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Effect of Cooperative Learning Method on the Performance of Mathematics Students in Public Secondary Schools in Rwanda: A Case of Karongi District

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Abstract

Purpose: The aim of this paper was to investigate the effect of cooperative learning on on the performance of Mathematics students in public day Schools in Rwanda" A case of Karongi District'.

Methodology: Simple random sampling technique was further applied to obtain Mathematics teachers and students of senior 4, 5 and 6, making 783 target students. The study used a sample of 230 respondents from the sampled schools. The collected data was analyzed using descriptive statistics, correlation, and regression analysis through the statistical package for social science (SPSS) version 21. The data collected were analyzed using descriptive statistics and multiple regression.

Findings: The results of the findings indicated that the teaching of mathematics via the cooperative learning method was more correlated with the performance of students in Karongi District ($r = 0.611$; $p= 0.000$). Multiple linear regression analysis showed that cooperative learning method contributed to 71.9% of variation on the performance, hence plays a vital role in performance of Mathematics students in public secondary schools in Karongi District. Additionally, it was further inferred that cooperative learning method increases positive attitudes toward learning the subject.

Unique Contribution to Theory, Policy and Practice: Social constructivism was used. A key factor in social constructivism is that the children's development is enhanced by participating in activities that are slightly above their level of competence with mastery occurring as a result of help from others; which is enhanced as students are given opportunities to teach each other and practice in a social context. Interactions among students are crucial to cooperative learning and it is the interactions that occur in the groups that help to inspire the learning motivation. The study recommended that to promote the implementation of cooperative learning method effectively, Mathematics teachers should attend seminars, workshops and conferences.

Keywords: *Cooperative, Learning Method, Performance, Mathematics, Students*

INTRODUCTION

Mathematics is still a subject that is considered difficult and boring to many students. According to Woodard (2014), weaker students feel anxiety toward mathematics, and this anxiety affects their performance in mathematics. Students who lack mastery in mathematics are less successful, despite being in secondary schools for a long period of time. Furthermore, low proficiency students in mathematics performed below average on the national tests in Indonesia. Based on observations of high school mathematics students, the information shows that students are not actively involved in developing knowledge; they receive information passively and are less motivated. This passivity has caused much concern among educators because knowledge of mathematics plays a significant role in enhancing the country's social economic development. The quality of education that teachers provide to students is dependent upon what teachers do in their classroom (Zakaria, 2017).

Ariyania (2013) observed that unconventional teaching methods have among other factors been responsible for the low performance exhibited by the students in mathematics. This study aims to provide a practical way to assist students learn better. This predicament could be overcome using a cooperative learning strategy which has been identified as one of the ways teachers may apply to increase academic achievement and ensure active learning among students (Narzoles, 2015). Many studies have been conducted and conclusions have shown that cooperative learning strategy is a helpful instructional strategy which promotes students' learning achievement (Van Dat, 2016).

The teaching method used in the class is one of the factors that make students become passive and have less interaction with each other in doing tasks. Lazarowitz (2014) have criticized the lecture method use by teachers because only hardworking students can benefit from it. Therefore, to enhance the understanding of mathematics, students must be more active in the classroom and must creatively acquire knowledge, especially in understanding and solving mathematical problems. Students should be given the opportunities to develop, to interact, and to share with friends through cooperative learning activity. Thus, the cognitive and affective development of students in mathematics can be improved. An alternative method for the delivery of material is cooperative learning.

