16 weeks. During this period, learners in the experimental groups were assessed through structured field-based observational assessment activities. They observed actual soil and crop conditions, identified observable changes or problems, interpreted evidence from the field, and made appropriate management decisions. The teacher's role was to observe and assess the learners' demonstrated problem-solving processes using predetermined criteria, while learner observation and interpretation constituted important processes through which the targeted problem-solving competency was developed. The observational assessment activities were marked using the rubric provided in Appendix B. Learners in the control groups also participated in the prescribed practical food-production activities but did not receive the structured field-based observational assessment intervention. Their teaching and learning were guided by the Grade 9 Agriculture Curriculum Design, and assessment was conducted using conventional methods. This arrangement helped maintain comparable curriculum exposure between the experimental and control groups while distinguishing the intervention through the assessment approach.

After the intervention period, a standardized pictorial skill test was administered to the relevant groups under common assessment conditions. The test served as the outcome measure for determining changes in learners' problem-solving competency and was separate from the field-based observational assessment activities used during the intervention.

Validity and Reliability

Content and face validity were established through expert review from specialists in Agricultural Education and Curriculum Instruction. Reliability of the instrument was determined through a pilot study conducted in Molo Sub-County involving 32 Grade 9 learners. A Cronbach's alpha coefficient of 0.751 was obtained, indicating acceptable internal consistency. In addition, the assessment procedures used during the intervention were standardized through retooling of teachers in the experimental schools before commencement of the intervention. The field-based observational assessment activities were scored using the predetermined criteria and rubric provided in Appendix B to promote consistency in assessment of learners' demonstrated problem-solving competency.

Data Collection Procedure

Ethical clearance was obtained from University Institutional Scientific and Ethics Review Committee and NACOSTI. Permission was also secured from county and sub-county education offices. Before data collection commenced, teachers in the experimental schools were retooled on the implementation of the structured field-based observational assessment. The retooling provided guidance on the intervention procedures, the predetermined assessment criteria, and the use of the rubric in Appendix B. Teachers in both experimental and control schools implemented the Grade 9 Agriculture content in accordance with the prescribed Grade 9 Agriculture Curriculum Design.

Following the initial assessment procedures, the intervention was implemented for two school terms, equivalent to 16 weeks. During the intervention period, learners in both experimental and control groups engaged in practical agricultural activities prescribed in the Grade 9 Agriculture Curriculum Design. In the experimental schools, the structured field-based observational assessment was integrated into these activities. Learners observed actual agricultural conditions, interpreted observable evidence, identified food-production problems, and proposed or made appropriate management decisions. Teachers observed and assessed the learners' demonstrated problem-solving processes using the predetermined criteria and the rubric in Appendix B. In the control schools, learners participated in the same curriculum-guided practical activities but did not receive the structured observational assessment intervention.

At the end of the intervention period, the standardized pictorial skill test was administered to the relevant groups as the posttest. The posttest was administered under common assessment conditions to provide a uniform measure of learners' problem-solving competency across the experimental and control groups.

Data Analysis

Data were analyzed using SPSS version 26. Descriptive statistics, including means and standard deviations, were used to summarize learners' problem-solving competency scores across the four Solomon groups. Given the Solomon four-group design, the analysis was structured to examine the effects of the intervention and pretesting and to determine whether pretesting interacted with the intervention. Given that the study used intact learners within schools and one school represented each experimental or control condition, the observations were not completely independent of school and teacher effects. Consequently, the findings were interpreted with recognition that school and teacher characteristics could not be completely separated from the treatment condition. Assumptions relevant to the selected analysis were examined before inferential testing. Where appropriate, effect sizes were also considered alongside statistical significance to indicate the magnitude of observed differences. The descriptive and inferential results, including means, standard deviations, degrees of freedom, sums of squares, mean squares, F-values, p-values and effect sizes, were to be generated from the same verified dataset to ensure consistency between the reported tables and the underlying data.

