Teaching and Learning in Fragile Contexts (TLFC) Research Report

Improvised Mobile Science Kit

Enhancing Scientific Literacy Among Grade 4 Learners in Kakuma Refugee Camp Using Improvised Mobile Science Kit

Dr. Ezekiel Nyambega Omwenga, (PI)
Dr. Elijah Omosa
Dr. Evelyne Njurai
Department of Curriculum, Instruction and Media
Kisii University

code | Promoting every child's right to read

TLFC

In partnership with Canada

Executive Summary

The study focused on enhancing Scientific Literacy among Grade 4 Learners in Kakuma refugee camp using Improvised Mobile Science Kits. Four public co-educational comprehensive primary schools were purposively selected. Two were taught integrated science by use of an Improvised Mobile Science Kit, and two were taught using conventional methods of teaching as the control. The learners were assessed before (pre-test) and after six weeks (post-test) to assess their achievement in integrated science. The pre-test and post-test consisted of test items that tested learners' improved science skills. The test item construction took into consideration the grade level and learners' mastery and application of scientific skills and critical thinking.

The study explored the use of Improvised Mobile Science Kits to improve teaching and learning of integrated science in the context of enabling grade four learners to develop the 21st century skills in the implementation of the competency-based curriculum (CBC) in Kenya. The focus was in four sampled primary schools in the namely: Kakuma Arid Zone, Kalemuchuch, Pokotom and Kakuma Mixed, all in Kakuma refugee camp with a population of 1065 learners, of whom about 50% are refugees.

Findings

The results of the study indicated that,

- The respondents have a positive perception of the Improvised Mobile Science Kit; it promotes hands-on learning enhancing retention of scientific concepts.
- The Improvised Mobile Science Kit is durable for re-use across multiple classes at different times.
- The Improvised Mobile Science Kit's effectiveness is influenced by contextual factors.
- It improves learner's interest, understanding, confidence and performance in science.
- It contributes positively to improve teacher capacity since they exhibit high levels of confidence, enhance creativity in the use materials found locally and it indicates that teacher preparation is not uniform since other teachers demonstrate limited capacity.
- In terms of gender differences, the Improvised Mobile Science Kit promotes equity in terms of learner participation, access, engagement and gender equality. It is generally gender inclusive.
- It was observed teachers experienced challenges in fully utilizing the kit, and the presence of the challenges are not uniform. They are contextual in nature, such as resource availability, resource shortage, high teacher turn-over, underutilization and misapplication of resources, constraints related to class size, language, time and storage and maintenance of the improvised science teaching resources.

Why the study is significant

The study points out that Improvised Mobile Science Kit is useful in the teaching to improve scientific literacy in this period of implementing the competency-based curriculum in Kenya. It enables the learners to:

- Improve the leaner's interest and participation in learning integrated science.
- Gives learners the opportunity to have hands-on (practical) activities in integrated science.
- It helps the learners to develop manipulative science skills.
- It supports the development of confidence in science learning.
- It improves retention of the science concepts learned.

Key recommendations

- Schools should consider using the Improvised Mobile Science Kit. This may call for adjustment or redrawing of the education policies.
- There is need for additional training, capacity building and support for teachers to maximize the instructional effectiveness of the Improvised Mobile Science Kit.
- There is need to improve storage facilities to protect and maintain the kit and other resources for science instruction.
- There is a serious need for indigenous local-context research to evaluate the kit's adaptability, cultural relevancy and efficacy.
- There is need for contextual proper teacher training, improved material design and continuous support (constant re-tooling) to enhance scientific literacy.
- For proper engagement of learners to develop the 21st century competencies adequate time should be provided by adjusting the timetables. Target teacher training and resource support to enhance resource-limited schools.
- Have counselling sessions for learners who have been traumatized due to impact of war, or displacement by natural calamities.
- Encourage teachers to collect, improvise and utilize locally available materials for teaching integrated science.
- Guidance and counselling need to be done to demystify believes held by learners that girls cannot excel in science related subjects as much as boys can do.
- The innovative approach holds particular relevancy for schools in refugee settings, since these schools are found within arid and semi-arid lands (ASALs) which are resource constrained regions.
- For proper learning, policy on class size of 35-40 pupils in a class should be adhered to; some classes had up-to 129 learners in one class.

Contents

Introduction

This research focused on the use of and Improvised Mobile Science Kit to promote science literacy in fragile contexts and its alleviation of lack of resources to promote science literacy. Kakuma Refugee Primary Schools lack resources for teaching, classes are overcrowded, desks are inadequate, and teacher capacity needs to be increased especially in the implementation of the competency-based curriculum (CBC). Physical environments such as adverse weather, limited resources like food, water, sitting space also took toll on the instructional program.

This research is a pilot study done in Kakuma refugee camp in Kenya. It is purpose was to find out how Improvised Mobile Science Kits can enhance scientific literacy in Class four leaners. The report commences by giving a brief background of the necessity of the use of the Improvised Mobile Science Kit in the teaching and learning of integrated science in fragile contexts.

The report explains the objectives and hypotheses that guided the study. The methodology used is outlined. The findings of the study are discussed which include the results from the pre-test and post-test leaner's achievement test, classroom observation schedule and teacher's questionnaire in line with the integrated science learning outcomes.

Background

In the teaching and learning of science, labs are of immense importance for science to be taught and learned effectively. They provide learners the chance to experiment, discover, and build skills that go far beyond the textbook. Despite this, in almost all fragile educational contexts, where meagre or no resources exist, teaching occurs theoretically or sometimes teachers are forced to improvise. They use locally available materials to make substitutes for standard equipment – for instance in place of beakers one could use plastic bottles, components from old electronics can be used to instruct electricity and electronics. These innovations bring life into science classrooms, but again they are associated with lots of challenges that affect learners' academic achievement.