The process of cooperative learning involves students working together in small groups on a structured activity. The members of the groups learn to work as a team to accomplish a specific goal, to solve a problem, to complete a project, or to develop a product. Teachers hold students accountable individually, but also assess group work. Students are responsible not only for learning the material, but also for ensuring that the other members of the group learn the material too (Gaine, 2017). He noted that understanding more about cooperative learning can help to create a positive social experience in the classroom. Johnson (2022) suggest that in order to effectively implement cooperative learning into a classroom, teachers must: First, understand what cooperative learning is and how it differs from competitive and individualistic learning. Second, they [teachers] must be confident that using cooperative learning is the most effective thing to do. Third, faculty must realize that simply planting students in discussion groups will not magically produce these outcomes. Fourth, faculty must know that there are many different ways to use cooperative learning. Finally, what is good for students is even better for faculty

Robertson (2019) reported cooperative learning as a viable and effective instructional methodology for teaching and learning mathematics. It helps to make mathematics exciting

and enjoyable for both students and teachers. Cooperative strategies can be integrated at any grade level and for any mathematics topic. Students learn to cooperate with others and to communicate in the language of mathematics. The classroom atmosphere tends to be relaxed and informal, help is readily available, questions are freely asked and answered and even the shy students find it easy to be relaxed. Many students maintain a high level of interest in the mathematics activities and have an opportunity to pursue the more challenging and creative aspects of mathematics.

Several studies have examined the effects of cooperative learning methods on student learning. Humphreys et al, (1982) compared cooperative, competitive and individualistic strategies in science classes and found that students taught by cooperative methods learned and retained significantly more information than students taught by the other two methods.

In developed countries, cooperative learning technique enables learners to learn from each other and gain important interpersonal skills (Murray, 2011). The goals of cooperative learning are to enhance learners' learning and to develop their social skills like decision-making, conflict management and communication skills (Eslamian, 2012). This teaching strategy provides opportunities for higher order thinking as opposed to passive listening, reinforces listening to others and gives opportunity for immediate feedback and adjustment of thought (Eslamian et al., 2012). Learners assist each other in understanding material/content and this may even help them broaden their perspectives on issues. Often learners assess the ideas of peers, determine whether they "fit" their own, whether they disagree, or partially agree, resulting in an opportunity for better formulation of their own ideas. Some learners often say, "I didn't think of that" or "That's a different slant". Thus, learners talking together provide for input and listening which improves performance.

In developed countries, cooperative learning is considered one of the modern educational methods that call for linking the school reality because it is based on the formation of a coherent, heterogeneous group that can be organized into small workgroups as it fulfils the students' psychological needs on the one hand and communicates the content of the material to them on the other hand (Abu, 2000). Besides, learners can practice two types of activities: innovative activities that stimulate students' motivation for interaction and cognitive activities. Their mission is to acquire knowledge for students and teach them facts and laws. This method also increases the effectiveness of education, especially for students.

Problem Statement

The poor performance as reflected by Examination results in Mathematics has continued to trigger a lot of concern among educationists and other stakeholders nationally. This poor performance in Mathematics among other factors is likely to undermine the attainment of the projected goals as envisaged in the vision 2030 development strategic plan. The teaching method is a crucial factor that may affect student's participation in the learning process, motivation and consequently achievement. The use of traditional methods of teaching have been cited as one of the major contribution to mass failures of students in mathematics. In attempt to address this issue, the present study explored the effects of cooperative learning approach on the academic achievement in mathematics.

Several studies have examined the effects of cooperative learning methods on student learning. Humphreys et al, (1982) compared cooperative, competitive and individualistic strategies in science classes and found that students taught by cooperative methods learned and retained significantly more information than students taught by the other two methods.

This method of teaching has not been tried out in mathematics and learning in Karongi District where performance in the subject has continued to decline. This study aimed at finding out the effect of cooperative learning approach in the teaching of mathematics in the district. The use of cooperative learning approach in teaching mathematics is likely to help improve the student's academic achievement. The available research does not indicate any research in the effect of cooperative learning approach in secondary mathematics in Karongi district. This study is therefore intended to fill this gap in the body of knowledge

This study sought to achieve the following research hypothesis:

H_{O1}: There is no significance effect between jigsaw of cooperative and performance of Mathematics students in public secondary schools in Karongi District.

