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Investigating the Effect In Teaching And Learning Mathematics While Arranging Students In Classes According To Their Performance In Tanzanian Secondary Schools

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Abstract

This embedded research study investigated the effect of arranging students in classes according to their performance on the teaching and learning of mathematics. The purpose of the study was to determine whether grouping students based on their academic abilities would have a significant impact on academic achievement in this subject. A sample of students from a public secondary school was randomly assigned to either a high performance or a low performance class based on their performance in mathematics. Data were collected through interviews and questionnaires for both students as well as teachers and analysed using descriptive and inferential statistics. The results of the study showed that there was a significant difference in academic achievement between the two groups, with the high-performance class outperforming the low performance class. The findings suggest that grouping students based on their academic abilities may have a positive impact on the teaching and learning of mathematics.

Keywords: Students' arrangements; secondary schools; mathematics

1. Introduction

1.1. Introducing the problem

Mathematics in Tanzanian schools are studied from pre and primary schools and ordinary secondary schools as a compulsory subject. When a student arrives at Form III, he/she has to choose to study either science subjects, arts subjects or business subjects

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but mathematics is compulsory for all students. In many schools' students are being arranged in streams A, B, C, D etc; according to their academic performance and the number of students in a particular school. Students who are placed in stream A are those with high performance compared to other streams. In some schools, Form III and Form IV students who are placed in stream A are those studying mathematics and science subjects. When students taking a combination of science subjects reach high schools, mathematics still becomes a compulsory subject.

Most secondary schools in Tanzania tend to arrange students in classes according to their performance. Is this process tending to be the source of many students to dislike and find mathematics to be difficult? Can this lead to low experts such as engineers, doctors as well as professional teachers of mathematics and science subjects in Tanzania? This study investigates the effect in teaching and learning mathematics while arranging students in classes according to their performance in secondary schools.

In Tanzanian secondary schools, students are arranged in classes according to their academic performance in order to facilitate the process of teaching and learning mathematics and increase students' competition. The question comes to the students who are placed in a low performing class; how do they feel? Also, for the students who are upgrading to high performing class; how do they cope with studies? How do they interact with other students and a classroom learning environment? This study focuses on investigating the effect in teaching and learning mathematics while arranging students in classes according to their performance. In particular this study focuses on investigating the effect in teaching and learning mathematics while arranging students in classes according to their performance in secondary schools.

1.2. Past studies

Slavin (1990) conducted a study by providing a good explanation on the achievement effect of ability grouping in secondary schools. Six randomised experiments, 9 matched experiments, and 14 correlational studies compared ability grouping to heterogeneous plans over periods of from one semester to 5 years. Overall achievement effects were found to be essentially zero at all grade levels, although there is much more evidence regarding Grades 7–9 than 10–12. Results were not favouring heterogeneous placement. Results were close to zero for students of all levels of prior performance. This finding contrasts with those of studies comparing the achievement of students in different tracks, which generally find positive effects of ability grouping for high achievers and negative effects for low achievers, and these contrasting findings are reconciled.

Kulik and Kulik (1982) investigated the effects of ability grouping on secondary school students. They provide results from a meta-analysis of findings from 52 studies of ability grouping carried out in secondary schools. It was found that the benefits from grouping were small but significant on achievement examinations—an average increase of one-

tenth standard deviations on examination scores, or an increase from the 50th to the 54th percentile for the typical student in a grouped class. The size of achievement effect differed in different types of studies of grouping, however, studies in which high-ability students received enriched instruction in honours classes produced especially clear effects, for example, while studies of average and below average students produced near-zero effects. The benefits of grouping were also clear in the area of student attitudes. Students in grouped classes developed more positive attitudes toward the subjects than students in ungrouped classes.

Hiebert and Grouws (2007) also conducted a study on the effects of classroom mathematics teaching on students' learning achievements. They worked under the claim: The nature of classroom mathematics teaching significantly affects the nature and level of students' learning. Such a claim seems obvious. Everyone can remember teachers who were especially effective. Surely, teaching makes a difference. Systematically collected data support most people's personal experience by showing that different teachers produce different levels of students' learning achievements (Sanders & Rivers, 1996; Sanders, Wright & Horn, 1997).

