Integration of Real-Life Situations in the Instruction of Statistics: Effects on High School Students' Performance in Tharaka/Nithi County, Kenya

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Abstract

Outcomes of integrating real-life situations in teaching mathematics have been underscored in several studies. This paper addresses the effect of incorporating real-life situations in teaching Statistics to high school students in Tharaka-Nithi County, Kenya. The study used a pre- test post-test quasi-experimental research design conducted on 232 students. The students were divided into two groups, the treatment group and the comparison group. The quantitative data was analysed using SPSS. A t-test was used to test for any statistically significant difference in the comparison and experimental groups' mean marks in the achievement tests. The statistical significance of means was tested at $\alpha = 0.05$. The study findings showed that group of students taught while integrating a real-life situation mean mark was above average and significantly higher than the group taught while using conventional teaching. This led to the conclusion that the use of appropriate real-life situations in teaching statistics can improve students' grades. The study recommends that mathematics teachers should incorporate more relevant real-life situations in teaching statistics as well as other topics in mathematics.

Keywords: Real-Life Situations, Mathematics Instruction, Statistics Instruction, High School Students, Performance in Statistics

INTRODUCTION

Statistical knowledge is crucial in daily life and other professions hence the need to include it in the mathematics curriculum globally (Gonda et al., 2022). Although statistical concepts are present in everyday life occurrences like in the presentation of weather reports, sports, and political analysis reports among others, statistical ideas remain abstract to many students(Kovacs et al., 2021). According to Damlamian and Sträßer (2009), the disparity between Statistics concepts presented in the classroom and the concepts used in real life greatly masks the visibility of Statistics concepts to many individuals. Moreover, this lack of visualisation of Statistics concepts leads to a lack of conceptual understanding which translates to poor performance in Statistics questions. Lack of conceptual understanding in mathematics stems from the disconnect between real-life and classroom Mathematics which makes numerical learning less engaging, complex, and abstract (Altay et al., 2017). This lack of context leads to students constantly questioning why they need to study the concepts being taught which is an indication of a lack of interest (Rangel et al., 2016).
Previous research has indicated that the use of appropriate real-life situations in teaching Mathematics also referred to realistic mathematics education or mathematical modelling can bridge the gap between classroom mathematics and out-of-classroom mathematics (Alsina & Salgado, 2022). This use of mundane situations or scenarios that are experientially genuine to students creates significance of the concepts being learned, makes learning mathematics more engaging and accessible to the students, and eventually serves as a tool for the development of students conceptual understanding of mathematical ideas in the learning process (Hakadiva, 2017). Most of these cited previous studies have noted that instruction of statistical ideas using actual data demonstrates practicality, and elicits reflections and incorporation of new ideas leading to life-long learning

of the concepts. However, although these studies highlighted the benefits of using situated learning, there were no studies that directly presented the empirical effects on high school students' performance in Statistics. Additionally, there is a need to give a Kenyan account regarding the use of real-life situations in teaching Statistics.

Objective

The objectives of the study were to:

a) Establish if there is a difference in performance in Statistics between students taught while using real-life situations and those taught using conventional methods.
b) Determine gender responsiveness on the use of real-life situations on students' performance in Statistics.

Hypothesis

This study tested the following null hypotheses:

$H0_1$: There is no significant difference in performance between learners taught integrating real-life situations and those taught without integrating RLS in the teaching methods.

H_02: There is no significant difference in performance between boys and girls taught while using real-life situations in the teaching of Statistics.