LITERATURE REVIEW

Cooperative learning is a set of teaching strategies used to promote face-to-face interaction among students and help them reach specific learning and inter-personal goals in structured groups (Slavin, 1997) Cooperative learning strategies may be informal groupings that allow students to work together. They may be structured, with students having specific tasks in their group and assessing their group and individual performance. while cooperative learning groups generally involves four members, the number of students may be greater or fewer. Groups may work together for a few minutes, a couple of weeks or for many months.

Johnson and Johnson (1994) described three types of cooperative learning groups: Cooperative base, informal cooperative learning and formal cooperative learning groups. Cooperative base groups are long-term heterogenous learning groups with stable membership (Richards and Rodgers 2001) which may last an year or more. This type of grouping is established to provide support, encouragement and assistance among the students to achieve academic goals. The students in those groups are also responsible to check their team member's attendance to lesson and completion of assignments. They may also discuss their personal problems in learning

Theoretical Review

This study draws upon the theory of social constructivism. Vygotsky (1986) as cited in Cobb (2005) argues that a key factor in social constructivism is that the children's development is enhanced by participating in activities that are slightly above their level of competence with mastery occurring as a result of help from others; which is enhanced as students are given opportunities to teach each other and practice in a social context.

Vygotsky (1978) maintains that learning is a social process in which students actively participate and contribute with ideas and arguments. Learners, who solve problems in groups, if structured effectively, gain better understanding and achieve better results than learners who work individually. This technique also allows learners to take responsibility for their own learning. It is claimed that during group work learners achieve far more than they would when working individually (Cooper, 2010). Interactions among students are crucial to cooperative learning and it is the interactions that occur in the groups that help to inspire the learning motivation (Cobb, 2005).

Vygotsky (1978) believes that knowledge is constructed using prior-knowledge, through language as well as experiences, beliefs and culture, in this way meaningful learning has to take place. Vygotsky also explains that the learner is capable of constructing new knowledge with the help of others who are more knowledgeable. This means that learners learn best through interacting with their peers, teachers and others. Therefore, constructivism is an

approach to teaching and learning which emphasises that learning is both an individual and social process. Cooper (2010) maintained that Vygotsky's theory is possibly the most useful theoretical framework if one wants to study learning in small groups and concluded that Mathematics educators should encourage small group work in their teaching.

METHODOLOGY

This study evaluated the effect of cooperative learning on student's performance in mathematics in public secondary schools of Karongi in Rwanda. For this study, the population was formed by public secondary school teachers from 6 public secondary schools offering general education in Karongi District of Rwanda. The study targeted those six schools because they are more affected with a big percentage of enrollment rate of students. Thus, the study targeted students, deans of studies, head teachers and teachers from those six selected schools. Besides, the research targeted secondary school Mathematics teachers since the study was to assess the effect of teaching methods on performance of Mathematics in public secondary schools in Karongi District. Science/Mathematics students of senior 4,5 and 6 was targeted because they have better knowledge and experience about their schools' teaching and learning methods compared to other students in their respective schools

Table 1: Table Showing Size of Population of Selected Schools

Schools	Number of Teachers	Number of Dean of Studies	Number of Head Teacher	Number of Students	Total Population
ES Bwishyura	4	1	1	138	144
GS Nyegabo	3	1	1	121	126
GS Kibuye	5	1	1	98	105
GS Nyamarebe	6	1	1	162	170
GS Nyabikenke	2	1	1	139	142
GS Rurangwe	2	1	1	125	129
Total	**22**	**6**	**6**	**783**	**817**

Source: Karongi District Report, 2022

Stratified sampling, purposive sampling and simple random sampling were used in this study. Stratified sampling was used to select a sample of 6 schools from other public secondary schools. The aim was to ensure that all schools in the region were represented in the study. Schools were stratified or clustered and then one school was randomly selected. The headteacher of the sampled schools were purposively selected to participate in the study. A simple random sampling method was also used to select mathematics teachers and pupils in grades 4, 5 and 6, i.e. 783 pupils from the sample of schools.

