

# Impact of Laboratory Method on Students' Motivation of Mathematics in Secondary Schools of Kapseret Sub County Kenya

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## Abstract

Mathematics is compulsory for all learners in secondary schools, as recommended by the Kenya Institute of Curriculum Development (2010). The performance of mathematics has been consistently low and one of the reasons is insufficient Mathematics laboratory. The study sought to determine Mathematics performance among secondary school students. The study instruments that were used included a pre-test, post-test, non-equivalent group experimental design, questionnaires, and an interview schedule. The researcher sampled 298 students and 26 teachers who took part in the study. The Form two students were selected to participate in the study. A sample size that represented the study population was selected using simple random sampling and purposive sampling while stratified sampling was used to select the schools. The study used the Solomon Four-Group design where two groups were formed, one experimental and one control group. The experimental group entered laboratory instructional strategy method while the control group entered conventional instructional strategy method. The respondents were assigned in their complete classes to four groups; experimental groups 1 and 3, and control groups 2 and 4. All the groups were taught the same content of the reflection and congruence. However, groups 1 and 3 were taught using laboratory method while groups 2 and 4 were taught by conventional methods. Groups 1 and 3 were pre-tested prior to the implementation of the laboratory method treatment. Teachers who took part in the study were inducted prior to the study by the researcher for period of three weeks. Mathematics Achievement Test 1 and Mathematics Achievement Test 2, questionnaires and interviews were used to collect data. SPSS was used to aid in data analysis. Chi-square tests were used to establish relationships. The study findings indicated that the laboratory method arouse the learners' interest, increased learner participation, boosted the performance, enabled learners to develop the necessary skills for more advanced study research and promoted the development of scientific thinking. The study recommends that there is need for teachers to use laboratory method, which ensures that learners are more involved and engaged more in doing Mathematics activities and teachers have to be trained on the use of such pedagogy.

**Keywords:** Mathematics, Laboratory method, Conventional method, Quasi experimental, Solomon Four-Group, Pre-test, Post-test, Motivation.

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## INTRODUCTION

Globally, Mathematics is regarded as core subjects in the school curriculum (Suleiman & Hammed, 2019). Studying mathematics is an essential condition for acquiring an education in most fields (Davidovitch & Yavich, 2018). It enables students to choose from a large variety of professions, and increases their chances of admission to academic studies, mainly in fields such as engineering, natural sciences, technology, and social sciences (Davidovitch & Yavich, 2018).

Mathematics study is a requirement for secondary education in Kenya for employment opportunities in the sciences, such as engineering, pharmacy, environmental science, and technology. Mathematics, according to Maass *et al.*, (2019), is the foundation of science and technology and performs several roles that are crucial to the operation of every field of the scientific and technical community. It is a subject, by Asad *et al.*, (2020) and Nkirote & Thinguri (2020) that enables a Learner to have an appropriate understanding and interpretation of general scientific and technological principles, which leads to technology. The importance of Mathematics in science, technology, and

invention (STI) has been widely recognized by the Kenyan government through the 2030 vision (Daniels, 2017).

Despite the highly applauded and acknowledged significance of Mathematics and the fact that it is a prerequisite for the majority of subjects, poor achievement and lack of interest in Mathematics (and STEM) among students continue to be a problem in both developed and developing countries' schools, colleges, and universities (Sharma *et al.*, 2018; 2019). According to students' perceptions of the topic in schools, Mathematics is still one of the most difficult (Brown *et al.*, 2020). Both internal exams and the Kenya Certificate of Secondary Education have often shown poor math performance (Ochieng *et al.*, 2017). According to KNEC (2021), math scores have historically lagged behind those in other science courses. Students routinely do poorly on internal and external Mathematics assessments, according to Desoete *et al.*, (2019), Eyong *et al.*, (2020), and Njoroge (2022).

Having motivation means being motivated to do something (Davidovitch & Yavich, 2018). An individual who feels a lack of urge or inspiration to act is characterized by lack of motivation, while someone who is charged with energy or acts towards some end is considered motivated (Alkaabi, Alkaabi & Vyver, 2017). In recent decades, recognition of the major role of motivation processes for students' success in their studies, as well as other processes of adjustment such as feelings towards learning and towards school, disruptive behavior in class, coping with difficulties and failure, and wellness in general, have been increasing (Alkaabi *et al.*, 2017).