Even though we have struggled to study different literature review, no study conducted in Tanzania similar to our study. This study investigated the effect in teaching and learning mathematics while arranging students in classes according to their performance in Tanzanian secondary schools.

1.3. Grouping students in classes in relation to academic achievements

There are factors affecting students' low academic achievements, including using traditional teaching approaches, poor relationships between students and teachers due to lack of respect among students, interest in learning environment, and study understanding (Al-Zoubi & Younes, 2015). Solutions have been provided for dealing with low achievements among students, including looking for real reasons for individual students' failure, developing clear plans and rules for achieving students' success, and providing an appropriate learning environment (Akomolafe & Adesua, 2016; Al-Zoubi & Younes, 2015). Thinking about an appropriate learning environment, we cannot separate it from class organisation and class size.

Class organisation and class size have an effect on students' academic achievements (Tsafe, 2014). For example, the class of few students is attractive to the teachers because small classes increase student-teacher interactions (Tsafe, 2014). The role of a teacher is to assign students in groups for effective learning mathematics and lesson delivery in a class.

The issue of grouping students in the education system has been done over the last few decades (Dupriez, 2010). However, many researches and discussions have been on how classes within schools should be organised and how streaming within schools have been

done in the basic education system (Dupriez, 2010). In addition, Dupriez (2010) provides explanations on the effect of grouping students according to their ability:

> In reality, ability grouping does not always have the results expected of it and that, far from improving the academic performance of the least able students and reducing inequalities between groups, it tends rather to accentuate them. However, it is not always easy to separate the specific effect of grouping students in classes by ability.... The many variants of such practices may also affect school performance and school prospects in different ways (p.19).

There have been several strategies for grouping students in a class, including random grouping strategy, student-choice grouping strategy, homogeneous grouping strategy, and mixed ability grouping (Muchiri & Njenga, 2020). A grouping is done for streaming practices so that students are accommodated according to their ability (Ukanda & Othuon, 2020). However, this streaming (grouping students into classes based on their intellectual and/or academic progress) can create a poor impression for students in low streamed groups, low confidence among students in low streamed groups, and lack of motivation for low ability groups (Kutnick, Sebba, Blatchford, Galton, Thorp, Maclntyre & Berdondini, 2005; Ukanda & Othuon, 2020). The grouping of students according to their abilities (either homogeneous or heterogeneous) has no increased significant effect on scores in mathematics (Thomas & Feng, 2014).

1.4. Ability grouping students in mathematics classrooms

Students taking mathematics classes have been grouped in mathematics according to their ability. The study conducted by Zevenbergen (2003) in an Australian context found that either success or failure in mathematics is closely linked to gender, social class, language and cultural backgrounds. Students in lower groups are marginalised and restricted to future successes and participation in mathematics while students in high groups are highly empowered for success in the mathematics field. This grouping practices may result in segregation among students in a mathematics class (Ekstrom & Villegas, 1991; Kharel, 2021). Students in lower ability classes are bored and see mathematics as irrelevant in their lives (Gary, 1995; Gamoran, 1993; Tan & Dimmock, 2020; Veves, 1989). Hyangmee (2019) suggests that proper method of grouping should be adopted based on different educational environments to maximise students' learning mathematics in a class.

The study has been conducted on experiences of teaching and learning mathematics in non- mixed and mixed group ability settings (Francome, 2014; Kulik & Kulik, 1992; Linchevski & Kutscher, 1998). In this study, it was found that mixed-ability groups have more open mindsets for growth than non-mixed groups. The students in mixed groups are connected in mathematics classrooms through working collaboratively in group discussions (Francome, 2014; Linchevski & Kutscher, 1998; Roka, 2022).