In addition, the study used the following formula proposed by Yamane (1973) to determine the sample size, as it is too large to waste scarce resources and may expose more participants than necessary to risk.

$$n = \frac{N}{1 + (N)(e^2)}$$

Where:

n = sample size
N = the population size
e = the acceptable sampling error (5%) at 95% confidence level
Thus; $n = 817/ (1+817) (0.05)^2$
n=272.3=272 respondents

A sample of 272 respondents was targeted to participate in this study. This formula was used to estimate a representative sample. A total number of 272 respondents was taken as simple size. The following is the table showing sample size for each category of five selected schools:

Table 2: Table Representing a Sample Size

Schools	Number of Teachers (Mathematics)	Number of Dean of Studies	Number of Head Teacher	Number of Students	Sample Size
ES Bwishyura	2	1	1	44	48
GS Nyegabo	1	1	1	40	43
GS Kibuye	2	1	1	30	34
GS Nyamarebe	3	1	1	53	58
GS Nyabikenke	1	1	1	44	47
GS Rurangwe	1	1	1	39	42
Total	**10**	**6**	**6**	**250**	**272**

Source: Researcher, 2023

In this study the researcher used interviews, questionnaires, and documentary review. Closed – ended questions were used where the answers were divided into categories such discrete, distinct and relatively few in number. It is easier for respondents to answer because they had only to choose categories. In that way a chance for irrelevant answers is limited to the minimum, because appropriate answer categories were provided. The main respondents were being teachers that was given the questionnaire as they were enough time to respond to the questions based on specific objectives. Questionnaires were given to Mathematics teachers, dean of studies and students from senior 4, 5 and 6.

The study involved oral questions based on the use of interview guides. This was a flexible way, because questions were both open and closed ended. This method helped the interviewer to collect supplementary information about the respondents as well as the researcher probed for more specific answers while at the same time helping the researcher to repeat a question when the response indicated that the respondent misunderstands the question

Interview guides were used to head teachers. The respondents were requested to answer questions, and the researcher used semi-structure interview questions which enabled the researcher to ask broad questions in any order considered appropriate. Also, questions gave the respondents room to answer freely and amplify the responses. The respondents were interviewed at their perspective school.

FINDINGS AND DISCUSSION

In this study the research sampled Mathematics teachers, headteachers, and science/Mathematics students of senior 4,5 and 6 because they have better knowledge and experience about their schools'

teaching and learning practices compared to other students in their respective schools. Table 3 shows the return rate of respondents.

Table 3: Response Rate

Respondents	Targeted	Obtained	Response Rate (%)
Head Teachers	6	6	100
Teachers of Mathematics	16	12	75
Students	250	212	84.4
Total	**272**	**230**	**84.5**

Source: Primary Data, 2023

As shown in table 3, from the targeted respondents, four questionnaires from teachers and 38 questionnaires from students were not returned, so the participation rate was reduced to 12 (75%) of the teachers and 212 (84.4%) of the students. Regarding headteachers, the study sampled 6 school headteachers from 6 secondary schools and 6 of them interviewed; therefore, the response rate was 100%. Overall, the response rate of respondents was 84.5%.

Descriptive Statistics

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In this research the study attempted to determine the effect of cooperative learning method on academic performance of mathematics subject in public day schools in Karongi District in Rwanda. The respondents were asked to rate the statements by indicating the extent to which they apply to their organization in 5-point Likert scale as shown on: 5. Strongly Agree (SA), 4Agree (A), 3. Neutral (N), 2. Disagree (D) and 1. Strongly Disagree (SD). Besides, the mean and deviation were used for interpretation of the findings where mean (M) is the average of group of scores and it is sensitive to extreme score when the population samples are small. Moreover, the standard deviation (SD) was also used to measure the variability in those statistics as it shows how much variation is there from the average (mean).