In the instruction of science and technology in primary schools, there is a lack of materials. In Rwanda, it was reported that only 17% of secondary schools had functional science laboratories (Ndihokubwayo, 2023). Teachers are forced to improvise, but again it has been documented that many of them lack the required skills to improvise effectively. Ismael (2018) supports this finding, by asserting that teachers have been found to struggle in activating school labs because of inadequacy of equipment and poor maintenance. Improvised teaching aids are often treated by teachers as "second best." Ndihokubwayo (2023) reported that teachers in Zimbabwe and Papua New Guinea considered improvised science materials as diluting the image of science, therefore undermining confidence in their use.

Teachers do not use experiential learning because of lack of time. This is because laboratory work requires time for preparation, experimentation, and supervision - which becomes hard to adjust so that they fit into the time constrained curricula. According to Ismael (2018) there are a limited number of science lessons, making it difficult for teachers to conduct practical activities. Improvisation normally needs a lot of time for designing, developing, implementation and evaluation of teaching, which is an extra burden on the teachers. External examinations also exert a lot of pressure on the teachers who need to cover the extensive syllabi, affording the teacher little room for creative, hands-on work. This competition between preparation for examination and practical engagement reduces both the frequency and quality of laboratory use.

Teacher training is a critical gap. Almost all teachers of science were never trained in improvisation of teaching materials during their pre-service training and some who have been trained during in-service training have not been properly trained, while some have never had the chance to be trained during in-service on improvisation techniques, which leads them be hesitant in adopting improvised materials. In Rwanda, Ndihokubwayo (2023) discovered that improvised resources were often dismissed by teachers, in preference to conventional learning resources even when those were unavailable. It is believed that they are reluctant because of concerns about accuracy, safety, and credibility. Ramothwala and Ramaila (2020) on improvised learning resources in South Africa found out that while improvised learning resources helps to demystify abstract concepts, teachers are worried about perpetuating misconceptions if creativity was lacking. Ismael (2018), while examining improvisation in Jordan found similar findings – time constraints and inadequate facilities as barriers.

Taken together, these challenges – material scarcity, traumatized learners, time constraints, lack of training, negative attitudes, and safety concerns – limit the effectiveness of improvised science resources. The potential of utilization of improvised mobile kits is undeniable. If teachers are effectively supported through training, then curricula are designed to permit space for hands-on, and with policies that legitimize use of locally materials in improvising learning resources as a valid pedagogical innovation, improvised kits can transform education in integrated science. They can turn resource-constrained classrooms into spaces of discovery, creativity, and achievement and in the long run minimize the many challenges that integrated science teachers' face.

Study objectives

The study was guided by the following research objectives.

1. Determine how Improvised Mobile Science Kit can enhance learners practical and problem-solving skills in grade 4 learners in Kakuma refugee camp.
2. Determine how the use of Improvised Mobile Science Kits can improve teacher capacity, effectiveness and confidence in inculcating scientific literacy in grade 4 in Kakuma refugee camp.
3. To assess the difference by gender in acquisition of competencies to enhance scientific literacy in grade 4 leaners in Kakuma refugee camp.

4. Determine the challenges faced by teachers in the use of mobile science kit resources to improve scientific literacy.
5. To find out if there is a significant difference between leaners taught by the use of the Improvised Mobile Science Kit resources and those taught by conventional methods.

Hypotheses and Research Questions

$H_0$1: The grade 4 learners' practical skills and problem-solving abilities are not significantly influenced by the use of Improvised Mobile Science Kit materials.

$H_0$2: There is no significant difference in the improvement of teacher capacity, effectiveness and confidence by teachers who use the improvised science kit and those teach by conventional methods.

$H_{03:}$ There is no significant difference by gender between grade 4 leaners taught by the use of improvised mobile science laboratory resources and those taught by conventional methods.

H_{04}: There is no significant difference in learners understanding of integrated science concepts between those taught using Improvised Mobile Science Kit and those using conventional teaching methods.

The following questions guided the study.

1. Does the use of Improvised Mobile Science Kit materials significantly influence Grade 4 learners' practical skills and problem-solving abilities?
2. Does the use of Improvised Mobile Science Kit significantly improve teachers' capacity, effectiveness and confidence in delivering integrated science lessons?
3. Are there gender differences in the acquisition of competencies that enhance scientific literacy among grade 4 learners in Kakuma refugee camp?
4. What challenges do teachers face in the use of Improvised Mobile Science Kit resources to improve scientific literacy?
5. Is there a significant difference in learners' understanding of integrated science concepts between those taught using Improvised Mobile Science Kit and those taught using traditional teaching methods?

Methodology

The project used a randomized pre-test, post-test experimental design. Four public co-educational comprehensive primary schools were selected. Two were taught integrated science by use of an Improvised Mobile Science Kit, and two were taught using conventional methods of teaching as the control. The learners were assessed before (pre-test) and after six weeks (post-test) to assess their achievement in integrated science. The design entails four groups, as shown in the Table 1 below.

Table 1 Showing the matrix of the research design.

Group	Pre-test	Intervention	Post-test
E1	X1	TUISK	X2
C1	X1	No intervention	X2
E2	O	TUISK	X2
C2	O	No intervention	X2

Key: E1: Experimental group 1; C1: Control group 1; E2: Experimental group 2; C2: Control group 2, X1: Pre-test; X2: Post-test; O: no test; TUMSK: Teaching using mobile science kit, Source: Creswell & Creswell, 2018.