Theoretical Framework

This study followed the social constructivism theory of Lev Vygotsky. Social constructivism holds that a person's cognitive processes and knowledge acquisition are products of how they engage with their surroundings in society. Deriving meaning from people's interactions with one another and their environment is the aim of social constructivism theory (Vygotsky, 1978). The zone of proximal development (ZPD) and the more knowledgeable others (MKO) have been the fundamental concepts that the social constructivism theory is based on (Vygotsky, 1978). The ZPD, according to Vygotsky, is the space between the point at which a child's mental functions are established as a result of certain developmental cycles being completed and the level at which the student can solve problems after receiving guidance from an adult or a youngster who is proficient in the concepts (MKO). Because it highlights the need for adult guidance or working with more experienced peers, the ZPD is also essential to Vygotsky's constructivist theory. With the right support, pupils grasp the material better and can finish tasks even if they are not given the same assistance later on. In this regard, the students' engagement with members of their society is inevitable. Therefore, the student needs should be known and addressed accordingly to ensure they are being imparted the right knowledge (Bunyakarte, 2010). Additionally, learning ought to be a social activity where the MKO or the instructor acts as a guide rather than an information source. To better understand the subject being taught, engaging students in activities that keep them active in the learning process as opposed to passive consumers of knowledge is encouraged.

Teaching and learning mathematics are a social contrast that adopts the social constructivist ideology. This ideology should raise the awareness that students acquire informal mathematical knowledge from their interaction with their peers and the older members of society and that this out-of-classroom knowledge can/should be the cornerstone of formal mathematics knowledge. Teachers of mathematics should, therefore, leverage the use of the use of students' prior mathematics knowledge and real-world informal activities in teaching to make learning more interesting and realistic. However, to reap the full benefits of utilizing real-life situations in teaching and learning mathematics, finding out how different cultural practices affect the learning process is crucial. This influenced the choice of this study to ascertain the impact of including a particular real-world scenario in statistics education.

REVIEW OF RELATED LITERATURE

Statistical concepts are sometimes seen as abstract making Statistics instruction and learning challenging at both high school and college levels (Neuman et al., 2013; Sawers et al., 2016). The perception of statistics ideas as abstract and inflexible makes understanding of these statistical concepts difficult (Neuman et al., 2013; Pale, 2016). Eventually, students may find it challenging to apply Statistics ideas encountered in real life to statical concepts learned in the classroom and vice versa. This gap between real-life and classroom

concepts may lead to learners developing unfavourable impressions of Statistics thus making learning less enjoyable. Finally, students end up cramming algorithms to pass examinations. Integration of real-life events in teaching has been recommended to close this gap between real-life and classroom statistics (Neuman et al., 2013).

According to Alsina and Salgado (2022), incorporating real-world circumstances in education helps students become used to solving real-world difficulties they may encounter in and out of school. Real-life events should serve as the beginning point for teaching Mathematics, where learners' mathematical concepts and methods are established, progressively leading to fewer context-specific formal generalisations (Drijvers & Heuvel, 2014). Although real-life scenarios can be pulled from the real world or made up, they should be experientially genuine in the eyes of the learners so that they can aid the creation of a stimulating learning environment. Real-life experiences serve as a tool for developing learners' Mathematics conceptual comprehension throughout the learning process, therefore, they should be utilised all through and not at the end of the topic.

Positive outcomes of the adoption of realistic mathematics education acknowledged in previous studies include making learning accessible, relevant, promoting discovery, and fostering logical reasoning from observations thus boosting mastery of the content rather than memorizing algorithms (Gonda et al., 2022; Neuman et al., 2013). Studies related to the effect of realistic mathematics education on performance showed similar positive results. For instance, a quasi-experimental study in Indonesia by Goni (2019) on the effect of using the realistic mathematics education approach revealed that students taught while using real-life situations recorded better grades at the end of the study than students taught using conventional methods. A similar study in Indonesia by Nuraina et al., (2021) showed that students taught while using real-life situations demonstrated a better understanding of the mathematics concepts, presented ideas more logically, and were more motivated to participate in the classroom as opposed to the students taught without integrating real-life situations.

On the contrary, a study conducted in the United Kingdom by Jones (2010) revealed that high school students would opt for less demanding questions with straightforward algorithms instead of more engaging questions based on real life. The same study noted that girls preferred solving short algorithm-related questions while boys chose more challenging questions based on real life.