The researcher has noted that Kapseret Sub-county has not been spared to this national predicament. Table 1.1 represents the Kapseret Sub-County KCSE performance for the past years (2017-2021).

**Table 1.1: Kapseret Sub-County KCSE performance for the past years (2017-2021)**

Year	Very good	Good	Average	Poor	Entry	Mean Score	Grade
2018	73	124	129	1477	1803	2.332	D-
2019	68	173	350	1367	1958	2.126	D-
2020	25	206	386	1409	2026	2.006	D-
2021	12	128	222	1101	1463	2.2372	D-

(Source: SCDE, 2021)

Proper solutions to improve learner performance in mathematics depend on knowing the causes of poor performance in the subject. One of the solutions to avert poor performance of mathematics is to change instruction methods. Recently, laboratory method has been proposed to aid mathematics performance as opposed to conventional method. Laboratory method refers to that method in which students learn Mathematics by carrying out mathematical practical in a Mathematics room/laboratory. The laboratory is highly helpful in subjects like Biology, Chemistry, and Physics since it allows students to engage in practical activity, which inspires them to learn more (Affeldt *et al.*, 2017). According to Njoroge (2022) problem-solving methods, such as using a laboratory to teach and learn chemistry, can help students improve their ability to communicate, work in a team, and access and utilize knowledge. Mathematics laboratory instruction can help students create concepts through experience with physical things (Okeke & Okigbo, 2021).

In Kenyan secondary schools, where there are no Mathematics laboratories, the laboratory method is not used to teach Mathematics; rather, it is only taken into consideration for other Science subjects, which is one of the reasons for low achievement in Mathematics (Okeke & Okigbo, 2021). Therefore, the use of such teaching techniques in Mathematics instruction is necessary to raise student achievement.

## METHODOLOGY

### Study Area

The study was conducted in Kapseret Sub County in Uasin Gishu County. Kapseret Sub-County has five wards and estimated surface area of about 451 square kilometers and approximately 121,178 individuals (Kenyacradle.com). The sub county has approximately 26 secondary schools.

### Research Design

Solomon's Four Group Design was used in the study's experimental procedures. This is due to the fact that secondary school classes that have already been formed continue to exist as complete units and that school authorities do not let such classes to be disbanded and reconstituted for study (Akhtar, 2016). The chosen schools were divided into intact groups and randomly assigned to the treatment and control conditions.

### Target Population, Sample Size and Sampling Techniques

The target population comprised of all the form two's students where topic on Reflection and Congruence is taught. The students are important because they provided evidence of laboratory methods enhancing good performance among students when compared to conventional methods. The respondents were selected using stratified random sampling, simple

random sampling and purposive sampling. The schools were first stratified (extra county, county and private secondary) then simple randomly selected to take part in the study within a strata. The researcher sampled 20 schools out of the possible 26 secondary schools within the sub-county, 10 schools were used as control and 10 experimental. The students were sampled using simple

random method; 298 were selected to take part in the study. Teachers were sampled using purposive sampling method and total of 26 teachers took part in the study. The students were distributed in control 1 & 2 and experiment 1 & 2. The total sampled respondents were 324 individuals.



Figure 1.1: A map of the study area in Kenya

Table 1.2: Solomon four groups

Group	Pre test	Treatment	Post test
Experimental 1	Yes	Lab Method	Yes
Experimental 2	No	Lab Method	Yes
Control 1	Yes	Conventional Method	Yes
Control 2	No	Conventional Method	Yes

**Research Instruments**

Questionnaire and interview schedule were used to collect data on the use of laboratory method on students’ motivation of Mathematics in Secondary Schools.

**Data Analysis**

Data collected was analyzed with the help of Statistical Package for Social Science (SPSS) software (version 21). Data collected through questionnaires was coded, analyzed and relationships between variables derived using cross-tabulation. Descriptive statistics were used to determine frequencies and percentages while inferential statistical analysis using the chi-square test was used to determine whether expected frequencies differed from the actual frequencies.

**RESULTS**

Two hundred and ninety eight (298) learners participated in this research study. In terms of gender male 154 (51.92%) and female 144 (48.08%) learners had almost equal proportion hence very low gender disparity. Twenty six teachers of Mathematics took part in the study; there were 14 (53.85%) females and 12 (46.15%) males.

