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Relationship between Learning Setting and Achievement on Different Mathematics Tasks among Secondary School Students in Kisumu County, Kenya

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Abstract: **Student ability can be classified as, high ability, medium ability and low ability, according to achievement test results. A learning setting may have students of similar or mixed ability and this may affect their achievement on different mathematics tasks. The purpose of the study was to determine the relationship between learning setting, mathematics tasks and the interaction between learning setting and mathematical tasks for each ability level. A factorial research design was used in the study. The independent variables were learning setting and mathematics task for each ability level. The dependent variable was achievement in mathematics. The population of the study consisted of 240 Form Three students from a public boys' secondary school. A stratified random sampling technique was used to select a sample of 48 students. The stratifying criterion was the ability level across streams. A mathematics achievement test consisting of tasks on Algebra and Probability was used to collect data. The findings of the study indicated that for high ability students, learning setting, mathematics tasks and the interaction between learning setting and mathematics tasks was not significant ($p>.05$). For the medium ability students, learning setting, mathematics tasks, and the interaction between the learning setting and the mathematics tasks was not significant ($p>.05$). For the low ability students, the effect of learning setting and the mathematics tasks alone was not significant ($p>.05$). However the interaction between the learning setting and the mathematics tasks was significant ($p<.05$). The findings are of significance to teachers, educational policy makers, test developers and test users.**

Keywords: **Learning setting, Student Ability, Mathematics tasks, Mathematics Achievement, Analysis of variance.**

1. INTRODUCTION

Background to the Study

Given the diverse range of students' backgrounds, levels and needs educators are continually searching for programs and strategies that provide appropriate support for all learners. Many administrators are implementing policies of ability grouping to address the ever changing demands. Teachers may use ability grouping with the aim of meeting individual students' needs, improve student learning and increase test scores. Student ability can be classified as, high ability, medium ability and low ability, according to achievement test results. Student ability level can be used to establish different learning units among the learners in secondary schools. Ability grouping is an educational approach that places students in groups based on academic achievement (Mathews, Ritchotte, & McBee, 2013). The groups are typically assigned by the teacher and may be heterogeneous or homogeneous. The homogeneous groups consist of students of similar ability while the heterogeneous groups have students of mixed ability (Nomi, 2010). The style of group composition could therefore determine mathematics achievement. Students of different ability levels may need particular styles of ability grouping instruction in order to be successful.

According to Smith (2011), students engage in individual learning of mathematics concepts when they are placed in learning settings of similar ability. The purpose of mixed ability grouping is to improve achievement and reduce the gap between students of different ability levels which is done through differentiation of instruction (Lleras & Rangel, 2009). According to Kaya (2015), high achieving students perform well regardless of how they are grouped and typically show more positive effects from ability grouping than their low performing peers.

Most school administrators are concerned with the most appropriate way of establishing learning units that could maximize the performance of students of varied ability levels. This is because the learning setting created encourages and optimizes certain kind of behavior while minimizing and discouraging others (Dukmak, 2009). The mixed ability learning setting enables students to interact with each other to enhance their learning opportunities. (Smith, 2011). Hallam and Ireson (2003) observed that a learner interacts with the learning environment, changes it and is in turn changed by the consequences of his actions.

Different mathematics tasks can be learnt better depending on the learning setting the students are exposed to. For instance the mathematics concepts in Algebra may be different from those on Probability. Therefore the capacity of students to conceptualize and understand them may be different. According to Peterson and Janicki (1979), students make different errors on different mathematics concepts. Mathematics errors can be classified into two types namely those specific to the algorithm for carrying out the task and computational errors not specific to the algorithm. An algorithmic error can be made by taking an incorrect step, using a wrong formula or a wrong guideline for arriving at the solution. A computational error is unrelated to the steps required in setting up or carrying out the algorithm. For example taking the square of 3 as 6 is a computational error.