RESULTS

Baseline Comparison of the Pretested Groups

Prior to implementation of the intervention, a pretest was administered to learners in the pretested experimental group (E1) and the pretested control group (C1) to establish baseline levels of problem-solving competency in food production processes. The assessment examined learners' ability to interpret agricultural situations, identify production problems, and propose appropriate solutions. The descriptive results are presented in Table 1.

Table 1. Descriptive Statistics of Pretest Scores for E1 and C1.

Group	n	Mean
Experimental group 1 (E1)	150	41.11
Control group 1 (C1)	59	42.17
Total	209	41.41

E1 recorded a mean pretest score of 41.11, whereas C1 recorded a mean of 42.17. The difference between the two-group means was 1.06 points. The overall mean for the 209 pretested learners was 41.41. A one-way ANOVA was conducted to examine the difference between the two pretested groups. The results are presented in Table 2.

Table 2. One-Way ANOVA of Pretest Scores for E1 and C1.

Source of variation	Sum of Squares	df	Mean Square	F	p
Between groups	54.324	1	54.324	1.830	.178
Within groups	6143.236	207	29.677		
Total	6197.560	208			

The analysis showed no statistically significant difference between E1 and C1, $F(1, 207) = 1.830$, $p = .178$. The two pretested groups therefore had similar measured levels of problem-solving competency at baseline. The baseline findings provided the starting point for examining the subsequent performance of the four Solomon groups. The relatively close pretest means demonstrate that E1 and C1 entered the intervention phase with closely positioned levels of measured problem-solving competency.

Descriptive Performance in Observational Assessment

The post-intervention observational assessment results are presented in Table 3. The assessment measured three competency domains: Soil Conservation (SC), Water Conservation (WC), and Pest and Disease Control (PDC).

Table 3. Descriptive Mean Scores for Observational Assessment by Competency and Group.

Group	n	SC Mean (%)	WC Mean (%)	PDC Mean (%)	Composite Mean (%)
E1	150	82.5	83.8	83.2	83.17
E2	78	80.2	81.6	81.0	80.93
C1	59	76.5	77.2	76.8	76.83
C2	48	75.0	75.8	75.5	75.43

A consistent performance pattern was observed across the four groups. E1 recorded the highest mean in all three competency domains, followed by E2, C1, and C2. For SC, the means were 82.5% for E1, 80.2% for E2, 76.5% for C1, and 75.0% for C2. For WC, E1 recorded 83.8%, E2 81.6%, C1 77.2%, and C2 75.8%. PDC means were 83.2%, 81.0%, 76.8%, and 75.5%, respectively. The composite scores followed the same ordering, with E1 recording 83.17%, E2

80.93%, C1 76.83%, and C2 75.43%. The difference between E1 and C2 was 7.74 percentage points on the composite measure. E1 exceeded E2 by 2.24 percentage points, while E2 exceeded C1 and C2 by 4.10 and 5.50 percentage points, respectively. The consistency of the group ordering across the competency domains indicates a stable pattern of higher performance among the experimental groups.

Soil Conservation Competency

The highest SC mean was recorded by E1 at 82.5%, followed by E2 at 80.2%, C1 at 76.5%, and C2 at 75.0%. E1 therefore exceeded C2 by 7.5 percentage points, while E2 exceeded C1 by 3.7 percentage points. The results show a clear progression across the four groups, with the experimental groups recording higher scores than the control groups.

Water Conservation Competency

E1 recorded the highest WC mean at 83.8%, followed by E2 at 81.6%, C1 at 77.2%, and C2 at 75.8%. The difference between E1 and C2 was 8.0 percentage points, representing the largest observed difference between the highest and lowest groups across the three competency domains. The experimental groups therefore recorded higher WC performance than both control groups, with the same group ordering observed for SC.

