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Instructional Videos and Their Effect on Learners' Performance in Mathematics Fractions in Junior Schools in Kwale County, Kenya

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Abstract
Research evidence has shown that technological advancement has enhanced classroom instruction. However, education is facing a challenge of keeping up with fast technological advancement and aligning technology to classroom instruction. One such technology is videos, which can become a powerful digital resource if used creatively. Videos have the potential to transform Mathematics Education by providing better understanding of concepts and improved attitudes towards Mathematics. The 21st century pedagogy focuses on several core competencies, one of which is the use of digital resources like videos. This study investigated the use of videos in the teaching and learning of fractions in Mathematics and its effect on the performance of learners in Junior Schools. The objective of the study was to investigate the effect of use of videos on learners' performance in fractions in Mathematics. The study was guided by the constructivism theory by Vygostky in 1978. The research design was quasi-experimental involving Solomon four (4) groups. The target population for this study consisted of grade seven (7) learners and their Mathematics teachers. Purposeful sampling method was used to select four (4) Junior Schools in Kwale County, Samburu sub-County. The sample included 216 grade seven (7) learners and four (4) Mathematics teachers. Of the learners, 108 were assigned to the experimental group, and 108 to the control group. Random sampling was employed to select both the control and experimental classes. Qualitative and quantitative data was gathered using Standard Student Assessment Tests (SSAT), a class observation schedule, and questionnaires. The observation schedule and questionnaires were administered to the teachers, while the SSATs were given to the students. The collected data was analyzed using independent t-tests and analysis of variance (ANOVA), with the Statistical Package for Social Sciences (SPSS) software. Descriptive statistics were presented in tables and figures. The finding revealed a significant difference in performance between the experimental group, which used videos, and the control group, which did not. Based on the finding, it is recommended that Mathematics teachers should be encouraged to utilize videos in the teaching of fractions to improve the academic performance of the learners.

Keywords: Digital learning materials, Mathematics education, Fractions teaching, learning persistence

Introduction

The literature reviewed underscores the capacity of digital learning materials in the teaching and learning of Mathematics. This includes use of videos as a valuable teaching tool that has improved learning. Videos represent moving images supplemented by voice or sound and multimedia applications for which both audio and respective animations are played simultaneously. As noted by Chen and Wu (2015) [4], videos as communication tools help attract the attention towards learning, which enhances the overall learning process. In a study by Shahid, Aleem, Islam, Iqbal, & Yousaf, (2019) [21], the authors argue that computer use and internet resources can significantly enhance the learning process, make it fulfilling and meaningful and improve performance.

The utilization of videos in teaching and learning offers many advantages. It enhances learning persistence and mitigates the impact of individual differences among students. According to Christ, Arya, & Chiu, (2017) [5], videos can be employed over an extended period due to their repeatability, resulting in time saving, cost-savings and improved re-distribution. Integration of videos in learning fosters the development of important mental activities like critical thinking skills in learners. This is in line with Afify, (2020) [1]and Laichena et.al (2024) [15] assertions that instructional videos yield various cognitive benefits, including improved learning and memorization. The studies conclude that videos facilitate the visualization of knowledge, aiding learners in comprehending complex concepts and subjects.

A study by Kosterelioglu, (2016) [14] conducted in education psychology classes at Amasya University intended to identify students' views regarding instructional videos. The study found out that 11.9% of students reported that videos aroused interest in the topic, 8.9 % of the students improved concentration and 27% reported that they improved memory. According to Wong, Nizam, Koh, Tan, & Toh, (2016), 68% of students agreed that videos enhanced their understanding and that they are good to explain concepts. The research reported that 77% of the students agreed that videos make the topic interesting. Though, use of videos makes lessons interactive, there are challenges that are likely to affect video use in the classrooms among many institutions (Pewu, et.al. 2023) [20]. Some of the challenges cited includes, limited resources, limited skills of the teachers to choose relevant videos to integrate in the lesson and lack of motivation among the teachers.