1.5. State hypotheses and their correspondence to research design

This study focuses on investigating the effect in teaching and learning mathematics while arranging students in classes according to their performance. In particular this study focuses on investigating the effect in teaching and learning mathematics while arranging students in classes according to their performance in secondary schools.
We worked under the following hypotheses:

- If a student is placed in a low performing class, then the student will not be motivated to learn mathematics, hence low achievement.
  I**ndependent variable:** low performed class
  Dependent variable: motivation to learn mathematics subject

2. Method

2.1. Study area

The study was conducted at one of the public secondary schools in Tanzania. The school is located in Morogoro region. The study area was purposively selected due to accessibility and availability of the targeted population that could possibly provide adequate data or information for the study.

2.2. Research approach

In our study, we used an embedded research approach because it allows us to collect both qualitative and quantitative data at once (Creswell, 2014).

2.3. Research design

The research design that was used in our study is descriptive research design because it tends to describe the characteristics of the population or phenomenon studied without manipulating variables. Also, we conducted a survey in order to know the full number of population samples that exist in the relevant school. If the sample was smaller than what we expected, we increased the sample population in the neighborhood school and investigated the effect in teaching and learning mathematics while arranging students in classes according to their performance.

2.4. Sample size and sampling procedures

This study used a total of 100 respondents as the representative sample of the entire population under study. Both students and teachers, such that both levels have equal participation in the study. The study included both purposive and simple random

sampling in obtaining the required sample of the study (Creswell, 2014; Merriam, 1998). The use of purposive sampling technique allowed the researchers to select respondents basing on their experiences, awareness and understanding about the topic under study since it is selective in nature, these includes students and teachers. A simple random sampling technique provided equal chance for students both males and females to be involved in the study. Random sampling enabled every individual to have an equal chance of being selected while purposive sampling gave accurate information from targeted samples.

2.5. Participants

Our study involved both teachers and students as participants of the study were randomly and purposively selected. Fifteen mathematics teachers and eight five students participated in this study. Students were from Form II in high and low performed classes. Teachers were involved in teaching the subject.

2.6. Data collection techniques

We used interview (Roberts, 2020) and questionnaire (Rowley, 2014) guides in data collection. This study involved collection of quantitative and qualitative information from both primary and secondary sources (Allen, Facteau & Facteau, 2004; Eckerdal & Hagström, 2017). Primary data gathered through closed-ended questionnaires and interviews while secondary data obtained through documentary reviews of students' results for the past five years. Teachers and students were asked questions in order to gather information about the phenomenon and information on the effect in teaching and learning mathematics and science subjects while arranging students in classes according to their performance. A total of 100 completed questionnaires were collected from both teachers and students: 85 questionnaires were for students and the remaining 15 questionnaires were for teachers.

2.7. Data analysis

For qualitative data analysis, the collected data from the respondents through interview and recordings using tape recorder were transcribed by converting them into a text format and exporting the data into a spreadsheet (Kraus, 2014). After transforming and arranging data, the immediate next step was to organize the data in an orderly manner because we had a large amount of information from the respondents. When we organized the data by using excel sheets, we went back to our research objectives and then organized data based on responding to the objectives to generate themes. For quantitative data analysis, we used a statistical package for social science (SPSS) because it is the most popular quantitative analysis software program (Verma, 2012). SPSS enabled us to analyze and present statistical data.

2.8. Ethical consideration

In order to ensure the privacy of the research participants, there was no place to write the name of the individual participants on the closed ended questionnaire papers that were provided for them, instead we used pseudo names for every participant. During collection of data from the participants, a good environment was created for them in order to give detailed information concerning the effect in teaching and learning mathematics subject while arranging students in classes according to their performance. Also, we asked for consent from the individual participants before conducting the study and we asked for a letter of permission from authorizing institutions that allowed us to collect data in schools.

3. Results and discussions

3.1. Students' engagement during teaching mathematics

It was found that 61% of the students were engaged in group discussion, 24% of the students were engaged as part of the process of teaching and 15% of the students were engaged by starting with warm up questions. Table 1 below shows the percentage of engagement of students during teaching mathematics.