Pest and Disease Control Competency

For PDC, E1 recorded 83.2%, E2 81.0%, C1 76.8%, and C2 75.5%. The difference between E1 and C2 was 7.7 percentage points, while E2 exceeded C1 by 4.2 percentage points. The identical ordering across SC, WC, and PDC demonstrates that the higher experimental-group performance extended across the three assessed dimensions of agricultural problem-solving competency.

Testing of Assumptions for One-Way ANOVA

The study objective examined differences in problem-solving competency in food production processes between learners exposed to observational assessment and those in the conventional assessment condition. The corresponding null hypothesis was:

H01: There is no statistically significant difference in problem-solving competency in food production processes between learners assessed using observational and conventional methods. Prior to the analysis, the distribution of scores and equality of group variances were examined as indicated in Table 4.

Table 4. Shapiro–Wilk Test of Normality for Observational Assessment Scores.

Group	Statistic	df	p
E1	.996	150	.952
E2	.988	78	.700
C1	.974	59	.229
C2	.903	48	.001

The Shapiro–Wilk results were non-significant for E1, p = .952, E2, p = .700, and C1, p = .229. C2 recorded a significant Shapiro–Wilk statistic, p = .001. The distributional results were considered alongside the assessment of variance homogeneity as indicated in Table 5.

Table 5. Levene's Test of Homogeneity of Variances for Observational Assessment Scores.

Test	Statistic	df1	df2	p
Based on mean	1.632	3	331	.182
Based on median	1.608	3	331	.187
Based on median and adjusted df	1.608	3	302.060	.188
Based on trimmed mean	1.620	3	331	.184

Levene's test based on the mean was not statistically significant, $F(3, 331) = 1.632$, $p = .182$. The median-based and trimmed-mean tests produced the same pattern, with p values between .184 and .188. The group variances were therefore statistically comparable.

One-Way ANOVA of Observational Assessment Scores

The omnibus comparison of observational assessment scores is presented in Table 6. The one-way ANOVA revealed a statistically significant difference in observational assessment scores among four groups, $F(3, 331)=52.473$, $p<.001$. The null hypothesis was therefore rejected. The result demonstrates statistically significant variation in problem-solving competency across the four study groups. The effect size was estimated using eta squared. The analysis produced $\eta^2 = .322$, indicating that group membership described for 32.2% of the variance in observed observational assessment scores. The significant omnibus result was followed by Tukey's HSD procedure to establish the specific group differences (Table 7).

Table 6. One-Way ANOVA of Observational Assessment Scores.

Source of variation	Sum of Squares	df	Mean Square	F	p
Between groups	3139.080	3	1046.360	52.473	.001
Within groups	6600.403	331	19.941		
Total	9739.483	334			

Table 7. Tukey's HSD Post Hoc Comparisons of Observational Assessment Scores.

(I) Group	(J) Group	Mean Difference (I–J)	SE	p	95% CI Lower	95% CI Upper
E1	E2	2.177	0.623	.003	0.568	3.787
E1	C1	6.458	0.686	.001	4.686	8.230
E1	C2	7.683	0.741	.001	5.771	9.595
E2	E1	-2.177	0.623	.003	-3.787	-0.568
E2	C1	4.281	0.770	.001	2.291	6.270
E2	C2	5.505	0.819	.001	3.390	7.621
C1	E1	-6.458	0.686	.001	-8.230	-4.686
C1	E2	-4.281	0.770	.001	-6.270	-2.291
C1	C2	1.225	0.868	.493	-1.017	3.466
C2	E1	-7.683	0.741	.001	-9.595	-5.771
C2	E2	-5.505	0.819	.001	-7.621	-3.390
C2	C1	-1.225	0.868	.493	-3.466	1.017

Note. SE = standard error; CI = confidence interval. Statistical significance was evaluated at $\alpha = .05$.