The experimental groups E1 and C1 were subjected to a pre-test (X1) for comparable characteristics. Groups E1 and E2 were subjected to the treatment (Teaching using mobile science kit: TUMSK). All the groups (E1, C1, E2, and C2) received the post-test (X2). The pre-test and post-test consisted of test items that tested learners' improved science skills. The test item construction took into consideration the grade level and learners' mastery and application of scientific skills and critical thinking. To avoid contamination of the results of the study, only one class from each school was selected to take part in the study. A total of four schools participated in the study. The target population of the study was 22,365 pupils of grade 4 learners from 21 comprehensive junior primary schools in Kakuma refugee camp. A sample of 1065 pupils, estimated to be 10-13 years old, from four schools was used. A pilot study was done in two schools, which were not considered in the study. Purposive sampling was used to select schools where the study occurred. Purposive sampling was preferred to enable the researcher to select schools with similar characteristics so as to control the effect of school characteristics on the achievement of integrated science. Grade 4 teachers teaching integrated Science were involved. Four teachers were involved, and the head teacher in each school. The schools must have met the following criteria. Must be having refugee learners, must be a public school, must have been a co-educational school (have both male and female learners) and must be offering competency-based education (CBE). A science achievement test (SAT), both pre-test and post-test, prepared by grade 4 science teachers, was used alongside the class observation questionnaire and Likert scale questionnaire. Data from the Likert questionnaire was sorted, coded and entered to excel sheet and imported to SPSS. Analysis was done using descriptive and inferential statistics.

Participating schools

The four schools used in the study are known as host schools which mean they host learners, refugees and community learners. The four schools sampled include Kakuma Arid Zone, Kakuma Mixed, Pokotom and Kalemuchuch Comprehensive Schools

Kakuma Arid Zone Comprehensive School

Kakuma Arid Zone had total of 114 learners in Class four, 74 males and 40 females. Of these 50 % are refugees. The Science teacher is a female PI trained. The head of the institution is a male. Refugees' learners are borders and the school feeds them. Most learners are emotional, impatient with each other and fight easily at the slightest provocation.

Kalemuchuch Comprehensive School.

This school has 96 learners, 46 males and 50 females. The class four science teacher is a trained P1. Head of institution is trained.

Kakuma Mixed Comprehensive School.

Is the oldest school in Pelekech Zone started in 1963; classes are large with grade four having 212 learners, 117 males and 99 females.

Pokotom Comprehensive school.

Pokotom has 59 learners, 32 males and 27 females. The science teacher is a female trained P1. The school is located in areas where it floods whenever rains come which often prevents learners from accessing the school.

Challenges

There were many challenges during the study period, and the researchers had to innovate ways to overcome them as indicated below:

1. There were delays in getting permits from United Nations Commission of Refugees (UNHCR) office in Nairobi to enable the researchers to access Kakuma refugee settlement. The researchers therefore could not gain access to schools under the jurisdiction of UNHCR, which led to the delays in research activities.
2. As an alternative to access the schools, researchers obtained permission from the County Director of Education in Turkana County in order to gain access to the host schools. The host schools, though outside the refugee Camp, are also under the Jurisdiction of UNHCR and they have 50 % of their learners being refugees.
3. The researchers adjusted their schedules for making their first visit from May-August 2025 to January 2026. This is because visitors are not permitted to visit Kenyan schools during third term since this is the period when summative end year examinations are conducted.
4. Third the research team faced a challenge in the utilization of the research funds as reflected in the original budget due to serious sky-rocketing cost of fuel which influenced the general cost of living.

Results

The results were obtained from the analysis of the pre-test and post-test based on each of the four hypotheses of the study together with analysis of the teacher's questionnaire and class observation schedule. The findings of the pilot study provided important insights on how the use the improvised science kit enhanced scientific literacy in the refugee settings to improve the science learning outcomes in fragile contexts. They also provided insights on science instruction in Kenya for formulating recommendations at the end of this report.

Learner's skills and problem solving

Testing hypothesis **$H_0$1: The grade 4 learners' practical skills and problem-solving abilities are not significantly influenced by the use of Improvised Mobile Science Kit.**

The analysis based on responses measured on a Likert scale, where 1 = Strongly Agree, 2 = Agree, 3 = Disagree, and 4 = Strongly Disagree, indicate that respondents generally held positive perceptions of the Improvised Mobile Science Kit, as reflected by low mean scores across most items. The aspect of the mobile science kit being sufficiently durable for re-use across multiple classes during the school term recorded comparatively lower mean scores, indicating stronger agreement and fewer potential challenges. Additionally, variations across schools suggest that the intervention's effectiveness is influenced by contextual factors. Overall, the results support the view that the intervention's effectiveness while highlighting areas for improvement.

The Improvised Mobile Science Kit promotes hands-on learning, thereby enhancing understanding and retention of scientific concepts. The high level of agreement among respondents suggests that improvised materials can effectively substitute for conventional laboratory equipment, especially in resource-constrained environments such as Kakuma Refugee Camp. The teachers noted that learners grasp the concepts more easily when engaged in hands-on experiments that connect abstract concepts to real-world environmental applications. However, concerns about durability, storage of improvised items and teacher preparedness indicate that successful implementation requires proper teacher training, improved material design, and continuous support and monitoring. Kizito (2017) opines that teachers believe a better way to improve is when the teacher brings what learners cannot get (teacher-compromised). They believe that improvisation can enable learners to participate in the classroom, motivate them to learn science, make it easier for learners, and develop the teacher's relationship between the social and real world.

Additionally, from the class observation report one of the teachers noted that during the review of the lesson that despite the policy requirement that the science teacher focusing on the 21st century skills on the development of the core competencies, they hardly have the materials and resources to fulfil the same.