**Effects of the laboratory method on students’ motivation**

To assess the effects of the laboratory method on students’ motivation both learners and teachers were asked to rate the statements provided. They stated that the method enabled the students to build confidence ( $p < 0.05$ ), increased the learners’ participation in the process of learning ( $p < 0.05$ ), teachers strongly indicated

that it made the students think and understand things and the world around them rather than making them memorize the facts ( $p < 0.05$ ), and made the learning of

the subject to be enjoyable ( $p < 0.05$ ) (as illustrated in Table 1.4).

**Table 1.3: Demographic characteristics**

Respondents	Participated
Teachers	26
Students	298

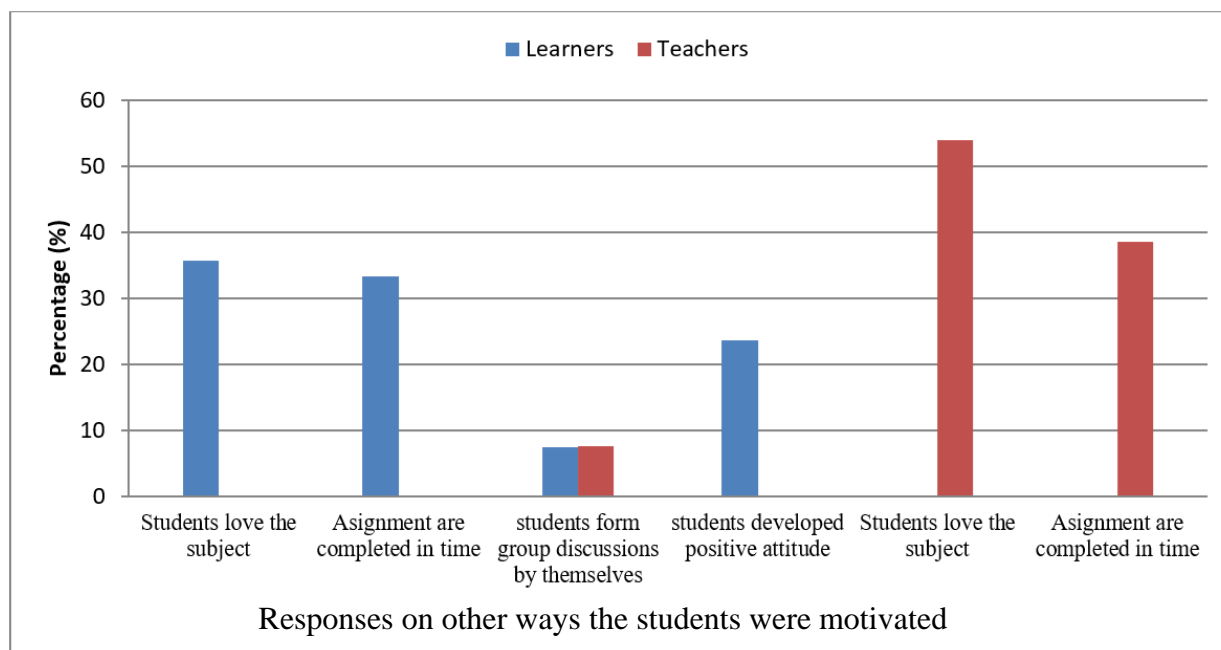
**Table 1.4: Effects of laboratory method on students' motivation for the topic reflection and congruence on mathematics among students**