Tukey's HSD revealed statistically significant differences between E1 and E2, mean difference = 2.177, $p = .003$, 95% CI [0.568, 3.787]. E1 also recorded significantly higher scores than C1, mean difference = 6.458, $p < .001$, 95% CI [4.686, 8.230], and C2, mean difference = 7.683, $p < .001$, 95% CI [5.771, 9.595]. E2 likewise recorded significantly higher scores than C1, mean difference = 4.281, $p < .001$, 95% CI [2.291, 6.270], and C2, mean difference = 5.505, $p < .001$, 95% CI [3.390, 7.621]. The comparison between C1 and C2 was not statistically significant, mean difference = 1.225, p=.493, 95% CI [-1.017, 3.466]. The post hoc pattern consequently showed significant differences across every experimental-control comparison. The experimental groups also differed significantly from each other, whereas the two control groups produced statistically similar scores.

DISCUSSION

Baseline Performance of the Pretested Groups

The baseline results showed closely aligned levels of problem-solving competency among the two pretested groups. E1 recorded a mean of 41.11 and C1 a mean of 42.17, representing a difference of only 1.06 points. The ANOVA confirmed that this difference was not statistically significant, $F(1, 207) = 1.830$, $p = .178$. The comparable starting levels provide an appropriate basis for examining the subsequent differences in performance among the four Solomon groups. The post-intervention results subsequently showed a marked separation between the experimental and control groups, with the experimental groups recording substantially higher observational assessment scores.

Observational Assessment and Problem-Solving Competency

The four-group analysis revealed statistically significant differences in observational assessment scores, $F(3, 331) = 52.473$, p =.001, with $\eta^2 = .322$. The post hoc analysis showed that both experimental groups recorded significantly higher scores than both control groups. The descriptive results reinforced this pattern, with E1 and E2 consistently recording higher scores across SC, WC, and PDC. The magnitude of the effect provides an important dimension to the finding. Group membership accounted for 32.2% of the variance in observational assessment scores. The result indicates substantial differentiation in measured problem-solving competency across the four assessment groups. The finding is consistent with research emphasising practical, experiential, and applied approaches to agricultural education. Sun (2024) reported stronger mastery of soil-management principles among learners involved in experiential farming education. Turyamureba et al. (2024) similarly linked practical agricultural activities with the development of diagnostic and problem-solving capabilities. Devaki (2024), Eleni et al. (2021), and Gissela et al. (2024) further demonstrate the relevance of practical engagement, active learning, and problem-oriented agricultural education. The present study extends this body of evidence by positioning assessment itself as part of the process through which agricultural problem-solving competency is demonstrated. Observational assessment creates opportunities for learners to demonstrate how they interpret agricultural conditions, identify production challenges, and formulate responses. The higher scores recorded by E1 and E2 are therefore consistent with an assessment environment centred on the application of agricultural knowledge and skills.

This pattern is particularly relevant to competency-based education, where learning outcomes encompass the ability to apply knowledge in authentic contexts. The observed differences suggest that the assessment context was associated with differentiated learner performance in tasks requiring practical interpretation and problem solving.

Performance Across Agricultural Competency Domains

The consistency of the group ordering across SC, WC, and PDC provides an important dimension of the findings. E1 recorded 82.5% in SC, 83.8% in WC, and 83.2% in PDC. E2 recorded 80.2%, 81.6%, and 81.0%, respectively. The corresponding scores for C1 were 76.5%, 77.2%, and 76.8%, while C2 recorded 75.0%, 75.8%, and 75.5%. The SC pattern is consistent with Sun (2024), who reported stronger soil-management mastery following experiential farming education. Turyamureba et al. (2024) similarly associated practical agricultural engagement with diagnostic and problem-solving competencies. Soil conservation requires learners to connect observable field conditions with appropriate management responses. The higher scores among the experimental groups therefore correspond with an assessment context in which learners engage with agricultural problems as observable situations. WC produced the largest descriptive gap, with an 8.0-percentage-point difference between E1 and C2. This finding is relevant to agricultural production because effective water management requires learners to recognise resource conditions and determine appropriate conservation practices. Kaur et al. (2020) emphasised the significance of water management in sustainable agricultural production. Balcha et al. (2025) further identified contextual learning, teacher engagement, and supervision as relevant to environmental-management competencies. Castro-Velásquez et al. (2024) and Valenzuela-Morales et al. (2022) similarly demonstrate the importance of structured and contextually meaningful learning in water-related agricultural practices.