The performance of the students on the different mathematics units may depend on the type of errors that are likely to be made. Different mathematics units are likely to encourage the occurrence of different errors. The ability level of the students and the learning setting in which the students are exposed to, may determine the kind of errors that are likely to be made. Webb and Cullian (1983) noted differences in the way students of various ability levels conceptualize different mathematics concepts. In their study, the performance on consumer mathematics was different from that on Probability and on Area and Perimeter. The purpose of the study was therefore to determine the relationship between the learning setting, and the mathematics tasks among students of different ability levels.

Objectives of the Study

The objectives of the study were to:

(i) Determine the relationship between learning setting and achievement in mathematics.

(ii) Determine the relationship between mathematics tasks and achievement in mathematics.

(iii) Determine the relationship between the learning setting, mathematics task and achievement in mathematics.

2. METHODOLOGY

Research Design

A factorial research design was used in this study. In a factorial design the researcher can modify certain variables and observe the effect of these modifications on the variable of interest (Kerlinger, 1986). In this design, every possible combination of factor levels was observed and therefore the set of factors was completely crossed. The design was therefore used to investigate the relative efficiency of different learning settings when working with different mathematics tasks.

In this study, the independent variable was the learning setting having two levels; individual and the group learning setting. There were two mathematics tasks namely Algebra and Probability. The dependent variable was measured using a mathematics achievement test.

Population

The population of the study consisted of 240 Form Three students from an urban secondary school that practiced ability grouping of students. The school was selected purposively because it is a boys' school that streamed its students according to ability. The school had six streams representing the each of the four Forms.

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Sample and Sampling Technique

Stratified random sampling technique was used to select 48 Form three students. The stratifying criterion was based on the classification of streams in terms of ability.

Table 1 shows how a stratified random sample was selected with an equal number of students from four of the six form three streams. The 3A stream was classified as the high ability group.

Table 1: Student Sample by stream,

Stream	**3A**	**3B**	**3C**	**3D**	**3E**	**3F**	**Total**
Population	40	38	41	42	37	42	**240**
Sample	12	0	12	12	0	12	**48**

The medium ability group was represented by the 3C and 3D streams while the low ability group was represented by the 3F stream. The actual selection was done by putting names of all the students in a box and picking 12 of them at random. The selected students were then used to form twelve groups each consisting of one high ability, two medium ability and one low ability student. The composition of the twelve groups was described in Table 2.

Table 2: Sample distribution by ability and groups

Ability	**Groups**												
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**TOTAL**
High	1	1	1	1	1	1	1	1	1	1	1	1	**12**
Medium	2	2	2	2	2	2	2	2	2	2	2	2	**24**
Low	1	1	1	1	1	1	1	1	1	1	1	1	**12**
Total	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**48**

Table 2 shows how the students from each stream were assigned to the twelve groups according to their ability level. The names of the twelve students were put in four different boxes each representing the high, medium and low ability strata. A name was then randomly picked from each box and assigned to a group. This was done to ensure that a group had one high ability student, two medium ability students and one low ability student. These groups were used in the group learning settings. Over the entire period of the study none of the students in the sample dropped out of the study.

Instrumentation

Instructional booklets, answer booklets, a package of complex questions and a package of stepwise solutions to the complex questions prepared by the instructor were used in the study. A mathematics achievement test was used in the study. The test consisted of complex questions on two tasks namely Algebra and Probability. Each task was scored on a 0-10 point scale, with the minimum possible score of 0 and the maximum possible score of 10. The test was pretested with similar students from a parallel secondary school that practiced streaming according to ability. An internal consistency reliability coefficient (Cronbach's alpha) of 0.75 was obtained. The test was also assessed by research experts from the department of Educational Psychology at Maseno University to ensure it had face validity.

Data Collection Procedure

The instructor gave the students in the study some learning materials which consisted of instructional booklets and their answer booklets; some complex questions and a package of stepwise solutions to the complex questions on Algebra. The students were shown how to use them to solve basic problems. They worked alone and consulted with the instructor after studying all the hints. They thereafter worked through the complex questions. This was done on some particular concepts on Algebra which were learnt individually.

The students then worked in groups of four with the learning materials consisting of concepts on Algebra which were different from those done individually. Each group consisted of one high ability student, two medium ability students and

one low ability student. The students were shown how to help each other in solving problems and solicit for explanations from each other in case of difficulties. There after the students worked through the complex questions while working in groups.