Table 2: Mean scores and modal response for use of Improvised mobile science Kit.

Statistics

		Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
N	Valid	8	8	8	8	8	8	8	8	8	8
	Missing	1	1	1	1	1	1	1	1	1	1
Mean		1.38	1.38	1.38	1.88	1.50	1.63	2.00	1.50	1.88	1.38
Mode		1	1	1	2	1[a]	1	2	1[a]	2	1
Std. Deviation		.518	.518	.518	.991	.535	.744	.926	.535	.991	.518
Variance		.268	.268	.268	.982	.286	.554	.857	.286	.982	.268

a. Multiple modes exist. The smallest value is shown

Table 2 above shows that, respondents generally held positive perceptions of the Improvised Mobile Science Kit, as evidenced by low mean scores and a modal response of "strongly agree." However, relatively higher mean scores and greater variability in items related to durability and teacher preparedness suggest areas for improvement. The findings support that the Improvised Mobile Science Kit can improve integrated science teaching and learning.

Teacher Capacity

Testing hypothesis **$H_0$2: There is no significant difference in the improvement of teacher capacity, effectiveness and confidence by teachers who use the improvised science kit and those teach by conventional methods.**

The findings shown in Table 3 below indicate that teachers generally possess moderate capacity to use the Improvised Mobile Science Kit as reflected in mean scores close to "agree." However, the presence of extreme responses reveals significant disparities in teacher capacity across locations.

As observed, some teachers are exhibiting high levels of competency, while others demonstrate limited capacity an indication that teacher preparedness is not uniform. This variability may influence the overall efficiency of the intervention. It is then of necessity to train teachers targeting to address gaps in the low-capacity regions; to enhance continuous consistent training to improve teacher confidence and to put in place monitoring systems to implement support ensuring consistent implementation. Further the findings show that the Improvised Mobile Science Kit has contributed positively to improving teacher capacity in enhancing creativity in the use materials available locally. The moderate mean scores and variability suggest that the improvement is not uniform with all the teachers. While some educators have gained confidence and competence in delivering science content, others still require additional support, particularly in simplifying complex concepts and facilitating hands-on experiments.

Table 3: Shows means for teacher capacity in the use of science kit.

Statistics

		Q1	Q2	Q3	Q4	Q5
N	Valid	8	8	8	8	8
	Missing	0	0	0	0	0
Mean		2.13	2.13	1.63	2.00	1.88
Mode		1[a]	1[a]	1	1	1
Variance		1.554	1.554	1.125	1.714	1.268

a. Multiple modes exist. The smallest value is shown

The descriptive statistics in Table 3 above indicate that the use of the Improvised Mobile Science Kit has positively contributed to teacher capacity, particularly by enhancing creativity and Competence in hands-on science activities. However, relatively higher mean scores and variability in items related to simplifying and demonstrating complex concepts suggest that

these areas have not improved uniformly among teachers. This implies that while the intervention has strengthened certain aspects of teaching capacity, targeted support is still required to ensure comprehensive improvement. There is a need for targeted professional development focused on strategies for simplifying complex scientific concepts and effectively demonstrating them using mobile science kits, to ensure consistent improvement in teacher capacity.

Gender Competencies

Testing hypothesis **H_{03}: There is no significant difference by gender between grade 4 leaners taught by the use of improvised mobile science laboratory resources and those taught by conventional methods.**

From Table 4 below, observations indicate that there was general agreement with the statements on gender competencies showing positive perception of the innovation especially in control school C1. The highest mean was recorded by the experimental school E1, the item recording that the difference between how boys and girls grasp concepts while using the intervention exhibited the highest mean. This reveals that while the innovation is overall effective, its weak agreement. These findings reveal that while the innovation is effective, the findings show that mobile science kit promotes equity in terms of participation, access, learner engagement and gender equality. However, some variation was observed in perceptions regarding the rate at which boys and girls grasp scientific concepts and their performance in practical tasks. This suggests that, while the intervention is generally inclusive, targeted strategies are needed to ensure full gender parity in learning outcomes. This is shown in the SPSS output for the gender-related items Table 4 below.

Table 4: Shows means of Gender equality in use of science kit.

Statistics

		Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
N	Valid	8	8	8	8	8	8	8	8	8	8
	Missing	1	1	1	1	1	1	1	1	1	1
Mean		1.38	1.38	1.38	1.88	1.50	1.63	2.00	1.50	1.88	1.38
Mode		1	1	1	2	1[a]	1	2	1[a]	2	1
Std. Deviation		.518	.518	.518	.991	.535	.744	.926	.535	.991	.518
Variance		.268	.268	.268	.982	.286	.554	.857	.286	.982	.268

a. Multiple modes exist. The smallest value is shown

The descriptive statistics table four above indicates that respondents generally agree that the Improvised Mobile Science Kit promotes gender equality in science learning. Both boys and girls are perceived to have equal access to the resources and to participate actively during practical activities. However, the slightly higher mean score for the item related to the rate of concept understanding suggests that some respondents perceive differences in how quickly boys and girls grasp scientific concepts. Overall, the findings support the role of the mobile science kit in promoting gender-inclusive science.