The PDC results followed the same pattern. E1 recorded 83.2%, compared with 81.0% for E2, 76.8% for C1, and 75.5% for C2. Crop pest and disease management requires learners to identify symptoms, interpret evidence, determine likely production problems, and select suitable management responses. FAO (2021) identifies pests and diseases as important constraints to agricultural production, underscoring the practical relevance of diagnostic capability.

Molnar et al. (2026) similarly associated practical agricultural engagement with learners' identification of crop-health problems and appropriate responses, while Pham Thi (2025) emphasised active engagement and reflection in the application of knowledge to practical situations. The PDC pattern in the present study is consistent with these findings and demonstrates the relevance of applied assessment to agricultural problem-solving tasks. Across the three domains, therefore, the experimental groups consistently recorded higher performance. The convergence of the domain-level patterns with the overall composite results strengthens the interpretation of the four-group differences.

Experimental-Group Differences and Solomon Pattern

An important feature of the results was the statistically significant difference between E1 and E2, with E1 recording a mean difference of 2.177 points over E2, p = .003. Both groups received the experimental assessment condition, while E1 was pretested and E2 was not. The difference demonstrates variation in performance between the two experimental groups within the Solomon structure. The control groups displayed a different pattern. C1 and C2 differed by only 1.225 points, and the difference was not statistically significant, p = .493. The 95% confidence interval, [-1.017, 3.466], encompassed zero. Thus, the control groups produced closely related post-assessment outcomes. The contrast between the experimental groups and the control groups is therefore distinctive. E1 exceeded

C1 by 6.458 points and C2 by 7.683 points, while E2 exceeded C1 by 4.281 points and C2 by 5.505 points. These results demonstrate a consistent experimental-control separation across the Solomon groups. The E1–E2 difference adds a further dimension to the findings because the two experimental groups did not perform identically. Within the structure of the study, E1 combined pretesting with the experimental assessment condition, whereas E2 received the experimental assessment condition without the pretest. The higher E1 mean therefore corresponds with the combined pretested-experimental condition. The pattern of E1, E2, C1, and C2 demonstrates the value of retaining the four groups in the analysis. The four group means were not simply separated into two homogeneous categories. Instead, the results showed the highest performance for E1, followed by E2, C1, and C2, with statistically significant differences among the experimental groups and between each experimental and control group, while the control groups remained statistically similar.

CONCLUSION

The study established that observational assessment was associated with higher levels of problem-solving competency in food production processes among Grade 9 learners. The baseline comparison showed that the pretested experimental and control groups were statistically comparable before the intervention, providing an appropriate basis for examining differences in learners' outcomes following implementation of the assessment approach. Following the intervention, the observational assessment groups recorded higher mean scores than the conventional assessment groups across soil conservation, water conservation, and pest and disease control competencies. The results demonstrated a consistent pattern across the three competency domains. The experimental groups recorded mean scores ranging from 80.2% to 83.8%, whereas the control groups recorded mean scores ranging from 75.0% to 77.2%. The overall composite mean was highest for E1 (83.17%), followed by E2 (80.93%), C1 (76.83%), and C2 (75.43%). The one-way ANOVA confirmed statistically significant differences among the four groups, with group membership accounting for 32.2% of the variance in observational assessment scores. Tukey HSD comparisons further showed statistically significant differences between the experimental and control groups, while the two control groups did not differ significantly. The findings demonstrate that observational assessment provided a meaningful context for learners to demonstrate agricultural problem-solving competency through the application of knowledge and skills in practical situations. The stronger performance observed in soil conservation, water conservation, and pest and disease control reflects the value of assessment practices that capture learners' ability to identify agricultural challenges, interpret practical situations, and respond appropriately to production problems. The findings also reinforce the relevance of authentic and contextually grounded assessment within competency-based agricultural education. The Solomon Four-Group pattern further showed higher performance among learners in the pretested experimental group than those in the non-pretested experimental group, while the two control groups recorded closely related outcomes. This pattern demonstrates the strong performance of learners exposed to observational assessment within both pretested and non-pretested experimental conditions.