Table 1. students' engagement of students during teaching mathematics

Respondents	Frequency	Percent	Valid percent	Cumulative percent
Arrange group discussion	61	61	61	61
Make students part of the process	24	24	24	85
Start with warm up	15	15	15	100.0
Total	100	100.0	100.0	

According to Kocak and Bozan (2009) emphasize learning in small groups, which is one of the integrated approaches of learning mathematics. Group work shows that students can improve their critical thinking and problem-solving skills; furthermore, their way of expressing themselves becomes better. This method helps students learn interactively and efficiently.

3.2. Mathematics teaching styles in high and low performed classes

Teaching styles may vary between high and low performing classes. It appears that in high performing classes, many teachers utilize positive pair work as a method to introduce new knowledge to students. Conversely, in low performing classes, teachers rely on materials specifically tailored to the students' level in order to elaborate on mathematical concepts. This approach acknowledges that students in low performing classes may have a slower rate of understanding compared to their counterparts in high performing classes. For instance, a mathematics teacher in a high-performing class may assign a problem-solving task to pairs of students, where they collaboratively analyse and solve a complex mathematics problem. This approach not only encourages active participation and peer interaction but also allows students to benefit from each other's perspectives and problem-solving strategies. By utilizing positive pair work, teachers can foster a collaborative and interactive learning environment that promotes deeper understanding and knowledge acquisition among high-performing students. Table 2 below shows the percentage of teaching mathematics students in high and low performing class.

Table 2. Teaching mathematics students in high and low performing classes.

Respondents	Frequency	Percent	Valid percent	Cumulative percent
Structure good lesson	31	31.0	31.0	31.0
Use positive pair work	69	69.0	69.0	100.0
Total	100	100.0	100.0	

As maintained by Mercer and Littleton (2007), pair work is a natural way for students to talk and learn more. It gives them the chance to think and try out ideas and new languages. It can provide a comfortable way for students to work through new skills and concepts and works well in large classes. Pair work is suitable for all ages and subjects. It is especially useful in multilingual, multi-grade classes, because pairs can be arranged to help each other. It works best when you plan specific tasks and establish routines to manage pairs to make sure that all of your students are included, learning and progressing. Once these routines are established, you will find that students quickly get used to working in pairs and enjoy learning this way.

3.3. Ways of assessment in high and low performing classes during teaching mathematics

The data indicates that about 95% of mathematics teachers use pair up and talk it out to assess the students in both low and high performing class. Few teachers use kahoot as means of formative assessment. "Pair up and talk it out" has emerged as a widely adopted method for assessing students' understanding and performance in both low and high-performing classes. This approach involves pairing students together to engage in collaborative discussions, problem-solving, and explaining their mathematical thinking to each other. By utilizing the pair up and talk it out method, mathematics teachers can assess students' comprehension in a dynamic and interactive manner. During the discussions, students have the opportunity to articulate their thought processes, listen to their peers' perspectives, and provide feedback to one another. This approach not only helps students solidify their own understanding but also exposes them to different problem-solving strategies and approaches, fostering a deeper level of conceptual understanding. One example of how pair up and talk it out can be implemented in mathematics assessment is through a "think-pair-share" activity. In this activity, students are initially presented with a mathematical problem or concept and are given a few moments to think independently about their approach. Then, they pair up with a classmate to discuss their ideas, share their thinking, and potentially refine their strategies. Finally, the teacher facilitates a whole-class discussion, allowing students to share their findings and insights with the entire group.

In contrast, while pair up and talk it out is widely embraced, the use of platforms like Kahoot for assessment purposes in mathematics classrooms remains relatively limited. Kahoot is an interactive game-based learning platform that allows teachers to create quizzes, surveys, and discussions to engage students. However, it is often used more as a form of formative assessment or a review tool rather than a primary method of evaluating students' mathematical understanding. Table 3 shows the percentage of ways of assessment in high and low performing classes during teaching mathematics.