In the African context, a study carried out in Ghana revealed that the use of artifacts and materials from students' surroundings brought new ideas and structures into the mathematics classroom (Ali, 2021). In return, students can engage and conceptualize mathematical ideas related to their everyday life thus boosting their performance in mathematics. However, Wessels' (2008) assessment of Statistics education in South Africa showed that although the use of real-life situations was highly emphasised in the mathematics curriculum, mathematics teachers preferred using real-life examples highlighted in textbooks. Similarly, Opolot et al. (2008) study in Ugandan schools which showed that a lack of clear guidelines for exploiting real-life data in teaching the data analysis strand restricted teachers in its application in the teaching process. As a result, Statistics instruction has remained traditional and rigid with less engaging and stimulating lessons. Although in the Kenyan mathematics curriculum, real-life occurrences are a critical precondition in teaching Statistics (KICD, 2002), few empirical studies show its effectiveness in teaching. Furthermore, there is still an adversity in studies showing how integration of real-life circumstances in teaching affects learners' performance. Therefore, more studies need to be conducted to determine how incorporating real-world situations in teaching Mathematics affects students' performance. This was the focus of this study

METHODOLOGY

A quasi-experimental research design was used in the study. The study group selected through purposive sampling of four high schools consisted 232 Form two high school students. This number was further divided into 114 students in the comparison and 118 in the treatment group. In this study, a Mathematics Achievement Test (MAT) was administered as before-treatment test to both the comparison and the treatment group groups at the start and end of the study. This ensured that the two groups were comparable in terms of their mathematics achievement. Afterwards, Statistics concepts were taught to both groups. However, for the experimental group, the concepts were introduced using a short video clip depicting a pair of dairy farmers with different records tracking habits and taught using Milk Yield Records (MYR) data from the farmer with

a farm records archive. This helped students to role-play the dairy farmers' routine and eventually draw conclusions on the significance of Statistics in dairy farming. In contrast, the comparison group was taught the same topic using conventional means, mainly using textbook illustrations as prominent real-life examples. After the learners had been taught the entire topic, the after-treatment was given to both groups, and their mean scores were obtained.

RESULTS

Characteristics of the Comparison and Treatment Groups by Performance

A pre-test which had a total of 20 marks was administered to the comparison and the treatment groups to determine the students' performance. The test was meant to verify the characteristics of the pair of groups before administration of the treatment that was taught using a selected actual-life situation to the treatment group. The mean marks from the pretest were obtained before subjecting them to an independent-sample t-test. This was meant to verify if a meaningful difference existed in the mean performance of the comparison and treatment groups. The descriptive statistics are displayed in Table 1

Table 1: Before-intervention Test Mean Scores

	Group	N	Mean	Std. Deviation	Std. Error Mean
Pre-test	Comparison	114	7.80	3.817	.357
	Treatment	118	7.29	4.032	.371

Table 1 presents that the comparison group's mean performance (M = 7.80, SD = 3.82) was slightly higher than the treatment group's (M = 7.29, SD = 4.03). However, the test results in Table 1 indicate that both groups' results were below the average mark of the total 20 marks in the test. These results show that both groups' achievement concerning answering real-life related questions was below average. To assess if the difference in the two groups' means was statistically significant a t-test on the means was executed. The results are presented in Table 2

Table 2: Pre-test T-test Results

								Error 95% Confidence	
		F	Sig	T	df	Sig (2-tailed)	Std Diff	Upper	lower
Pre-test	Equal variances assumed	.246	.621	.989	230	.324	.516	-.506	1.526
	Equal variances not assumed			.990	229.9	.323	.515	-.505	1.526

The t-test for equality of means results in Table 2 indicate no statistically significant difference in performance between the treatment group (M = 7.29, SD = 4.03) and the comparison group (M = 7.80, SD = 3.8); t (230) = .99, p = .32. This was an indication that the comparison group had similar characteristics in terms of performance as the treatment group. This observation set the premise for the comparison of the two groups' means after the after-treatment test was administered.