Recommendations

Based on the findings of the study, following recommendations are proposed for strengthening the assessment of agricultural competencies within competency-based education.

Agriculture teachers should integrate observational assessment systematically into classroom and field-based assessment. Teachers can use structured observation checklists and clearly defined performance indicators to assess learners as they undertake agricultural activities. Such assessment can provide evidence of learners' ability to apply knowledge, perform practical tasks, identify production challenges, and develop appropriate solutions.

Schools should strengthen opportunities for practical agricultural learning and assessment. Adequate time should be provided for learners to engage in activities involving soil conservation, water management, pest and disease identification, and crop-production problem solving. Linking assessment to these practical activities can provide learners with opportunities to demonstrate competencies in authentic agricultural contexts.

Teacher professional development programmes should include training on observational assessment. Training should focus on developing clear assessment criteria, constructing observation checklists, documenting learner performance, providing feedback, and maintaining consistency when assessing practical agricultural competencies. Such preparation can strengthen teachers' capacity to implement authentic assessment approaches within competency-based education. Curriculum developers and education stakeholders should strengthen the integration of observational assessment within agricultural education. Assessment guidance should provide practical examples of observation-based tasks, competency indicators, scoring criteria, and feedback procedures that teachers can adapt to different agricultural contexts. This would support greater consistency in the implementation of competency-based assessment.

Schools should strengthen the availability of resources that support practical agricultural assessment. Access to appropriate demonstration plots, soil and water conservation materials, crop-production resources, pest and disease specimens, and other agricultural learning materials can enhance opportunities for learners to demonstrate practical competencies through observation-based assessment.

Limitations of the Study

The study had some limitations. First, the research involved only four schools, with one school representing each Solomon Four-Group condition, which limited the range of school contexts represented and the generalizability of the findings. Individual learners were not randomly assigned to the experimental and control conditions because intact classes were used to preserve existing school structures. Consequently, school and teacher characteristics were inherently associated with the respective treatment conditions. Differences in teacher facilitation, instructional experience, school resources, and opportunities for practical agricultural engagement may have contributed to variation in learner performance. In addition, observational assessment involved teacher judgement of learners' demonstrated problem-solving processes, creating the possibility of rater-related variation despite the use of predetermined criteria and a common rubric. The assessment also focused on selected sustainability-oriented food-production competencies, particularly soil conservation, water management, and pest and disease control, limiting coverage of other sustainability competencies such as biodiversity conservation and agroecological innovation.

REFERENCES

Adewusi, O. E., N. M. Hamad, I. J. Adeleke, U. C. Nwankwo and G. C. Nwokocha. 2023. Assessment and evaluation in adaptive early childhood education: A comprehensive review of practices in Nigeria. International Journal of Applied Research in Social Sciences, 5: 292–307.

African Population and Health Research Center (APHRC). 2024. Aligning assessment practices with the competence-based curriculum in Kenya. African Population and Health Research Center, Nairobi, Kenya.https://aphrc.org/wp-content/uploads/2024/10/CBC_Policy-Brief-3-1.pdf

Balcha, T. A., K. Worku and A. Lemma. 2025. The status of environmental education in promoting students' sustainable environmental management capabilities in Asella secondary schools, Oromia, Ethiopia. Cogent Education, 12: 2576280.

Blanca, M. J., J. Arnau, F. J. García-Castro, R. Alarcón and R. Bono. 2023. Non-normal data in repeated measures ANOVA: Impact on type I error and power. Psicothema, 35: 21–29.