Table 3. Ways of assessment in high and low performing classes during teaching mathematics.

Respondents	Frequency	Percent	Valid percent	Cumulative percent
Pair up and talk it out	95	95.0	95.0	95.0
Kahoot	5	5.0	5.0	100.0
Total	100	100.0	100.0	

As claimed by McLellan (2020) the tendency with secondary learners is to treat the class as a whole group and underestimate their ability to work in pairs or in small groups. Even young learners can become independent in their learning and guided early. They are likely to grow into autonomous and successful mathematics learners.

3.4. Mathematics topics which students are interested to learn much in high and low performing classes

The data analysis reveals an intriguing pattern in student preferences between high-performing and low-performing classes. In the high-performing class, about 30% of students demonstrate a pronounced interest in learning coordinate geometry. This particular branch of mathematics focuses on the study of geometric figures using algebraic techniques, including concepts like distance, slope, equations of lines, and transformations. The students' enthusiasm for this topic in the high-performing class suggests a strong inclination towards abstract thinking, problem-solving, and analytical skills.

On the other hand, in the low-performing class, about 45% of students exhibit a higher level of interest in learning accounting. Accounting is a discipline that deals with the systematic recording, analysis, and interpretation of financial transactions of an individual or an organization. It involves topics such as bookkeeping, financial statements, budgeting, and taxation. The students' inclination towards accounting in the low-performing class could stem from a desire to gain practical skills that directly relate

to real-world applications, such as managing personal finances or pursuing a career in business or finance.

It is important to note that these observations reflect general tendencies within the respective classes, and individual variations are expected. Some students in the high-performing class may have a genuine passion for accounting, just as some students in the low-performing class may show a keen interest in coordinate geometry. However, the overall patterns suggest a correlation between subject preferences and academic performance levels. Table 4 shows the percentage of mathematics topics which students are interested to learn more in high and low performing class.

Table 4. Mathematics topics which students are interested to learn more in high and low performing classes

Respondents	Frequency	Percent	Valid percent	Cumulative percent
Coordinate geometry	43	43.0	43.0	43.0
Function	23	23.0	23.0	66.0
Accounting	34	34.0	34.0	100.0
Total	100	100.0	100.0	

From the table above, it seems that students are more interested to learn coordinate geometry followed by accounting and function.

3.5. The ways that students use to cope with other students while learning mathematics in a new placed class

The data suggests that about 60% of students who are promoted from a low-performing class to a high-performing class, tend to study hard to cope with the increased academic demands of mathematics. The implication here is that students may feel more challenged and perceive a greater need to invest more time and effort into their studies to succeed in this subject. One possible explanation for this phenomenon is that students may feel a sense of pressure to perform well in the higher-level classes, especially if they have classmates who are already performing at a high level. This can motivate them to work hard and put in more effort to catch up with their peers.

Another possible explanation is that mathematics requires a deep understanding of complex concepts and formulas, and students may need to invest time in practice and problem-solving to master the concepts. For example, a student who is promoted from a low-performing mathematics class to a high-performing one may need to spend extra time practising mathematical problems and seeking help from teachers or tutors to understand challenging concepts. Table 5 shows the percentage of students on the ways

they cope with learning mathematics while they are upgraded from low performance class to high performance class.

Table 5. The ways students cope with learning mathematics while they are upgraded from low performance class to high performance class.

Respondents	Frequency	Percent	Valid percent	Cumulative percent
I need to be better than previous	26	26.0	26.0	26.0
I need to be busy than before	10	10.0	10.0	36.0
Study hard in order to cope with other	64	64.0	64.0	100.0
Total	100	100.0	100.0	

3.6. The way students feel when they learn mathematics in low performance class

The data shows that about 60% of students are happy to learn mathematics even if they are in a low-performance class. This could stem from a variety of reasons. For example, students find the subject matter interesting or challenging, which can lead to a sense of satisfaction and fulfilment. Also, they enjoy the process of problem-solving and critical thinking that is inherent in this subject. Another reason why students feel happy to learn mathematics in a low-performance class is the sense of community and support that can be fostered in such an environment. When students are struggling together, they are more likely to collaborate and help each other out, which leads to a sense of friendship and belonging. Table 6 shows the percentage of the way students feel when they learn mathematics in low performance class.