Comparison and Treatment Groups Mean Scores

The comparison and treatment groups received an after-treatment mathematics assessment test. The Kenyan high school mathematics curriculum guidelines indicate that statistics at the Form Two level should be taught for a duration of three weeks (KICD, 2002). The post-test administration was done in the fourth week after the topic had been fully presented to the learners in the comparison and treatment groups. The treatment group was taught using an actual-life situation, the dairy records obtained from a local dairy farmer, and a short video clip depicting two dairy farmers' daily routines. The comparison group was taught using conventional methods mainly limited to textbook examples and exercises. An independent samples t-test on the post-test achievement test mean scores was used to assess whether a statistically significant performance gap existed between the comparison and treatment groups. A t-test is a quantitative statistical test for comparing the known scores of two independent groups (Creswell, 2014). The comparison and treatment groups were independent of one another. Therefore, the t-test was the appropriate statistical test to ascertain if the difference in the means between the two groups was statistically significant. The descriptive statistics are displayed in Table 3

Table 3: After-Treatment Average Scores

	Group	N	Mean	Std. Deviation	Std. Error Mean
Post-test	Comparison	114	8.18	4.231	.396
	Treatment	118	11.43	3.731	.343

Table 3 illustrates that the treatment group's post-test achievement test mean score (M = 11.43, SD = 3.73) was higher than the comparison group's (*M* = 8.18, *SD* = 4.23). It is worth noting that the results in Table 3 also show that the experimental group's mean score was above average score while the comparison group's mean score remained below the average score of the total 20 marks in the post-test. To verify if this difference in the mean scores was statistically significant, a t-test was carried out and the results are displayed in Table 4.

Table 4: Post-test Independent Samples T-Test

							Error 95% Confidence	
		F	Sig	Df	Sif (2-tailed)	Std Diff	Upper	Lower
Pre-test	Equal Variance assumed	2.07	.152	230	.000	.523	-4.279	-2.21
	Equal variance not assumed			224.3	.000	.524	-4.281	-2.21

The outcomes in Table 4 reveal that the treatment group mean (*M* = 11.43, *SD* = 3.73) was significantly higher, *t* (230) = -6.21, *p* = .01, than the comparison group's score (*M* = 8.18, *SD* = 4.23). The null hypothesis $H_0$1, there is no significant difference in performance between learners taught using real-life situations and those taught without integrating real-life tools in the teaching methods, was rejected. This indicated a

statistically significant difference in the mathematics assessment test means between learners taught using real-life situations and those taught without integrating real-life tools in the teaching methods. Additionally, the mean mark of the group taught while integrating a real-life situation was above average of 20 marks while that of the group taught conventionally remained below average.

This contrast in achievement between the comparison and treatment groups shown in Table 3 may be due to integrating the selected actual-life event during the teaching of Statistics. The demonstration of the practicality of Statistics using a situation that is well known to the students might have made the learning process more engaging, interesting, and accessible to all learners hence facilitating a better understanding of Statistical concepts. The study findings concur with Goni (2019) observations that information drawn from everyday life events fosters active engagement in the learning process, makes learners develop data analysis arguments, and eventually elicits in-depth learning that facilitates a deeper understanding of ideas. The results contradict Koparan (2014) views that the use of real-life connections can be distracting in learning Statistics.

Post-test MATs Results Comparison by Gender

The second objective was to establish gender responsiveness of integration of RLS on students' performance. The study compared the treatment group's post-test scores by gender to achieve this objective. The treatment group was considered because it was the group that had received the treatment, hence the need to test its effects on learning by gender. The treatment group's post-test scores grouped by gender are displayed in Table 5.