The students then went through the same procedures but working on basic and complex questions on Probability. This was to ensure that the students completed both tasks while working in the individual and group learning settings on both tasks. It was assumed that the mathematics concepts were new and the students had not had any prior knowledge of the concepts. The topics selected had not been taught in class during their normal class lessons. It was also assumed that there was no differential teacher effect and that the data collected was purely as a result of the experimental conditions.

After the last learning sessions the students were given a mathematics test which was administered under power conditions. The test consisted of complex items which tested the concepts learnt in the individual learning setting and the group learning setting on both Algebra and Probability. The test was administered under the supervision of the instructor while strictly under examination conditions. They sat for the tests alone and no consultations were allowed. The tests were scored, coded and entered into computer sheets for further analysis.

Methods of Data Analysis

Analysis was done using the Statistical Package for Social Sciences (IBM SPSS Version 20) computer software. Descriptive statistics such as the mean were used to describe the performance on the test in the individual and group learning setting on Algebra and on Probability. A Two way Analysis of variance was used to test the main and interaction effects of learning setting and mathematics tasks for each ability level. ANOVA uses the concept of F-distribution. This sampling distribution can be used to test hypotheses about two or more population variance and the interaction between one variable and another. The most common use of the F-ratio is testing hypotheses regarding equality of two or more population means. The level of significance was 0.05 with 1, 20 degrees of freedom for the mathematics tasks alone for high ability students, 1, 44 degrees of freedom for the medium ability students and 1, 20 degrees of freedom for the low ability students. For the learning setting there was 1, 20 degrees of freedom for high ability students, 1, 44 degrees of freedom for the medium ability students and 1, 20 degrees of freedom for the low ability students. For the interaction of ability and learning setting, there was 1, 20 degrees of freedom for high ability students, 1, 44 degrees of freedom for the medium ability students and 1, 20 degrees of freedom for the low ability students. Post-Hoc Tukey statistic was used to compare the difference among the means where the difference was statistically significant.

3. RESULTS

Mean scores for each ability level in the learning settings for Algebra

The mean scores at each ability level were determined at both the individual and group settings.

Table 3 shows the mean scores for ability and the learning settings for algebra.

Table 3: Mean scores for varied ability and learning setting for Algebra

Ability	Group Setting	Individual Setting
High	8.33	7.50
Medium	7.92	7.33
Low	5.67	5.00

From Table 3, it can be seen that the mean score for the group setting was higher than that of the individual setting regardless of the ability level. The group setting therefore improved the performance of the students in all the ability levels over the individual setting. It was therefore seen that ability contributed to the variations in the mean scores while the learning setting contributed slightly, especially for the low ability students, to the variations in the mean scores of the students.

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Mean scores for each ability level in the learning setting for Probability

The mean scores at each ability level were determined at both the individual and group settings.

Table 4 shows the mean scores for ability and the learning setting for Probability.

Table 4: Mean scores for varied ability and the learning setting for Probability

Ability	Group Setting	Individual Setting
High	6.67	6.50
Medium	6.33	5.92
Low	2.67	1.83

From Table 4, it can be seen that the mean score for the group setting was higher than that of the individual setting for each ability level. The group setting therefore improved the performance of the students in all the ability levels over the individual setting. It was therefore seen that ability contributed to the variations in the mean scores while the learning setting contributed slightly, especially for the low ability students, to the variations in the mean scores of the students.

Relationship between learning setting and mathematics tasks

The following null hypotheses were tested in order to investigate the main and interaction effects of leaning setting and achievement on different mathematics tasks.

a) There was no significant relationship between learning setting and scores on a mathematics achievement test.

b) There was no significant relationship between mathematics tasks and scores on a mathematics achievement test.

c) There was no significant combined relationship between learning setting, mathematics tasks and scores on a mathematics achievement test.