Teachers Challenges

Testing research question: **What challenges do teachers face in the use of Improvised Mobile Science Kit resources to improve scientific literacy?**

The findings in Table 5 below indicate that teachers have varied experiences with challenges in using mobile science kits. While some respondents strongly agreed that they face challenges, others strongly disagreed, resulting in mixed mean scores and high variability. This suggests that the presence of challenges is not uniform and may depend on contextual factors, such as teacher preparedness, training, and resource availability. Teachers in ASALs face challenges such as resource shortages, high teacher turnover, and inadequate ICT training, which undermine their ability to leverage digital STEM tools effectively. They require adequate training and support, without which some tools may be underutilized and misapplied. High initial costs and ongoing maintenance expenses pose significant barriers to implementation. (Mutua, 2022; Hassan & Zao, 2022; Tietiie Omene et al., 2024). There is a need to standardize training and provide continuous professional support to teachers to ensure consistent and effective use of mobile science kits across all locations. Furthermore, these findings reveal that teachers experience varying levels of challenge in using mobile science kits. While some respondents indicated significant constraints related to class size, time, storage, and material replacement, others reported minimal difficulties. The relatively moderate mean scores and high variability suggest that these challenges are context-specific rather than universal. This highlights the need for targeted interventions to address disparities in implementation. There is a need to reduce the learner-to-resource ratio in order to improve access during practical lessons; adjust school timetables to allocate sufficient time for practical work; provide material support and ensure regular replacement of kit components; improve storage facilities to protect and maintain equipment; and enhance teacher training to build confidence and competence in using the kits. Table 5 shows the statistics.

Table: 5 Shows mean scores for teacher challenges.

Statistics

		Q1	Q2	Q3	Q4	Q5
N	Valid	8	8	8	8	8
	Missing	0	0	0	0	0
Mean		1.75	1.63	1.75	2.00	2.00
Mode		1	1	1	1	1
Variance		1.071	1.125	1.071	1.714	1.714

The findings in Table five above indicate that teachers generally agree they face challenges in using mobile science kits, particularly due to limited instructional time, large class sizes, and difficulties replacing materials. However, challenges related to storage and the need for additional training showed higher variability, suggesting that these issues are context dependent. Overall, while the mobile science kit is beneficial, its effective implementation is constrained by both structural and capacity-related factors. There is a need to address time

constraints, improve resource provision, and offer targeted professional development to ensure effective and consistent use of mobile science kits across different school contexts.

Learners Understanding

Testing hypothesis **H_{04}: There is no significant difference in learners understanding of integrated science concepts between those taught using Improvised Mobile Science Kit and those using conventional teaching methods**.

Tests were administered to Grade 4 pupils in two control schools and two treatment schools. The control schools were Pokotom and Kakuma Mixed, while the treatment schools were Kalemuchuch and Kakuma Arid. In the control schools, teaching was conducted without the use of improvised science kits, after which both a pre-test and a post-test were administered. In the treatment schools, pupils were initially taught without the use of an improvised science kit, and their pre-test scores were recorded. The same class was then taught the subject using the improvised science kit, after which a post-test was administered.

Learners at control schools showed no improvement

Kakuma Mixed. At control school Kakuma Mixed, the SPSS output was as shown table 6 & 7 below. The results showed that post-test scores (M = 10.06, SD = 5.49) were slightly lower than pre-test scores (M = 10.58, SD = 6.06) see table 6. However, this difference was **not statistically significant**, t (68) =1.798, p>0.05. The mean difference was 0.522, with a 95% confidence interval ranging from -0.057 to 1.101.

Table 6. Pre and post testing at control school Kakuma Mixed.

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PER-TEST	10.58	69	6.064	.730
	POST-TEST	10.06	69	5.485	.660

Table 7. Pre and post testing at control school Kakuma Mixed

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	PER-TEST - POST-TEST	.522	2.411	.290	-.057	1.101	1.798	68	.077

Pokotom. At control school Pokotom, the SPSS output was as shown table 8 below. The results indicated that post-test scores (M = 11.00, SD = 5.34) were also slightly lower than pre-test scores (M = 11.45, SD = 5.53) see table 9 above. This difference was statistically

significant, t (52) =3.539, p<0.05, with a mean difference of 0.453 and a 95% confidence interval ranging from 0.196 to 0.710.

Table 8 Pre and post testing at control school Pokotom.

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PRE-TEST	11.45	53	5.528	.759
	POST-TEST	11.00	53	5.335	.733

Table 9 Pre and post testing at control school Pokotom

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	PRE-TEST - POST-TEST	.453	.932	.128	.196	.710	3.539	52	<.001

Learners in treatment schools showed significant improvement

Kakuma Arid Zone. In treatment school Kakuma Arid Zone, a paired samples t-test was conducted to determine whether the use of improvised science kits had a significant effect on Grade 4 learners' performance. The SPSS output is shown below. The results showed that the **mean score increased** from pre-test (M = 13.78, SD = 4.67) to post-test (M = 15.28, SD = 4.62), indicating an improvement in learners' performance after the intervention. Further analysis using the paired samples t-test revealed that this difference was **statistically significant**, t(115)=−5.864,p<0.05 see table 11 above. The mean difference was -1.509, with a 95% confidence interval ranging from -2.018 to -0.999. Since p<0.05, the null hypothesis is **rejected**. The findings indicated that the use of improvised science kits significantly improved learners' understanding and performance in the subject. The study also showed that the use of improvised science kits had a **significant positive effect** on Grade 4 learners' academic performance. Learners who were exposed to the improvised materials performed better compared to when conventional teaching methods were used.

Table10. Pre and post testing at treatment school Kakuma Arid Zone School.

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PRE-TEST	13.78	116	4.670	.434
	POST-TEST	15.28	116	4.621	.429

Table 11. Pre and post testing at treatment school Kakuma Arid Zone School.