Statement	Respondents	Strongly agree	Agree	Undecided	Disagree	Strongly disagree	Chi-Square ( $\chi^2$ )
Enabled the students to like the subject	Learners'	16(7.69%)	89(42.79%)	51(24.52%)	32(15.38%)	20(9.62%)	$\chi^2 = 41.15$ d.f.= 4 $p < 0.0001$
	Teachers	2(7.69%)	13(50.0%)	6(23.08%)	4(15.38%)	1(3.85%)	$\chi^2 = 66.70$ d.f.= 4 $p < 0.0001$
Build the students' confidence	Learners'	71(34.13%)	122(58.65%)	9(4.33%)	1(0.48%)	5(2.40%)	$\chi^2 = 134.86$ d.f.= 4 $p < 0.0001$
	Teachers	11(42.31%)	14(53.85%)	1(3.85%)	-	-	$\chi^2 = 40.87$ d.f.=2 $p < 0.0001$
Increased the learners' participation in the process of learning	Learners'	112(53.85%)	77(37.02%)	8(3.85%)	2(0.96%)	9(4.33%)	$\chi^2 = 115.8$ d.f.= 4 $p < 0.0001$
	Teachers	14(53.85%)	11(42.31%)	1(3.85%)	-	-	$\chi^2 = 0.87$ d.f.= 2 $p < 0.0001$
Made the students to think and understand things and the world around them rather than making them memorize the facts	Learners'	67(32.21%)	154(74.04%)	21(10.10%)	14(6.73%)	19(9.13%)	$\chi^2 = 122.72$ d.f.=4 $p < 0.0001$
	Teachers	18(69.23%)	7(26.92%)	1(3.85%)	-	-	$\chi^2 = 65.18$ d.f.= 2 $p < 0.0001$
Made the students develop an interest in learning the subject	Learners'	68(32.69%)	98(47.12%)	30(14.42%)	7(3.37%)	5(2.40%)	$\chi^2 = 77.35$ with d.f.= 4 $p < 0.0001$
	Teachers	11(42.31%)	15(57.69%)				$\chi^2 = 2.56$ d.f.= 1 $p = 0.1096$
Increased learners' attention	Learners'	64(30.77%)	86(41.35%)	4(1.92%)	22(10.58%)	32(15.38%)	$\chi^2 = 49.6$ d.f.= 4 $p < 0.0001$
	Teachers	8(30.77%)	8(30.77%)	2(7.69%)	4(15.38%)	3(11.54%)	$\chi^2 = 24.61$ d.f.= 4 $p < 0.0001$
Made the learning of the subject to be enjoyable	Learners'	94(45.19)	98(47.12%)	7(3.37%)	4(1.92%)	5(2.40%)	$\chi^2 = 114.55$ d.f.= 4 $p < 0.0001$
	Teachers	14(53.85%)	11(42.31%)	1(3.85%)			$\chi^2 = 40.87$ d.f.= 2 $p < 0.0001$
Made the learners do mathematics willingly	Learners'	39(18.75%)	56(26.92%)	7(3.37%)	80(38.46%)	26(12.50%)	$\chi^2 = 35.60$ d.f.= 4 $p < 0.0001$
	Teachers	5(19.23%)	7(26.92%)	1(3.85%)	10(38.46%)	2(7.69%)	$\chi^2 = 40.08$ d.f.= 4 $p < 0.0001$

**Key:** Strongly Agree (SA), Agree (A), Undecided (UN), Disagree (D), Strongly Disagree (SD)

Both learners and teachers had varied reasons in addition to the statements provided, which included that students love the subject (36.63%), assignments are completed on time (33.33%), students form group discussions by themselves (7.47%) as well as students develop positive attitudes (23.56%) according to learners

with a significant difference ( $\chi^2 = 20.4$ , d.f.=3,  $p=0.0001$ ) while teachers pointed out that the method led to students loving the subject (53.85%) and that assignments are completed in time (38.46%) with significant difference ( $\chi^2 = 32.72$ , d.f.=2,  $p=0.0000$ ) as illustrated in Figure 4.2.



**Figure 1.2: More ways the students were motivated**

## DISCUSSION

The analysis of motivation indicated that the laboratory method boosted student engagement and confidence in Mathematics learning more than the conventional method. This explains why they preferred the unconventional technique and tended to engage with it more. This is in line with the results of empirical studies that demonstrate that participating in worthwhile activities increases motivation (Fischer *et al.*, 2019; Wambu & Fisher, 2015). Also, the findings demonstrated how the laboratory approach affected students' enthusiasm to study reflection and Mathematical congruence. According to the research, the laboratory instruction approach inspired students to enjoy the subject, and they successfully finished the assigned tasks on time. The results concur with those of Hall-Powell (2022), who asserted that motivation is the act of being moved to action, and Fischer *et al.*, (2019) and Wambu & Fisher (2015), who found that engaging in valuable activities boosts motivation. This is because, as stated by Nkirote & Thinguri (2020) & Schiefele & Schaffner (2015), motivation is crucial in explaining behavior and the length and level of involvement. This supports the findings that Mathematics should be taught practically using a laboratory approach since learning by doing increases the learner's motivation.