These hypotheses were tested using two-way Analysis of variance. The independent variables were mathematics tasks and learning setting. The dependent variable was scores on a mathematics achievement test. The level of significance was 0.05. Table 5 shows results of two way Analysis of Variance at a level of significance of 0.05

Statistically significant differences in the mean scores were noted for mathematics tasks only (F = 10.232, df 1, 20, P=0.024) and not for learning setting (F=0.007, df 1, 20 P=0.832) and the interaction between mathematics tasks and learning setting (F= 0.605, df 1, 20, P=0.724). The findings failed to reject the null hypotheses of no significant effect of the learning setting and no significant combined effect of the learning setting and mathematics tasks on achievement in mathematics at a level of significance of 0.05. However the null hypothesis of no significant effect of mathematics tasks on achievement was rejected at 0.05 level of significance. The alternative hypothesis of a significant relationship between mathematics tasks and achievement was accepted at 0.05 level of significance.

Table 5: Two way Analysis of Variance for learning setting and mathematics task (N=24) for High Ability students

Source of Variation	Sum of Squares	df	Variance Estimate	F Ratio	Sig
Learning Setting	0.042	1	0.042	0.007	0.832
Mathematics tasks	57.042	1	57.042	10.232*	0.024
Mathematics tasks × Learning setting	3.375	1	3.375	0.605	0.724
Within Group error	111.500	20			
Total	171.959	23			

*0.05 level of significance

From the findings it was evident that whether the students were in the individual or group learning setting, it did not have a significant effect on the scores on a mathematics test. However mathematics tasks did have a significant effect on the scores on achievement test. The interaction between the mathematics task and the learning setting was not significant at 0.05 level of significance. Table 6 shows results of Post-Hoc Tukey comparison of the mathematics tasks.

Table 6: Post-Hoc Tukey comparison for Mathematics tasks for high ability students.

Mathematics Tasks	Mean Score	Difference	Tukey Value	Sig
Algebra	7.725	2.496*	1.906	0.031
Probability	5.229			

*0.05 level of significance

From Table 6 shows a significant difference between Algebra and Probability for high ability students. It can be seen from table 6 that the performance of the high ability students greatly depended on the tasks. The mean score for high ability students on Algebra was significantly higher than the mean score on probability ($p<.05$). This showed that high ability students performed better on Algebra than on Probability regardless of the learning setting they were exposed to. From the findings the mathematics tasks accounted for 29% of the variance in the total scores. A strong association existed between mathematics tasks alone and the total scores for high ability students. The association was sizable in a predictive sense for any population that corresponds to the current study.

Table 7 shows results of two way Analysis of Variance at a level of significance of 0.05

Table 7: Two way Analysis of Variance for learning setting and mathematics task (N=48) for Medium Ability students

Source of Variation	Sum of Squares	df	Variance Estimate	F Ratio	Sig
Learning Setting	1.021	1	1.021	0.161	0.983
Mathematics tasks	20.021	1	20.021	3.158	0.070
Mathematics tasks × Learning setting	1.021	1	1.021	0.161	0.983
Within Group error	278.92	44			
Total	300.98	47			

Table 7 shows that no statistically significant differences in the mean scores were noted for mathematics tasks only ($F = 3.158$, df 1, 44, $P=0.070$), the learning setting only ($F=0.161$, df 1, 44 $P=0.983$) and the interaction between mathematics task and learning setting ($F=0.161$, df 1, 44 $P=0.983$). The findings failed to reject the Null hypotheses of no significant effect of the learning setting, no significant effect for the mathematics tasks and no significant combined effect of the learning setting and mathematics tasks on achievement in mathematics, at a level of significance of 0.05. From the findings it was evident that the performance of the medium ability students did not depend on the tasks. The mean scores on Algebra were not significantly different from those on Probability. Also the performance of the medium ability students did not depend on the learning setting. The mean scores in the group setting were not significantly different from those in the individual setting.

From the findings the mathematics tasks alone accounted for 4.45% of the variance in the total scores for the medium ability students. A weak association existed between mathematics tasks alone and the total scores for medium ability students. The association was not sizable in a predictive sense for any population that corresponds to the current study.

Table 8 shows results of two way Analysis of Variance at a level of significance of 0.05.