Table 5: Post-Test Scores by Gender

Gender	Mean	N	Std. Deviation
Female	13.20	60	3.096
Male	8.81	58	3.477
Total	11.04	118	3.947

Table 5 shows that girls performed better in the Statistics post-test MAT (M = 13.20, SD = 3.10) than boys (M = 8.81, SD = 3.48). A one-way chi-square test was used to ascertain if there was a meaningful difference in the learners' performance. The Chi-square test is a non-parametric statistical test that compares nominal variables such as gender (Creswell, 2014). The Chi-square test was performed in this study to see if there was a statistically significant difference between the boys' and girls' means. The gender distribution of learners in the treatment group is displayed in Table 6.

Table 6: Observed and Expected Values

	Observed N	Expected N	Residual
Female	60	59.0	1.0
Male	58	59.0	-1.0
Total	118		

Table 6 shows that 60 females and 58 males were in the treatment group. All their mean scores were used to compute the Chi-square test since gender is nominal data. The Chi-square test outcomes are displayed in Table 7.

Table 7: Chi-Square Test Results			
	Value	**Df**	**Asymptotic Significance (2-sided)**
Pearson Chi-Square	44.648[a]	16	.000
Likelihood Ratio	53.990	16	.000
Linear-by-Linear Association	36.476	1	.000
N of Valid Cases	118		

The Chi-square test results in Table 7 show a statistically significant difference in the boys' and girls' performance X^2 (1, N = 118) = 44.65, p = .01. The null hypothesis that there is no statistically significant difference in performance between boys and girls taught while integrating actual-life situations in the teaching of Statistics was rejected. Hence, the difference in the treatment group's boys' and girls' performance in the post-test quiz was statistically significant.

This difference between the boys' and girls' performance shown in Table 7 might be attributed to the difference in opinion about using RLS in teaching Statistics. These study findings show that more girls than boys believed that the use of real-life situations helped improve their Statistics grades (U = 5359.00, P = .01). The findings agree with Jones (2010), that boys and girls have distinct views of incorporating actual-life situations in Mathematical instructions, which is ultimately transferred into their performance on various Mathematical activities and test scores. Girls' performance being higher than that of boys is an indicator of a possibility that more girls highly considered using real-life connections during teaching or, generally, highly regarded the entire learning process. These study results, however, contradict Jones (2010) findings that more girls believed that real-world contexts made studying Mathematics more difficult and would easily forgo attempting contextual questions, while boys believed that contextual learning of Mathematics was more stimulating and gratifying and would opt to do applied mathematics questions.

CONCLUSION AND RECOMMENDATION

Summary of Study Findings

The study findings showed that the students taught while integrating real-life connections post-test mathematics assessment test mean mark (M = 11.43, SD = 3.73) was statistically significantly higher, t (230) = -6.2, p = .01, than that of learners taught without integrating real-life situations (M = 8.18, SD = 4.23). This implies that the use of real-life situations in teaching can improve students' achievement in statistics.

The study results also showed that girls' mean mark in the Statistics post-test mathematics assessment test (M = 13.20, SD = 3.10) was significantly higher, X^2 (1, N = 118) = 44.65, p = .01, than the boys' mean performance in the same test (M = 8.81, SD = 3.40). Hence students' achievement in mathematics is not static and can shift to favour any gender depending on the variation of teaching resources and students' views.

Conclusion

Based on the study findings above, the following conclusions were drawn:

I) The use of real-life situations helps enhance Statistics learning for students. The demonstration of relevance and practicality of Statistics can help improve students' performance in Statistics.

II) The comparison of results by gender shows that girls posted higher performance than boys showing the variation in sentiments about contextual learning of mathematics. However, this should not be treated in totality but rather as a guide for teaching uniform content to all students so that they can make their own free choices.

Recommendations

Teachers of Mathematics should use more real-life situations in teaching Statistics.

i) Integration of real-life situations in teaching should be extended to other Mathematics topics to help learners improve their conceptual understanding of concepts that may result in better Mathematics performance.

ii) The Ministry of Education should provide additional educational materials and online resources that incorporate real-world examples into Mathematics instruction, supplementing textbooks. This will support teachers in preparing lessons with relevant and practical scenarios, ultimately enhancing the learning experience for students while promoting uniformity and consistency in teaching.

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