The topic, Fractions, was considered in this study because it is a challenging topic to the learners and presents pedagogical challenges for teachers. Learning and teaching of Fractions is still regarded as one of the most difficult areas for learners (Wijaya, Retnawati, Setyaningru & Aoyama 2019) [23]. In accordance with Getenet & Callingham, (2021) [6], Fractions are renowned for their complexity, often posing ongoing pedagogical hurdles for Mathematics educators. Siemon *et al* (2015), argue that the challenge of understanding Fractions arises from the fact that fractions are used frequently to convey relationships between numbers, as opposed to representing an absolute quantity.

There are diverse reasons that make it difficult for learners to understand Fractions. For example, Fractions are not built on a number of inter-connected sub-constructs which include part-whole, ratio, quotient, operator and measure. This multi-faceted notion encompassing five (5) related sub-constructs make Fractions a complex topic to the learners. This suggests that a specific Fraction can depict various meanings based on the context. For example, a Fraction such as two thirds ($\frac{2}{3}$) can be regarded as part of whole which represents two out of three equal parts, as a quotient representing two divided by three, an operator which represents two-thirds of a quantity, a ratio representing two parts to three parts and ultimately, as a measure which is a point on a number line.

The introduction of Fractions to learners, if not carefully done, can lead to misconceptions. For instance, students may perceive the numerator and the denominator as separate values. In reality, the relationship between the numerator and denominator presents a single magnitude since it is a single position in the number line yet the numerals used to converse the magnitude keep on changing. (E.g. four eighths ($\frac{4}{8}$) is equivalent to a half ($\frac{1}{2}$). Others think the larger the denominator, the bigger the fraction. This is done in primary school and before the learners get to the seventh grade, most of the learners have accumulated significant misconceptions making it difficult to learn advanced Mathematics.

The Kenya National Examinations Council (KNEC) report for the year 2020 indicated that 70.7 % of Grade seven (7) learners did not attain the 50% minimum bench mark in Mathematics. The data shows that 53.8 % of learners attained a minimum competency in addition involving Fractions. In addition, the data shows that 54% of the learners attained minimum competency in converting fractions to decimals and percentages. On working out combined operations involving fractions, only 27.0 % attained minimum competency. The Kenya Primary School Education Assessment (KPSEA) national report (2023) was carried out to give feedback to relevant stake holders through the provision of detailed analysis of learner performance in each subject assessed. In Mathematics only 10.41% of the learners exceeded expectation, 42.46% of the learners were approaching expectation and 9.42% of the learners were below expectation. On the concept of fractions, only 19.82% of the learners were able to answer questions correctly. This indicates that learners had difficulties in fractions. The Kenya Certificate of Secondary Education (KCSE) report, (2017) suggested that instructors need to be innovative in order to enhance the learning outcomes. One way of being innovative is by use of instructional videos to enhance the performance of learners in Mathematics.

Teaching Fractions is considered difficult because of its abstract nature (Obersteiner, Alibali & Marupudi, 2020) [19]. To circumvent this, videos are recommended because they are well suited to illuminate abstract phenomena. This is in line with Edgar Dale's Cone of Experience, a learning model that depicts the varying levels of concreteness in learning experiences depending on the medium utilized. The model is represented as an inverted cone, with the most abstract experiences at the top and the most concrete experiences at the bottom. The middle of the cone is categorized by motion pictures like videos. Kohler & Dietrich, (2021) [13] assert that videos can be a highly effective device to improve learners' knowledge. However, the effective use of videos requires instructors to consider three key elements. These focus on strategies to reduce cognitive load, enhance learner engagement with the video, and promote active learning through the video. The video should not be long since students' attention and focus may be lost. (Guo, Kim, & Rubin, 2014) [7]. Manasrah, Masoud, & Jaradat, (2021) [16] proposes the optimum video length to be between six (6) to ten minutes.

Teachers should actively engage with the video lesson by pausing, posing questions, replaying important sections, and evaluating comprehension. To enhance learners understanding of the content, it is better for the teacher to stop the video when explaining the concept. Explanation should never be done when the video is running. This is buttressed by Beheshti, Taspolat, Kaya, & Sapanca, (2018) [3] who opine that one of the significant benefits of instructional videos is that it could be paused, or rewinded. For effective utilization of videos in classroom, teachers should recognize the nature and characteristics of their learners. This will enable the teacher to develop the cognitive, affective and psychomotor domains of the students.