Boge, F. J. 2025. Re-assessing the experiment/observation divide. Philosophy of Science, 92: 470–487.

Cai, Y. and E. S. Lee. 2026. Analysis of variance. In: Translational Plastic Surgery. p. 149–152.

Castro-Velásquez, F. E., A. Ramírez-Segado and A. Benarroch. 2024. A teaching proposal on the new water culture for students aged 14–15: Design, application and evaluation in a Colombian context. Frontiers in Education, 8: 1341690.

Chan, C. K. Y. 2023. Assessment for experiential learning. Routledge, London.

Chebii, R., S. Wachanga and Z. Anditi. 2018. Effects of cooperative e-learning approach on students' chemistry achievement in Koibatek Sub-County, Kenya. Creative Education, 9: 1872–1880.

Cho, H., H. Jeong, J. Yu, J. Lee and H. J. Jung. 2024. Becoming a doctor: Using social constructivism and situated learning to understand the clinical clerkship experiences of undergraduate medical students. BMC Medical Education, 24: 236.

Devaki, V. 2024. Exploring the impact of innovative assessment methods on learning outcomes: A review of project-based assessments, portfolios, peer assessment and self-assessment. In: Policy Development, Curriculum Design, and Administration of Language Education. p. 343–374.

Dignath, C. and M. V. J. Veenman. 2021. The role of direct strategy instruction and indirect activation of self-regulated learning: Evidence from classroom observation studies. Educational Psychology Review, 33: 489–533.

Eleni, T., Ma and A. Kofou. 2021. Observation as an alternative assessment method in assessing second-language productive skills. Conference: Πρακτικά Εργασιών 6ου Διεθνούς Συνεδρίου, για την Προώθηση της Εκπαιδευτικής Καινοτομίας, Λάρισα 16-18 Οκτωβρίου 2020, http://synedrio.eepek.gr

Fahmi, H. Fajeriadi, Y. Irhasyuarna, Suryajaya and Abdullah. 2021. The practicality of natural science learning devices on the concept of environmental pollution with problem-solving learning models. Journal of Physics: Conference Series, 2104: 012025.

Food and Agriculture Organization of the United Nations (FAO). 2021. Climate change fans spread of pests and threatens plants and crops, new FAO study. Food and Agriculture Organization of the United Nations, Rome, Italy. https://www.fao.org/newsroom/detail/Climate-change-fans-spread-of-pests-and-threatens-plants-and-crops-new-FAO-study/en

Gissela, H. M., J. C. Adam and E. Lyamtane. 2024. Practicality of case study assessment practice in enhancing students' active learning in English subject in public secondary schools in Same District, Tanzania. International Journal of Innovative Science and Research Technology, 9: 911–917.

Habibzadeh, F. 2024. Data distribution: Normal or abnormal? Journal of Korean Medical Science, 39(3):e35

Issa, Z., J. Mwakapina and O. Nyinondi. 2024. Competence-based curriculum in practice: English curriculum implementation prospects and challenges in Mtama District secondary schools in Tanzania. International Journal of Research, 13: 29–39.

Karani, A. 2025. Infrastructural adequacy in implementing competence-based education in Grade Four Agriculture: A case of public primary schools in Njoro Sub-County, Kenya. Journal of Social Transformation and Regional Development, 7: 1–10.

Karani, A., M. Kyule and J. Ng'eno. 2024. The extent of inculcating competencies in teaching competence-based Grade Four Agriculture among public primary schools in Njoro Sub-County of Kenya. International Journal of Education, Technology and Science, 4: 1736–1759.

Kaur, G., G. Singh, P. P. Motavalli, K. A. Nelson, J. M. Orlowski and B. R. Golden. 2020. Impacts and management strategies for crop production in waterlogged or flooded soils: A review. Agronomy Journal, 112: 1475–1501.