## CONCLUSION

Motivated students were used in the laboratory approach to teaching mathematics. This is because the system allowed students to develop their self-esteem, engage in Mathematical activities willingly, develop an interest in learning mathematics, increase their participation in the learning process, and think critically about and understand their surroundings rather than memorize facts. It can also be used for the prediction of student success in their mathematics course by the understanding of their motivational beliefs towards mathematics.

## RECOMMENDATION

Teachers of mathematics should also use the laboratory teaching method to enhance motivation to study mathematics, especially on reflection and congruence, as well as in other related sub-topics in mathematics.

## REFERENCES

- Affeldt, F., Tolppanen, S., Aksela, M., & Eilks, I. (2017). The potential of the non-formal educational sector for supporting chemistry learning and sustainability education for all students—a joint perspective from two cases in Finland and Germany. *Chemistry Education Research and Practice*, 18(1), 13-25.
- Akhtar, D. M. I. (2016). Research design. Research



- Design (July 20, 2023).
- Alkaabi, S. A. R., Alkaabi, W., & Vyver, G. (2017). Researching student motivation. *Contemporary Issues in Education Research (CIER)*, 10(3), 193-202.
  - Asad, M. M., Hussain, N., Wadho, M., Khand, Z. H., & Churi, P. P. (2020). Integration of e-learning technologies for interactive teaching and learning process: An empirical study on higher education institutes of Pakistan. *Journal of Applied Research in Higher Education*.
  - Brown, S., Naiker, M., Sharma, B., Wakeling, L., Johnson, J., Mani, J., ... & Khan, N. (2020). Attitudes towards science among senior secondary students in Fiji. *Waikato Journal of Education*, 25(1), 57-72.
  - Daniels, C. (2017). Science, technology, and innovation in Africa: conceptualizations, relevance, and policy directions. *What do science, technology and innovation mean from Africa*.
  - Davidovitch, N., & Yavich, R. (2018). The Effect of Motivation and Self-Efficacy on Math Studies in the Israeli Ministry of Education's Program "Give Five". *International Journal of Higher Education*, 7(6), 63-77.
  - Desoete, A., Baten, E., Vercaemst, V., De Busschere, A., Baudonck, M., & Vanhaeke, J. (2019). Metacognition and motivation as predictors for mathematics performance of Belgian elementary school children. *ZDM*, 51(4), 667-677.
  - Eyong, E. I., Ugada, C., & Aminu, A. (2020). Indicators of Improved Achievement of Students' in Mathematics. *The Universal Academic Research Journal*, 2(1), 29-37.
  - Fischer, C., Malycha, C. P., & Schafmann, E. (2019). The influence of intrinsic motivation and synergistic extrinsic motivators on creativity and innovation. *Frontiers in Psychology*, 10, 137.
  - Hall-Powell, T. (2022). The Principalship: Transitional Leadership Considerations for Overcoming Obstacles to Laboratory School Implementation in Partnership with an Urban School District in North Carolina.
  - Maass, K., Geiger, V., Ariza, M. R., & Goos, M. (2019). The role of mathematics in interdisciplinary STEM education. *ZDM*, 51(6), 869-884.
  - Media Team, KNEC News. (2022). KCSE Results 2021 Check Your KCSE Results via KNEC SMS and Online <https://educationnewshub.co.ke/kcse-results-2021-check-your-kcse-results-via-knec-sms-and-online/>
  - Njoroge, G. (2022). Demystifying Mathematics: Handling learning difficulties in Mathematics among low achievers in Kenyan schools. *Journal of Language, Technology & Entrepreneurship in Africa*, 13(1), 75-96.
  - Nkirote, V., & Thinguri, R. (2020). Influence of teachers' motivation on learning outcomes among pre-primary learners in maara sub county, kenya. *African Journal of Education and Practice*, 6(2), 33-43.
  - Ochieng, K. R., Kiplagat, P., & Nyongesa, S. (2017). Influence of teacher competence on mathematics performance in KCSE Examinations among public schools in Nyatike Subcounty, Migori County Kenya.
  - Okeke, J. C., & Okigbo, E. C. (2021). Effect of generative learning model on secondary school students' achievement and retention in algebra. *South eastern journal of research and sustainable development (sejrsd)*, 4(2), 32-45.
  - Suleiman, Y., & Hamed, A. (2019). Perceived causes of students' failure in mathematics in Kwara State Junior Secondary Schools: Implication for educational managers. *International Journal of Educational Studies in Mathematics*, 6(1), 19-33.