Table 4: Cooperative Learning and Performance of Mathematics Students

Statements	Mean	Std Dev
Cooperative learning provides students with a sense of confidence that they can solve math problems.	4.3	.87
This method often works best if the team members are not of the same level in mathematics	4.0	.79
This method contributes to the discussion with students in planning the solution of arithmetic problems	4.3	.91
Students are more willing to ask questions and take risks in small groups	4.0	.46
Students are often able to explain things to each other in ways that make more sense than the teacher's original explanation.	4.1	.80
Students are taught arithmetic in a free-thinking atmosphere through cooperative learning and this help students to learn more when they invest in math discourse	4.3	.87

Source: Field Research, 2023

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As shown in Table 3, the results relate to the six statements assessing the effect of cooperative learning method on the performance of Mathematics students in public secondary schools in Karongi District. The results show that for the first statement, the majority of respondents strongly agreed that cooperative learning provides students with a sense of confidence that they can solve math problems, with a mean value of 4.3, and a high positive correlation standard deviation of 0.87. The second statement asked respondents whether this method often works best if the team members are not of the same level in mathematics. The results showed that the majority of respondents strongly agreed with this statement (M=4.0, SD=0.79). For the third statement, this method contributes to the discussion with students in planning the solution of arithmetic problems, the majority of respondents agreed with this statement, with a mean of 4.3 and a very positive and low standard deviation correlation (0.91). The fourth statement asked whether students are more willing to ask questions and take risks in small groups. Respondents strongly agreed with this statement, with an average mean of 4.0 and a very strong positive standard correlation of 0.46. The next item was whether Students are often able to explain things to each other in ways that make more sense than the teacher's original explanation. The majority of them strongly agreed that statement with a mean of 4.1 and standard deviation of 0.80. On the last statement respondents were asked if students are taught arithmetic in a free-thinking atmosphere through cooperative learning and this help student to learn more when they invest in math discourse (M=4.3, SD=0.87). From the results, it implies that the majority of respondents strongly agreed and agreed that all of the above are key elements of cooperative learning method used in their six selected schools and have an effect on performance in Mathematics students in public secondary schools in Karongi District

Correlation Analysis

The findings of the correlations between the independent variables and the dependent variables are summarized and presented in Table 4

Table 4: Correlation Analysis Cooperative Learning and Performance of Mathematics

		Cooperative Learning Method	Performance of Mathematics Students
Cooperative learning method	Pearson Correlation	1	
	Sig. (2-tailed)		
	N	230	
Performance of Mathematics students	Pearson Correlation	.611**	1
	Sig. (2-tailed)	.000	
	N	230	230

**. Correlation is significant at the 0.01 level (2-tailed).

According to the findings reported in Table 4, the Pearson correlation analysis showed that cooperative learning method (r=0.611, p=0.000) is positively and significantly related to performance of Mathematics students in public secondary Schools in Karongi District. The correlation was deemed to be statistically significant since the p-value was less than 5%.

The findings therefore the correlation analysis showed that there is a positive and statistically significant relationship between cooperative learning method and performance of Mathematics students in the six sampled public day schools in Karongi District.

The model specification for student Performance in Mathematics establishes that jigsaw of cooperative learning method has a positive effect on Performance of Mathematics students in

Secondary Schools in public day schools in Karongi District and the relationship is statistically significant (p=>0.05).

These findings were supported Al-Heela (2016) who indicates that cooperative learning is considered one of the teaching methods advocated by the contemporary educational movement after research and studies have proven their effectiveness and positive role in raising learners' academic achievement and developing teamwork skills have the greatest impact on their daily lives. Besides, a study by Zakaria (2010) also found that cooperative learning improves students' achievement in Mathematics. Further, cooperative learning is an effective approach that mathematics teachers need to incorporate into their teaching. Cooperative learning promotes deep learning of materials and helps students to achieve better grades.

Multiple Regression

A multiple regression analysis was performed in this study to identify the predictor and its contribution towards the criterion. It aims to determine the prediction of a single dependent variable from a group of independent variables. The multiple regression analysis was performed with all the assumptions complied with. The study would like to test the following hypothesis:

H_1: There is no significant effect between cooperative learning method and performance of Mathematics students in Secondary Schools in public day schools in Karongi District

Table 5: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.848a	.719	.708	.48113

a. Predictors: (Constant),cooperative learning method

The R-squared shows the variation in the dependent variable that can be explained by the independent variables being studied. The R-squared in this study was 0.719, which implies that the independent variable can explicate 71.9% of the dependent variable whereas the remaining 29.1% variation is explained by other factors which are not included in the model.