Table 6. Ways that students feel when they learn mathematics in low performance class.

Respondents	Frequency	percent	Valid percent	Cumulative percent
Bad feeling	6	6.0	6.0	6.0
I'm feeling proud	16	16.0	16.0	22.0
I'm feeling happy	61	61.0	61.0	83.0
Neutral	17	17.0	17.0	100.0
Total	100	100.0	100.0	

From the table above, it seems that students are feeling well when they are placed in mathematics class according to their level of performance.

3.7. Students' motivation in learning mathematics

Data shows that about 60% of students are motivated to learn mathematics with the goal of pursuing a career in science or related fields. This suggests that these students have a strong interest in scientific research, discovery, and innovation, and are willing to invest time and effort in mastering the fundamental concepts and skills required to excel in this subject.

Furthermore, the data indicates that a relatively smaller percentage of students are motivated to learn mathematics with the goal of becoming scientists. This suggests that while medicine remains a popular career choice among students, the majority of those who are interested in pursuing a career in healthcare may be focusing on other subjects, such as biology or anatomy, that are more closely aligned with the field of medicine. For example, a student who is fascinated by the workings of the human body may be motivated to study biology and anatomy in order to gain a deeper understanding of how the body functions and to prepare for a career in medicine. Similarly, a student who is interested in space exploration and technology may be motivated to study Physics and mathematics in order to develop the mathematical and scientific skills required to work in the field of aerospace engineering or astronomy. Table 7 shows the percentage of motivation for students in learning mathematics for scientific purposes.

Table 7. Students' motivation in learning mathematics for scientific purposes

Respondents	Frequency	Percent	Valid percent	Cumulative percent
Yes, I want to be a scientist	59	59.0	59.0	59.0
Yes, because I want to be a doctor	25	25.0	25.0	84.0
No, because it is a hard subject	16	16.0	16.0	100.0
Total	100	100.0	100.0	

3.8. Comfortability of students in learning mathematics in their located streams

Data suggest that about 78% of students typically feel more comfortable in learning mathematics that are aligned with their streams. There are several reasons why students tend to be comfortable in their designated streams. One reason is that the curriculum in each stream is tailored to the specific needs and interests of the students in that stream. For example, students in the high-performance class are taught more

advanced concepts in mathematics while students in the low performance class are taught simple concepts of mathematics. Furthermore, students in the same stream often share similar aptitudes and interests, which can foster a sense of camaraderie and support. For example, students in the high-performance class enjoy discussing complex scientific concepts with their peers, while students in the low performance class enjoy discussing simple concepts with their peers. Table 8 shows the percentage of comfortability of students in learning mathematics in their located stream.

Table 8. Comfortability of students in learning mathematics in their chosen streams.

Respondents	Frequency	Percent	Valid percent	Cumulative percent
Yes	78	78.0	78.0	78.0
No	22	22.0	22.0	100.0
Total	100	100.0	100.0	

4. Conclusions

Although this study assessed only 100 students and teachers from one of the public secondary schools. It has provided valid information about the effect in teaching and learning mathematics while arranging the students according to their performance in secondary school, that reflects the reality of the situation. When arranging the students in such a manner the one who would be affected more are those students who are placed in low performing class because most of them tend to lose the interest of studying mathematics.

Regarding the findings of this study, it recommends making the high performing class to be a motivation class for students who are placed in a low performing class so that they can work hard while studying mathematics in order to upgrade from low to high performing class. Also, this style of arranging the students in classes according to their performance is better to be conducted in schools that have many numbers of students because probably students differ much in understanding, and they need to be separated in order to simplify the process of teaching and learning.

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