Kenya Institute of Curriculum Development (KICD). 2024. Junior school curriculum design: Agriculture Grade 9. Kenya Institute of Curriculum Development, Nairobi, Kenya. https://kicd.ac.ke/wp-content/uploads/2024/06/Agriculture-Grade-9-Formatted-April-2024.pdf

Kien, P. T. 2025. The relevance of John Dewey's pragmatism for educational innovation in contemporary Vietnam. Cogent Education, 12: 2510055.

Kigwilu, P. C. and D. K. Mokoro. 2022. Teachers' assessment practices in implementing competence-based curriculum in secondary schools in Arumeru District of Tanzania. East African Journal of Education Studies, 5(2): 324-333.

Kikwei, J. C. 2023. Influence of teacher characteristics on the implementation of competency-based curriculum in primary schools in Molo Sub-County, Nakuru County, Kenya. Thesis, The Catholic University of Eastern Africa, Nairobi, Kenya.

Lee, U., Y. Jeong, J. Koh, G. Byun, Y. Lee, H. Lee, S. Eun, J. Moon, C. Lim and H. Kim. 2024. I see you: Teacher analytics with GPT-4 vision-powered observational assessment. Smart Learning Environments, 11: 48.

Mohanty, A. 2025. Does being observed alter the observation being made? PhD thesis, University of Iowa, Iowa City, United States. https://iro.uiowa.edu/view/pdfCoverPage?instCode=01IOWA_INST&filePid=131024429760002771&download=true

Molnar, J. J., A. Gopaul and J. R. Lindner. 2026. Experiential learning modules for teaching international agricultural development: How to use these tools and assess their impact. Education Sciences, 16: 75.

Murray, T. 2024. The playful entrepreneur: Fostering entrepreneurial education in early childhood education. https://sword.cit.ie/allthe/821/

Nabor, E. 2024. Evaluation of learning modules in mathematics. https://philpapers.org/rec/NABEOL

Nair, S. and J. Mathew. 2021. Evaluation of gamified training: A Solomon four-group analysis of the impact of gamification on learning outcomes. TechTrends, 65: 750–759.

Okutu, A. A. and A. K. Nyambane. 2024. Challenges of domiciling junior secondary schools in primary schools: A case of Migori County, Kenya. Journal of

Research Innovation and Implications in Education, 8(4), 135 – 144.

Otieno, A. I., J. Bett and J. Changeiywo. 2024. Effects of social constructivist teaching and learning approach on learners' academic achievement in English among public co-educational secondary schools in Njoro Sub-County, Kenya. Egerton Journal of Humanities, Social Sciences and Education, 13: 172–184.

Salinas-Navarro, D. E. and E. Vilalta-Perdomo. 2025. What active learning and authentic assessment in higher education can do for the world. Emerald Publishing. https://www.emerald.com/books/edited-volume/17048/chapter/94048341

Sun, R. 2024. The impact of farming education on college students' agricultural skills and knowledge. Journal of International Education and Development, 8: 28–34.

Turyamureba, E., E. Ssemakula and G. Nuwemuhwezi. 2024. Relevancy of modern agriculture education on students' farming practical skills in secondary schools of Kabujogera Town Council, Kitagwenda District. Teacher Education and Curriculum Studies, 9: 12–20.

United Nations. 2023. World population projected to reach 9.8 billion in 2050 and 11.2 billion in 2100. United Nations, New York, United States. https://www.un.org/en/desa/world-population-projected-reach-98-billion-2050-and-112-billion-2100

United Nations Educational, Scientific and Cultural Organization (UNESCO). 2024. Transforming education towards SDG 4: Report of a global survey on country actions to transform education. UNESCO, Paris, France.

Valenzuela-Morales, G. Y., M. Hernández-Téllez, M. D. L. Ruiz-Gómez, M. A. Gómez-Albores, R. Arévalo-Mejía and C. A. Mastachi-Loza. 2022. Water conservation education in elementary schools: The case of the Nenetzingo River Catchment, Mexico. Sustainability, 14: 2402.