Table 8: Two way Analysis of Variance for learning setting and mathematics task (N=24) for Low Ability students

Source of Variation	Sum of Squares	df	Variance Estimate	F Ratio	Sig
Learning Setting	15.042	1	15.042	3.949	0.083
Mathematics tasks	0.042	1	0.042	0.011	0.853
Mathematics tasks × Learning setting	18.374	1	18.374	4.825*	0.021
Within Group error	76.167	20			
Total	109.625	23			

*0.05 level of significance

Table 8 shows that no statistically significant differences in the mean scores were noted for mathematics tasks only (F = 0.011, df 1, 20, P=0.853) and the learning setting (F=3.949, df 1, 20, P=0.083). However the interaction between mathematics tasks and learning setting was significant (F=4.825, df 1, 20 P=0.021).

The findings failed to reject the null hypotheses of no significant effect of the learning setting, and no significant effect of the mathematics tasks at a level of significance of 0.05. However the null hypothesis of no significant combined effect of the learning setting and mathematics task on achievement was rejected at a level of significance of 0.05. The alternative hypothesis of a significant combined relationship between learning setting and mathematics tasks at 0.05 level of significance was accepted.

From the findings it was evident that the learning setting combined with the mathematics tasks determined the performance of the low ability students. The group setting therefore significantly increased the mean scores of the low ability students and was quite beneficial to achievement in Algebra. The individual setting however appeared to benefit achievement of the low ability students on probability.

From the findings the combination of the mathematics tasks and the learning setting accounted for 12.84% of the variance in the total scores while the mathematics tasks alone accounted for 9.9% of the variance in the total scores. In each of the associations described previously the following could have contributed to the unexplained variance.

a) The level of interest and attitude of the students in mathematics. It was possible that some had a negative attitude towards the subject.

b) The students' personality might have affected their contributions in the group discussions. Some students were introverts while others were extroverts.

c) The level of motivation of the students during the study. Some students were highly motivated while others were not motivated.

d) The size of the sample used was small and only represented a small fraction of the whole population.

These among others were some of the factors that could account for the unexplained variance and were not considered in this study. It is hoped that a study will be conducted to find out whether this is the case.

4. DISCUSSION OF FINDINGS

The findings of the study showed that the mathematics tasks had a significant effect on achievement of the high ability students. However there was no significant effect of the learning setting and also the interaction of the learning setting and the mathematics tasks. This indicated that the performance of the high ability students depended on the mathematics tasks given. This was regardless of the learning setting which were exposed to them. The effect of the learning setting, mathematics tasks and the interaction between the mathematics tasks and learning setting was not significant for the medium ability students. This indicated that the performance of the medium ability students did not differ across the tasks and the learning settings.

The finding also indicated that there was no significant effect of the learning setting and the mathematics tasks only for the low ability students. However there was a significant interaction effect between the learning setting and the mathematics tasks only for the low ability students. The performance of the low ability students therefore depended on the learning settings. On one task, the low ability students performed better in the individual setting while on another they performed better in the group setting. This indicated that the low ability students' performance depended on the mathematics tasks and the learning setting.

The finding of no significant effect of the Learning setting on the total scores was consistent with previous research. Nomi (2010) found insignificant results determining that the style of ability grouping, paired with the level of student participants and subject area studied, had neither improved nor decreased academic achievement. Gallagher and Merrotsy (2011) have shown differences in attainment scores of students in mixed ability group settings. Puzio and Colby (2010) found positive results on students' achievement when implementing mixed ability heterogeneous groups but negative effects when grouping students homogeneously.

The finding of a significant effect of the mathematics tasks on achievement was not consistent with previous research. Webb and Cullian (1983) noted that the performance on different mathematics topics was not different regardless of the learning setting. In their study, they used three tasks on Consumer mathematics, Area and Perimeter and Probability. They found that the tasks had no effect on mathematics achievement. Webb and Cullian (1983) study used one hundred and five students in four classes. The students learnt a unit on consumer mathematics, Area and Perimeter and Probability. The study found out that group interaction predicted the performance of the students on the mathematics topics.