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	PRE-TEST - POST-TEST	-1.509	2.771	.257	-2.018	-.999	-5.864	115	<.001

Kalemuchuch. A similar paired samples t-test in treatment school Kalemuchuch was conducted to examine the effect of improvised science kits on learners' academic performance. The SPSS output is shown table 12 below. The results indicated that the mean score increased from pre-test (M = 11.73, SD = 4.82) to post-test (M = 14.04, SD = 4.87), suggesting an improvement after the intervention. The paired samples t-test revealed that this difference was **statistically significant**, $t(91)=-4.747, p<0.05$ see table 13 above. The mean difference was -2.315, with a 95% confidence interval ranging from -3.284 to -1.346. This indicates that the use of improvised science kits had a significant positive effect on learners' performance.

Table 12 Pre and post testing at treatment school Kalemuchuch

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PRE-TEST	11.73	92	4.818	.502
	POST-TEST	14.04	92	4.872	.508

Table 13 Pre and post testing at treatment school Kalemuchuch.

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	PRE-TEST - POST-TEST	-2.315	4.679	.488	-3.284	-1.346	-4.747	91	<.001

Discussion

The purpose of this study was to examine the effect of improvised science kits on Grade 4 learners' academic performance by comparing results from control and treatment schools. The findings revealed a **clear difference in outcomes** between the two groups.

In the **control schools** (Pokotom and Kakuma Mixed), where conventional teaching methods were used without improvised science kits, learners' performance either **declined slightly or showed no significant improvement**. This suggests that traditional instructional approaches alone may not be sufficient to enhance learners' understanding of scientific concepts. These findings are consistent with studies in Science Education which argue that passive learning methods often limit learners' engagement and conceptual understanding.

In contrast, the **treatment schools** (Kalemuchuch and Kakuma Arid Zone), where improvised science kits were introduced, showed **statistically significant improvements in learners' performance**. This indicates that the use of improvised instructional materials can enhance learning outcomes. These findings align with the principles of Constructivist Learning Theory, which emphasizes that learners acquire knowledge more effectively through active engagement and hands-on experiences.

The study compared learners' performance in two **control schools** (Pokotom and Kakuma Mixed), where no improvised science kits were used, and two **treatment schools** (Kalemuchuch and Kakuma Arid), where improvised science kits were introduced. The results showed a clear contrast between the two groups. While learners in the control schools showed no improvement or even a decline in performance, learners in the treatment schools demonstrated significant gains. This provides strong evidence that the use of improvised science kits enhances learners' academic performance. Learners exposed to improvised science kits performed significantly better than those taught using conventional methods.

The improvement observed in the treatment schools can be attributed to the fact that improvised science kits provide learners with opportunities to **interact directly with learning materials**, making abstract scientific concepts more concrete and easier to understand. This supports the work of Jean Piaget, who emphasized that learners construct knowledge through interaction with their environment. Similarly, Lev Vygotsky highlighted the importance of guided learning and the use of tools in enhancing cognitive development, which is reflected in the use of improvised teaching aids.

Furthermore, the findings are consistent with empirical studies that show that **hands-on and activity-based learning approaches** significantly improve learners' achievement in science subjects. Improvised materials, especially in resource-constrained settings, serve as effective substitutes for standard laboratory equipment, thereby promoting experiential learning.

However, the variation observed within the control schools—where one school showed a statistically significant decline while the other showed no significant change—suggests that **other factors may also influence learners' performance**. These may include teacher effectiveness, classroom environment, and learner characteristics. This highlights that while teaching methods are important, they must be supported by effective implementation and adequate teacher preparation.

Overall, the findings of this study demonstrate that improvised science kits are a **valuable instructional strategy** for improving learners' academic performance. However, their success depends on how well they are integrated into teaching and learning processes.

Conclusions

The study concludes that mobile science kits significantly enhance teaching and learning of integrated science.

- Use of improvised chemicals and materials in resource constrained settings is a welcome idea.
- Findings reveal that while the theoretical teachings due to material shortages, improvised chemicals and materials shortages like ash, lemon, and eggshells are occasionally used to bridge the gap between theory and practice.
- The improvement observed in the treatment schools can be attributed to the fact that Improvised Mobile Science Kit provide learners with opportunities to interact directly with learning materials, making abstract scientific concepts more concrete and easier to understand.
- Overall, this study's findings demonstrate that Improvised Mobile Science Kits are a valuable instructional strategy for improving learners' academic performance. However, their success depends on how well they are integrated into the teaching and learning process.
- The study concludes that Improvised Mobile Science Kits significantly enhance the teaching and learning of integrated science among Grade 4 learners. Despite minor challenges, the kits are effective, practical, and sustainable for use in schools with limited resources.

Key findings

- The Improvised Mobile Science Kit promotes hands on learning thereby enhancing understanding and references of scientific concepts thus improves acquisition of 21st century skills that increase scientific literacy.
- Improvised materials can effectively substitute conventional laboratory equipment especially in resource- constraint environments such as Kakuma refugee camp.
- It is notable that during transition to CBC teachers in primary schools in Turkana County especially Kakuma refugee camps have encountered numerous difficulties

with teaching methods and lack of materials. They lack plant and animal material because not many plants and animals are found in semi-arid and arid region.

- It requires proper training of teachers, improved design of the materials, continues support and constant reference to the mobile Science kit user manual.
- Learners struggle with trauma of war, poverty and of physical, emotional and academic challenges endured by refugee learners in semi-arid and arid regions.
- Gender parity is another challenge; the girls are not well equipped with sanitary pads and often skip attending school due to poverty, and gender and cultural...
- Textbooks are adequate at a ratio of 1:1, however the classes are overcrowded and congested and desks ware inadequate. The learners sat facing all directions and for some it is difficult to read what the teacher is writing on the black board.
- Crisis of lack of resources expose gaps particularly in meeting basic needs like food, sanitary pads, poverty and risk of drop out due to early pregnancy.