There is evidence highlighting the benefits of using videos in education (Noetel, 2021) [17]. One of the benefits is that implementing videos in instruction enhances learners' academic achievement (Arevalo, Solorio, Montes-y-Gomez, & González, 2020) [2]. Other studies also concurred that use

of educational videos in you tube promoted subject objective achievement, as well as overall student academic achievement (Jill, Wang, & Mattia, (2019) [10]; Hapsari, & Hanif, (2019) [9] and Hanif, (2020)) [8]. The improved performance could be explained through the perspective that students find it easier to absorb information provided through videos as it is presented in attractive visuals (Yulianto, 2019) [24]. Research has also documented that learners are able to retain more and for a longer period of time when they use videos that are in line with their entry behavior, environment and attracts their interest for easy understanding of the concepts being taught Omariba and Miima (2024) [18].

Objective of the study

The objective of the study was to establish the effect of use of instructional videos in teaching Fractions in Mathematics on learners' performance in Junior Schools in Kenya.

Research Methodology

The study adopted a quasi-experimental approach involving Solomon four (4) groups. The approach was suitable due to the non-random selection of participants to respective groups. Junior School classes are treated as intact groups. The design also enabled to control the major threats of external and internal validity. The Solomon four (4) groups design has four (4) distinct groups, namely, two (2) experimental groups and two (2) control groups. Two (2) groups are exposed to a pretest and all the groups are exposed to a post test. This design enabled the study to assess whether the pretest alone had an effect on the subjects. (Kumari 2013 cited in Julius, 2018). The Solomon four groups design is illustrated in Table 1

Table 1: Solomon four groups design

GROUP	Pretest	Treatment	Post test
Group 1	O_1	X	O_2
Group 2	O_3	©	O_4
Group 3		X	O_5
Group 4		©	O_6

O_1 and O_3 were pretests, O_2, O_4, O_5 & O_6 were the post tests. X was the treatment where learners were taught using video. © is the control condition or no treatment where learners were taught in the regular method. Group 1 served as the experimental group, undergoing the pretest, the intervention, and the post-test. Group 2 acted as the control group, receiving the pretest, the standard instructional method, and the post-test. Group 3, another experimental group, received the treatment and the post-test. Lastly, Group 4 was given only the post-test and the standard instructional method. Groups 1 and 3 were taught using videos, while Groups 2 and 4 followed the traditional teaching approach.

Location of the study

The study was conducted in Samburu sub-County of Kwale County, situated in the Coast region in Kenya. It covers an area which is equivalent to 2444 square kilometers with a population of approximately 202,235 people according to the 2019 census. It has 82 Junior Schools. The selection of the location of this study was based on the consistent poor performance in Mathematics, especially the questions related to Fractions, in the Kenya Primary School Education Assessment (KPSEA) taken by Grade six (6) learners before they proceed to Junior School.

Target Population

The target population for the study included 86 principals, 86 teachers of Mathematics and 7858 grade seven (7) learners in Public Junior Schools in Samburu sub-County. Grade seven (7) was targeted in this study since there is evidence that majority of studies conducted in Kenya targeted primary and secondary schools. The studies so far done in Kenya that targeted the understanding of mathematical concepts include, Early Grade Mathematics Assessment (EGMA) Baseline and Midline both in 2016, Endline in 2019 and post Endline in 2022. Other studies include National Assessment System for Monitoring Learner Achievement (NASMLA) in 2018; and Southern and Eastern Africa Consortium for Monitoring Educational Quality (SACMEQ IV). Monitoring Learner Achievement (MLA) in 2018 focused on secondary schools. Grade seven (7) is targeted since they have already done KPSEA examination in grade (6) six. Competency Based Curriculum phase of supplementation is currently at Grade nine (9) and this makes public Junior Schools ideal for this study. At this phase, grade seven (7) teachers have undergone training on how to develop digital literacy in instruction and are able to teach the lessons professionally.