Table 6: Significance of Independent Variable

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	156.849	3	52.283	164.885	.000[b]
	Residual	57.710	182	.317		
	Total	**214.559**	**185**			

a. Dependent Variable: performance of mathematics students
b. Predictors: (Constant), cooperative learning method

The Table 6 above indicated standard regression which provides the effect of individual predictor variables. Analysis of variance was carried out on the regression model and the results are as presented in Table 6 above. The findings above show that the F-critical (164.885), which shows that the model can be used in predicting the effect of the independent variables on the dependent variable. The results on the analysis of the variance (ANOVA) indicate that the overall model was statistically significant at 95% confidence level.

Discussion

From the findings, the study found that cooperative learning method affects performance of Mathematics students, as this method provides students with a sense of confidence that they can solve math problems, when this method often works best if the team members are not of the same level in mathematics, it contributes to the discussion with students in planning the solution of arithmetic problems, when students are more willing to ask questions and take risks in small groups, when students are often able to explain things to each other in ways that make more sense than the teacher's original explanation and when students are taught arithmetic in a free-thinking atmosphere through cooperative learning and this help students to learn more when they invest in math discourse.

The interview data gathered the views of the participants on the effect of cooperative learning method on the performance of the students in Mathematics subject in Karongi District.

The head teachers and District Education Officer (DEO) of Karongi District have interviewed. The findings from the interview showed that all respondents unanimously agree that there is a strong correlation between cooperative method of learning and the performance of students in the Mathematics subject.

One of them expressing his views by stated that:

> *"Here in my school, jigsaw cooperative learning method is used in classroom as it is beneficial for all students because it promotes self-guided learning in which each student takes ownership while working as part of a team. This method encourages students to communicate with peers in harmony. In this way, cooperative learning promotes values such as honesty, cooperation, mutual respect, responsibility, tolerance, and willing to sacrifice a consensus. Execution of duties in cooperative learning can develop self-confidence in pupils "(20th November, 2023).*

The DEO also observed that criticized the lecture method use by teachers because only hardworking students can benefit from it. Therefore, to enhance the understanding of mathematics, students must be more active in the classroom and must creatively acquire knowledge, especially in understanding and solving mathematical problems.

These findings are relevant with Topping (2011) who pointed out that cooperative learning technique enables learners to learn from each other and gain important interpersonal skills. The goals of cooperative learning are to enhance learners' learning and to develop their social skills like decision-making, conflict management and communication skills. This teaching strategy provides opportunities for higher order thinking as opposed to passive listening, reinforces listening to others and gives opportunity for immediate feedback and adjustment of thought.

Therefore, the researcher can conclude by saying that the research hypothesis was tested; verified and then it is rejected referring to the statistical (regression analysis) findings and then according to the research, the correlation of 71.9% categorized as positive and very high correlation; this leads to confirm that there is significant relationship between accounting automation and performance of financial institutions.

Conclusion

Based on the findings of this study, it was concluded that cooperative learning method affects students' academic performance in those six selected schools in Karongi District as this method study. The students in Jigsaw group had higher participation in the process of learning than

students in the comparison group. Cooperative learning also enhances understanding and self-confidence. These results would imply that incorporating cooperative learning in the mathematics classroom would enhance the learning of mathematics in secondary schools.

It was recommended that to promote the implementation of cooperative learning method effectively, Mathematics teachers should attend seminars, workshops and conferences that Jigsaw strategy of cooperative learning approach form part of their main themes, also teachers of mathematics should use Jigsaw learning method in teaching mathematics in order to enhance positive attitude to improve the academic achievement of the student in secondary schools specially in Karongi District.

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