Recommendations

1. Use of Improvised Mobile Science Kit should be considered for adoption for its ability to provide alternative sources of T/L resources to supplement the lack especially the lack of plant and animal material in the Arid and Semi-Arid lands as in Turkana County. This may require policy review.
2. The integration of mobile labs into national education strategies has significant implications for academic achievement. Policymakers should invest in training programs that equip teachers with skills to improvise, manage, and contextualize experiments. Professional development should emphasize inquiry-based pedagogy and safety protocols.
3. Teacher capacity should be built for improvisation while the teacher is in service training so that as they graduate, they are equipped to deliver during the instructional process.
4. Provide more training on integrating local materials to supplement the improvised science kit especially when class sizes exceed 40.
5. Encourage teachers to refer to the user manual, which guides how each improvised item in the science kit can be used effectively. Encourage teachers to prepare thoroughly and to figure out how to use the teaching and learning resources such as the items found in the improvised science kit effectively before the actual teaching.
6. Provide adequate storage facilities to store the durable and re-usable T/L resources improvised by the teacher, encourage teachers to motivate the learners to apply the knowledge they have gained from the learning of integrated science to solve everyday challenges, such as water filtration, the separation of substances, and maintaining a clean environment.

7. About gender differences, guidance and counselling need to be done to demystify believes held by learners that girls cannot excel in science related subjects as much as boys can do.
8. Encourage women to become science teacher so that they can mentor girls and encourage them to excel in STEM subjects.
9. The innovative approach holds particular relevancy for schools in refugee settings. Since these schools are found within ASALs which is a resource constrained region.
10. Have counselling sessions for learners who have been traumatized due to impact of war, or displacement.by natural calamities.

References

Akhigbe, J. N. (2020). Using gender responsive collaborative learning strategy to improve students' achievement and attitude towards learning science in virtual and hands-on laboratory environment. *Journal of Pedagogical Research*. https://doi.org/10.33902/JPR.2021063948

Bandura, A. (1997). *Self-efficacy: The exercise of control*. W.H. Freeman.

Ndihokubwayo, K. (2017). Investigating the status and barriers of the science laboratory activities in Rwandan teacher training colleges towards improvisation practice. *Rwandan Journal of Education, 4*(1), 47–54.

Nkundabakura, P., Nsengimana, T., Nyirahabimana, P. *et al.* Usage of modernized tools and innovative methods in teaching and learning mathematics and sciences: A case of 10 districts in Rwanda *Educ Inf Technol* 28, 11379–11400 (2023). https://doi.org/10.1007/s10639-023-11666-z

Ngendabanga, C., Nkurunziza, J. B., & Mugabo, L. R. (2025). The use of improvised chemicals and materials in teaching and learning chemistry in two selected districts of Rwanda. *Cogent Education, 12*(1). doi.org

Tietie Omene, B., Karanja, J., & Obura, M. (2024). AI and robotics in STEM education: A case study in marginalised Kenyan schools. *East African Journal of Education and Technology, 11*(1), 74–93

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Harvard University Press.

Appendix 1

Teacher's Questionnaire

This survey is designed to evaluate the **effectiveness, pedagogical value, and practical challenges** of using improvised science kit and the school environment.

Teacher Evaluation Survey: Improvised Science Kits in Grade 4 Integrated Science

Instructions: Please read each statement carefully and tick or checkmark the box that best describes your level of agreement.

- **SA** = Strongly Agree; 1
- **A** = Agree 2
- **D** = Disagree 3
- **SD** = Strongly Disagree 4

#	Evaluation Statement	SA	A	D	SD
	The improvised science kit.				
1	The improvised resources for the mobile Science kit effectively demonstrate the intended Integrated Science concepts for Grade 4				
2	Using improvised mobile Science kit has increased learner participation and engagement during science lesson.				
3	The materials in the Science kit are safe and age-appropriate for 4th grade learners to handle.				
4	Every time I prepare for the Science lesson I check for an appropriate resource from the science kit.				
5	The mobile Science kit encourages leaners to develop life- skills to deal with real life challenges.				
6	I have observed an improvement in learners' ability to recall scientific facts after using the mobile Science kit				
7	The mobile Science kit is durable enough to be reused across multiple classes during school term.				
8	The use of local materials in the Science kit helps learners connect science to their everyday activities and environment in general.				
9	I feel adequately prepared to troubleshoot issues that arise when using improvised Science kit.				
10	Improvised Science kits are a viable long-term solution for schools with limited access to commercial lab equipment.				
	Enhancement of Scientific literacy				
11	Learners find it easier to explain scientific concepts after using the Mobile kit.				
12	Learners find it easier transforming science into a tool for safety, resilience and daily survival				

13	Leaners can now identify various scientific tools and their uses because of the mobile science kit				
14	Using the mobile kit has increased learner's interest in learning how things work in nature				
15	Leaners feel more confident discussing science topics with classmates after using Mobile science kit.				
16	Learners feel more confident to apply science on issues such as climate, health, hygiene and environmental sustenance.				
	Gender competencies				
16	Boys and girls show equal levels of curiosity when using the mobile science kit resources.				
17	The mobile science kit resources are equally accessible and user-friendly for both boys and girls				
18	Both genders participate equally during group experiments during the use of mobile science kit.				
19	There is no noticeable difference in how quickly boys and girls grasp concepts using the mobile science kit.				
20	Female learners perform just as well as male learners in practical tasks while using the mobile science kit.				
	Methods of delivery				
21	I would prefer to use the mobile science kit in every science lesson I teach.				
22	The mobile science kit makes science lessons more exciting than traditional classroom teaching				
23	I teach science better when using the mobile science kit than when talking to learners without resources.				
24	I teach science experiments better when I touch the materials in the mobile science kit myself.				
25	It is easier to solve science problems when I can see the experiment using the mobile science kit.				
	Teacher challenges				
26	The high number of students in the refugee camp makes it hard to give everyone time with the mobile science kit.				
27	I lack enough time in the school timetable to set up and use the mobile science kit effectively.				
28	Replacing broken or consumed materials in the improvised mobile science kit is a major challenge.				
29	The lack of proper storage for the mobile science kit equipment affects my ability to use it.				
30	I require more specialized training to fully utilize the mobile lab resources in a fragile context.				