The findings of a significant interaction effect between the mathematics tasks and the learning setting were not consistent with previous research. Gallagher and Merrotsy (2011) showed no difference in attainment scores of students in mixed ability settings regardless of the different tasks they studied. Macqueen (2013) revealed that low ability students did better in groups than individually; regardless of the tasks they were given. The performance of the low ability students was however the same regardless of the mathematics tasks and the learning settings.

5. CONCLUSION

From the findings of the study it was concluded that for high ability students the learning setting had no significant effect on achievement in mathematics, the mathematics tasks had a significant effect on achievement in mathematics while the interaction of the learning setting and the mathematics tasks was not significant. For the medium ability students, the learning setting, the mathematics tasks and the interaction between the learning setting and the mathematics tasks was not significant. For the low ability students, the learning setting had no significant effect; the mathematics tasks had no significant effect while the interaction of the learning setting and the mathematics was significant.

6. RECOMMENDATIONS

The following recommendations were based on the findings of the study.

i) Teachers should consider using different learning settings when teaching different topics to enhance the learning activities of the students.

ii) Educational policy makers in Kenya should consider the relationship of learning setting and the mathematics tasks when establishing learning units in secondary schools.

7. SUGGESTIONS FOR FURTHER RESEARCH

The following were suggestions for further research;

i) Research on learning settings while focusing on other topics in mathematics.

ii) Research on learning settings and mathematics tasks at other levels of education like Primary schools, colleges and the University.

iii) Research on learning settings using other subjects.

iv) Research mathematics tasks and learning setting using a true experimental design and the use of a control group.

v) Research on mathematics tasks and learning setting while focusing on female secondary school students.

REFERENCES

[1] Dukmak, D. (2009). Ability Grouping and Teacher-Student Interaction among High achieving students in middle primary schools in the United Arab Emirates.

[2] Gallagher, S., Smith,S.R. & Merrotsy, P. (2011). Teachers' perceptions of the socio- emotional development of intellectually gifted primary age students and their attitudes towards ability grouping and acceleration. *Gifted and Talented International*. 26(1); 11-24.

[3] Hallam, S. & Ireson, J. (2003). Secondary school Teacher's Attitudes to and Believes about Ability Grouping. British Journal of Educational Psychology, 73, 343-356.

[4] Kaya, S. (2015). The effect of the type of achievement grouping on students' question generation in science. *Australian Educational Researcher*, 42, 429-441. doi: 10.1007/s133 84-014-0164-x

[5] Lleras, C., & Rangel, C. (2009). Ability grouping practices in elementary school and African American/Hispanic Achievement. *American Journal of Education*, 115, 279-304.doi:10.1086/595667

[6] Macqueen, S. (2013). Grouping for inequity. *International Journal of exclusive Education* 17(3): 295-309.

[7] Mathews, M. S., Ritchotte, J. A., & McBee, M. T. (2013). Effects of school-wide cluster grouping and within-class ability grouping on elementary school students" academic achievement growth. High Ability Studies, 24, 81-97. doi: 10.1080/13598139.2013.846251

[8] Nomi, T. (2010). The effects of within-class ability grouping on academic achievement in early elementary years. *Journal of Research on Educational Effectiveness*, 3, 56-92. doi: 10.1177/0162353214541326

[9] Peterson, P. L., & Janicki, T. C. (1979). Individual characteristics and children's learning in large group and small group approaches. *Journal of Educational psychology*, 71, 677-687. Retrieved on 4th May 2015 from http://www. apm.sagepub.com/content/34/3/166.refs.

[10] Puzio, K., & Colby, G. (2010). The effects of within class grouping on reading achievement: A meta-analytic synthesis. *Society for research on educational effectiveness*. Available: http:// fillies.eric.ed.gov/fulltext/ED514135. pdf

[11] Smith, C. (2011). "Ability in Primary Mathematics Education. Patterns and implications" Proceedings of the British Society for Research into learning mathematics, 31. 97-118

[12] Webb,N.M., & Cullian, L.K. (1983). Group interaction and achievement in small groups: Stability over time. American Educational Research journal, 23, 243-261. Retrieved on 10th June 2018 at 0830 hours from http://www. researchgate.net/publication/326/36908.