Sampling techniques and sample size

Sampling denotes picking out a representation of cases to draw conclusion about the rest of the population. A sample is a subset of the population, selected for study, whose characteristics are examined in order to make inferences about the broader population. An adequate sample size is necessary for valid generalizations and to avoid sampling errors or biases (Taherdoost, 2017) [22]. Samburu sub-County in Kwale County has 86 Public Junior Schools. Purposeful sampling was employed to select the four (4) schools. This was to ensure that schools with similar academic rating are selected. The study design required two (2) groups to be pre tested and post tested and two (2) others to be post tested only. In light of this, a simple random method was employed to choose two (2) schools in the interventional group and two (2) in control group. In Samburu sub-County, majority of Junior Schools have an average of two (2) streams per class. If the school had multiple streams, only one (1) stream was randomly selected for the study. The other streams not sampled for the study were exposed to similar conditions but no research instruments were administered to them. This was done for ethical reasons and also because members in the control group were unaware of the experimental group. This helped to reduce John Henry effect. It also enabled the study to obtain equivalent group sizes.

Research findings and discussions

The study employed a quasi-experimental design, specifically using the Solomon four-group method. In line with this, there were four (4) public schools used for the study. A group of grade seven (7) learners from each school were randomly assigned to four (4) groups namely experimental 1 and experimental 2 which had 54 students each and control 1 and control 2 which had 52 and 56 students respectively. A total of 216 grade seven (7) learners participated in the study. Figure 1 in form of a pie chart shows the distribution of students in each group as percentages.

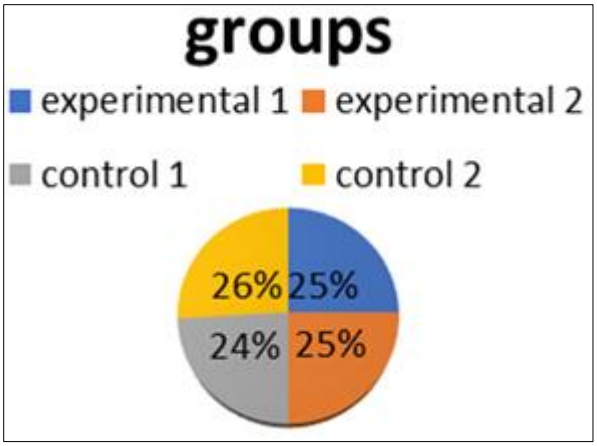

Fig 1: Distribution of students in groups

Effect of use of videos on learners' performance in fractions.

The objective of the study was to investigate the influence of use of videos on learners' performance in Fractions. The study employed a quasi-experimental design using the Solomon four-group method. To form the four (4) groups, the learners were first divided into two (2) main categories: the experimental group and the control group. The experimental group was further split into two (2) subgroups: Experimental Group 1 (E1) and Experimental Group 2 (E2). Likewise, the control group was divided into Control Group 1 (C1) and Control Group 2 (C2). E1 was first given a pretest, then exposed to the treatment, which involved learning fractions Through videos, and was finally given a post-test. C1 received the pretest, continued with traditional learning methods without videos, and then took the post-test. E2 learned Fractions using videos and was subsequently given a post-test. C2 learned Fractions without the use of videos and also took a post-test.

The primary objective was to determine whether there is a significant statistical difference in performance on Fractions between learners taught using videos and those taught without. To achieve this, the control group (C1) and the experimental group (E1) were both given a pretest. The intervention, which involved the use of videos, was then administered to the experimental groups (E1 and E2). Afterward, all learners were issued with a post-test to assess the impact of the treatment.

To measure significant statistical difference in the performance, two (2) approaches to data analysis were employed. The first approach involved comparing the means of the pre-test and post-test scores for both the C1 and E1 groups using a paired t-test. The second approach compared the post-test means across all groups using the single factor analysis of variance test.