	Teacher capacity				
31	The improvised mobile science kit has improved my ability to demonstrate complex science topics.				
32	The mobile science kit resources allow me to simplify Integrated Science for Grade 4 learners.				
33	I have become more creative in using locally available materials to teach science.				
34	My overall confidence in delivering the Integrated Science curriculum has increased				
35	I feel more competent in facilitating hands-on science experiments than I did before				

Appendix 2

Learner's questionnaire

Grade 4: LEARNER's PER-TEST QUESTINNARE

1. The dog is pulling on the leash. The boy is also pulling on the leash. Neither the dog nor the boy move.

   Are the forces acting on the leash balanced or unbalanced?

a. balanced forces
b. unbalanced forces

2. ☐ A state in which matter has no definite shape and no definite volume is _____.

a. liquid
b. solid
c. gas

3. ☑ Ice is an example of water in which state of matter?

a. gas
b. liquid
c. cold
d. solid

4. ☐

Which animals are found in swamps?

a. crabs, mussels, muskrats, and egrets
b. turtles, whales, lobsters, and shrimp
c. loggerhead turtles, pelicans, and crabs
d. frogs, cranes, alligators, and turtles

5. ☐ When a plant or animal organism is gone forever it is

a. extinct.
b. endangered.
c. threatened.
d. fossilized.

6. ☐ Which of these words is the name for the imaginary line around which Earth rotates?

a. sun
b. axis
c. model

7. ☐ Mercury is NOT the hottest planet in the solar system.

a. True
b. False

8. ☐ What do sea jellies, earthworms, and spiders have in common?

a. They all have 8 legs.
b. They all have stinging body parts.
c. They all have a backbone.
d. They all lack a backbone.

9. ☐ Volume is the amount of _____ that matter takes up.

a. gases
b. space
c. liquid

10. ☐ A(n) _____ is something that helps any living thing survive in its environment.

a. ecosystem
b. adaptation
c. physical change
d. camouflage

11. ☐ A testable question can be answered by
a. reading a science book.
b. creating and performing an experiment.
c. searching the internet.

12. ☐ _____ has small grains and holds very little water.
a. Sand
b. Clay
c. Rock

13. ☐ All planets have only one moon.
a. True
b. False

14. ☐ What is a tool that is used to magnify or enlarge an object's features?
a. balance
b. dropper
c. hand lens
d. spring scale

15. ☐ _____ is a measure of how hot or cold something is.
a. Temperature
b. Volume
c. State of matter
d. Mass

16. ☐ A habitat gives a living thing everything necessary to survive.
a. True
b. False

17. ☐ Mrs. Wong leaves her bowl of ice cream on the sidewalk during a hot summer day. Which is the best prediction of what will happen to the ice cream?
a. The ice cream will change from a solid to a liquid.
b. The ice cream will change from a liquid to a gas.
c. The ice cream will change from a gas to a liquid.

18. ☑ A slide is an example of a(n) _____.
a. wedge
b. inclined plane

19. ☐ What happens to the particles in a solid when you heat the solid?
a. They melt.
b. They speed up.
c. They slow down.
d. They no longer exist.

20. ☐ While doing an investigation, you collect information. What should you do with this information?
a. tell a friend
b. write or draw it
c. just remember it

Appendix 3

Learner's Post-Test Questionnaire

Instructions

1. *Answer **ALL** the questions in the spaces provided.*

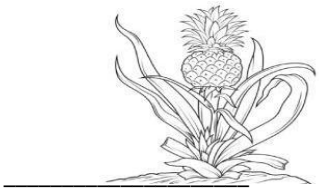
ENVIRONMENTAL ACTIVITIES (20 MARKS)

1. When there is little rain, we have _____. **(floods, drought)**

2. Tim used a clean piece of cloth to make water clean. This method is known as _____ **(boiling, filtering)**
3. The roughness and smoothness of soil is known as_____**(texture, fertility)**
4. The item below uses _____ fuel. **(electricity, petrol)**

5. State whether these plants are poisonous or edible.

_____



_____

6. A _____ gives us mutton. **(cow, sheep)**

7. State the use of heat shown in the picture below.

_____ **(ironing, boiling)**

8. The best weather condition for winnowing is _____.

9. Name two safety clothes we should wear when we clean the market.
_____, _____

10. A _____ is a cultural event that promotes care of the environment.
(Circumcision, market cleaning)

11. This health habit is known as _____

(fishing, swimming)

12. We should wash our hands after _____

13. Circle the food which is good for our teeth.

14. Fadhila wants to clean his bedroom. Name two materials he will need.
_____, _____

15. Name two cleaning materials which can be improvised.
_____, _____

16. Ointment medicines are _____ on the body. **(injected, rubbed, swallowed)**

17. Name two crops we can grow in a kitchen garden.
_____, _____

18. The following are steps of making beds.

Tuck the sheets.

Put the pillow

Spread blanket

Spread the sheets

Arrange them in the correct order.

(i) _____
(ii) _____
(iii) _____
(iv)_____

19. Parasites can cause lack of enough _____ in the body. (**Sleep, food, blood**)

20. Name two foods that provide our bodies with energy.

_____, _____