Paired t-test

Paired t-test was used to compare the means between the pretest and post-test means for C1 group and E1 group respectively. To obtain this data E1 and C1 groups were pre tested before the teaching of Fractions. They were later given a post-test after teaching Fractions by use of videos for E1 and regular teaching for C1. The findings obtained are shown in Tables 2 and 3

Table 2: Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	**C1 POST-TEST**	9.96	52	3.272	.454
	C1 PRE-TEST	8.62	52	2.843	.394
Pair 2	**E1 POST-TEST**	18.11	54	6.695	.911
	E1 PRE-TEST	10.74	54	3.852	.524

The findings in Table 2 show that the post-test means exceeded pre-test means for both groups.

Table 3 on Paired Samples Test was used to determine if the differences noted in Table 2 are actually significant

Table 3: Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean difference	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	**C1 Post-test C1 Pre-test**	1.346	1.235	.171	1.002	1.690	7.861	51	.000
Pair 2	**E1 Post-test E1 Pre-test**	7.370	4.358	.593	6.181	8.560	12.428	53	.000

From Table 3, there was significant mean differences between the groups in each case since the p-values were less than 0.05. This is in congruent to a study by Kamau, (2022) which dealt with effects of cooperative learning in students' performance in Mathematics. The pre- test and posttest mean scores of control group 1 was 18.64 and 21.16 respectively. The pre-test and post-test mean scores for Experimental Group 1 were 19.06 and 54.18, respectively. A significant mean difference was noted between the two scores in each case. In addition, the post-test means scores for both groups were higher than the pre-test means scores. This is due to the learners being taught mathematical fractions.

Single factor analysis of variance

After treatment, all the groups under investigation were issued with a post test. Only post-test values were considered in single factor analysis of variance. The objective was to compare the post-test mean scores across the four (4) groups. The scores were analyzed using ANOVA. The mean scores for the four (4) groups are as shown in Table 4.

Table 4: Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Control 1	52	3	19	9.96	3.272
Control 2	56	4	17	9.16	2.977
Experiment 1	54	2	19	18.11	3.852
Experiment 2	54	8	29	18.22	4.840

As shown in Table 4 the mean scores of the experimental groups are higher than those of the control groups. For example, the mean scores for Experimental Group 1 and Experimental Group 2 are 18.11 and 18.22, respectively, while Control Group 1 and 2 have mean scores of 9.96 and 9.16, respectively. The means scores for the four groups are graphically presented in Figure 2.

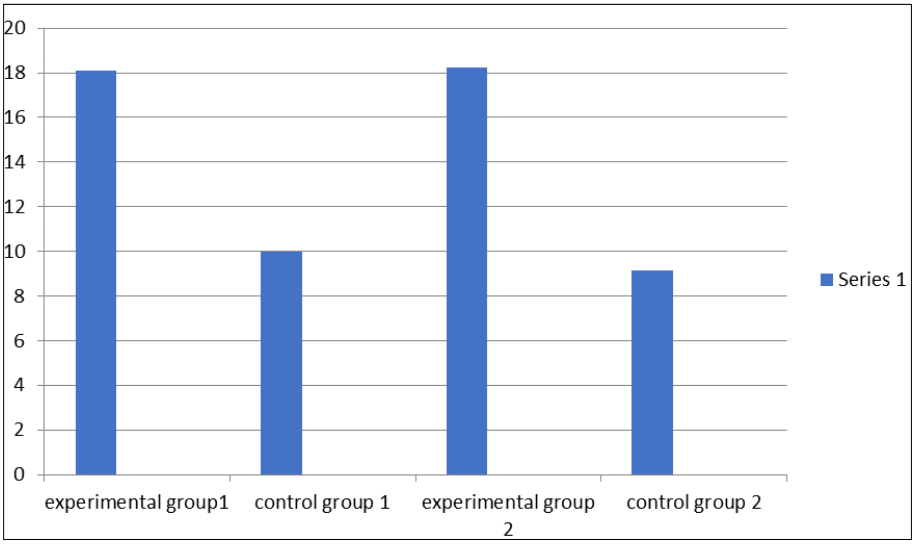

Fig 2: The mean scores of the four (4) groups

Figure 2 illustrates that the average SAT post-test scores of the experimental groups were higher than those of the control groups. This suggests that students taught using videos performed better than those taught without. To determine if there was a statistically significant difference between the group means, a one-way ANOVA test was conducted on the SAT post-test scores. The results are shown in the table 5: Table 5 gives the ANOVA to establish if the differences exhibited in Table 4 are significant.

Table 5: ANOVA

Score	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4030.408	3	1343.469	61.249	.000
Within Groups	4650.143	212	21.935		
Total	8680.551	215			

Table 5 shows that significant differences among the groups. To identify which specific groups differed, a post-ANOVA test was conducted, and the findings are shown in Table 6.

Post ANOVA Test

Post ANOVA test was done to determine whether there were significant differences across the groups and results obtained are shown table 6.

Table 6: Multiple Comparisons

Dependent Variable: SCORE LSD						
(I) GROUPS	**(J) GROUPS**	**Mean Difference (I-J)**	**Std. Error**	**Sig.**	**95% Confidence Interval**	
					Lower Bound	**Upper Bound**
Control 1	Control 2	.801	.902	.376	-.98	2.58
	Experiment 1	-8.150*	.910	.000	-9.94	-6.36
	Experiment 2	-8.261*	.910	.000	-10.05	-6.47
Control 2	Control l	-.801	.902	.376	-2.58	.98
	Experiment 1	-8.950*	.893	.000	-10.71	-7.19
	Experiment 2	-9.062*	.893	.000	-10.82	-7.30
Experiment 1	Control 1	8.150*	.910	.000	6.36	9.94
	Control 2	8.950*	.893	.000	7.19	10.71
	Experiment 2	-.111	.901	.902	-1.89	1.67
Experiment2	Control 1	8.261*	.910	.000	6.47	10.05
	Control 2	9.062*	.893	.000	7.30	10.82
	Experiment 1	.111	.901	.902	-1.67	1.89

Table 6 presents the comparisons between the groups, with each row illustrating the differences between one group and the other three groups. The findings indicate a statistically significant difference between Experimental Group 1 and Control Group 1 (p = 0.000). A significant difference was also found between the post-test scores of Experimental Group 1 and Control Group 2 (p = 0.000).

A significant difference was also found between the post-test scores of Experimental Group 2 and Control Group 1 (p = 0.000), as well as between Experimental Group 2 and Control Group 2 (p = 0.000). In both instances, the p-values were less than the 0.05 threshold required for statistical significance. However, when comparing Experimental Group 1 to Experimental Group 2 (p = 0.902) and Control Group 1 to Control Group 2 (p = 0.376), the results indicate that there were no significant differences. This suggests that Experimental Groups 1 and 2 performed similarly in the post-test, as did Control Groups 1 and 2, with their post-test scores being relatively consistent.

In contrast, when comparing the experimental groups to the control groups, the performance outcomes diverged. The experimental groups exhibited higher mean post-test scores compared to the control groups. As detailed in Table 6, this disparity in post-test achievement in Fractions between the experimental and control groups is statistically significant. Therefore, it is evident that students instructed using videos achieved higher test scores than those taught through conventional methods.

Conclusion

The findings of the study, carried out in Kwale County in Kenya, show that students who were taught Fractions by use of videos had higher performance than those taught by means of traditional and conventional teaching methods. The experimental groups benefited a lot from the use of video in instruction based on the observed mean scores. Therefore, it was established that use of videos can improve learners' performance in Fractions of numbers and in Mathematics in general. The study underscores the remarkable potential of learners to excel when instructional videos are integrated in Mathematics lessons. The integration of videos in learning Fractions yielded transformative academic performance. Instructional videos were able help learners to translate abstract concepts to facilitate visualization of knowledge which aided learners to comprehend complex concepts. This is in line with Afify, (2020) [1] assertion that instructional videos yield various cognitive benefits, including improved learning and memorization.

The study offers valuable insights into pedagogical methodologies of using instructional videos in teaching fractions and also developing digital literacy among the learners through learning experiences that has been a challenge to majority of teachers. Based on the study it is recommended that deliberate effort should be made by teachers to use videos in Mathematics instruction to leap the inherent benefits of video integrated lessons.

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