Effect of Classroom Learning Environment on Students' Academic Performance of Mathematics Subject in Public Day Schools in Rwanda: A Case of Musanze District, Rwanda

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Abstract:
This study aimed to determine the effect of classroom learning environment on students' academic performance in Mathematics subject in public day Schools in Rwanda: A case of Musanze district. The study has a correlational research design, with both quantitative and qualitative research. The target population of the study consisted of education officers in the area, including students, teachers and school headmasters. Therefore, the total number of population was 1,600. A sample size of 320 respondents was selected using random sampling techniques. Quantitative data were analyzed using descriptive statistics. Qualitative data were analyzed using content analysis. Data analysis was supported by Statistical Package for the Social Sciences (SPSS) version 21. Pearson correlation analysis showed that the classroom learning environment ($r=0.714$, $p=0.000$) was positively and significantly correlated with students' academic performance. This correlation was also statistically significant as the p-value was less than 5%. In conclusion, the study provided recommendations to improve students' academic performance. The study recommends that the management of schools should frequently visit classrooms to assess participation, involvement, and understanding of the students and offer support to those teachers who lack the competencies required to improve the learning situation and environment in mathematics classrooms due to the size of the class.

Keywords: Classroom seating arrangement, students' academic performance and mathematics

1. Introduction

The teaching-learning process cannot take place in a vacuum. In formal education settings, it occurs as a result of interaction among members of the classroom. In classroom settings, elements of the teaching-learning process include: teachers, students, content, learning process and learning situation. The learning situation or learning environment means the conditions in which learning takes place. Each classroom has unique teaching-learning conditions. According to Arend (2007), classes may seem similar from a distance but are different in their procedures and processes.

A classroom setting has two major components, namely, the physical component and the human component. The physical component comprises all the physical objects present in the classroom, e.g. black board, furniture, lighting, projector, books, computers, etc., whereas the human component comprises individuals, i.e., teachers and students in the classroom. It generally involves the nature of the interaction of teachers with students and student-student as well. This pattern of interaction generates a particular atmosphere, which may be called a learning condition/situation/environment. This aspect is also called the psycho-social environment of the classroom. Most scholars agree that students' academic achievement varies with learning conditions. Therefore, this study was designed to investigate the effect of students' perception of the classroom learning environment on their academic achievement in mathematics at the secondary level.

The importance of Mathematics cannot be denied in this age of science and technology. The knowledge of mathematics proved to be an essential vehicle to train the minds of the learners to think logically, objectively and reasonably in solving day-to-day problems. Mathematics is different from other social science subjects because, according to Sharan (2006), mathematics is the study of an abstract system that deals with abstract elements. These elements are not described in a concrete fashion. Teaching and learning mathematics requires a proper attitude and deep thinking from the students in terms of their learning styles, as well as the teacher's knowledge and behavior in the classroom. It is often said that a better environment in a class helps during group work and hence improves the learning of the students.

Fraser (1986) divides the classroom learning environment into four major components, which include physical things, the social interaction among its members, the characteristics of its members and systems, values, cognitive structures, etc., so a classroom learning environment can be explained with reference to either physical or social aspects. This study considers only the social aspects of the classroom learning environment, which includes teacher's behavior and students' behavior (both verbal and non-verbal communications), teaching and learning methodologies, teachers' classroom management practices, teaching and learning styles, attitudes, personality traits, beliefs, group dynamics, socio-

economic status of the students, cultural diversity of the classroom called its social component of the classroom environment.

Empirical studies on the classroom environment revealed that the physical arrangement of the classroom has a significant role in the teaching-learning process. It can affect the performance of both the teachers and the students. Anderson & Walberg (2013) found that the school environment, as portrayed in the design, desks' arrangement and book availability in the classroom are firmly associated with the performance of learners in English language. Baker, Grant, and Morlock (2018) reported that classrooms with large class sizes pose a difficult condition for students to focus and, therefore, minimize the duration teachers can use in actual instruction of learners. Randhawa and Lewis (2016) reported that crowds within a classroom delay the teaching-learning process. This is because the teacher may not find it easy to move around the classroom to offer individualized attention to some students sitting in the rare angles of the classroom. Adequate and sufficient arrangement of the classroom environment plays a significant role in enabling the instructional process to be more effective and establishes an optimum atmosphere for both learners and teachers (Hall, 2012).

2. Problem Statement

In fulfilling Education for All, the government of Rwanda has struggled to increase the number of secondary schools. At least each ward has a secondary school, which is a good deal indeed. This aimed to provide an opportunity for students who completed standard seven to join the university. The number of students enrolled in those schools was big compared to the available classrooms and the number of teachers employed to teach them. This has resulted in many students being put in one class so that they can all be taught by few teachers available in schools (MINEDUC, 2022).

The Rwandan education system places significant emphasis on mathematics as a foundational subject for students pursuing careers in science and technology. Despite this, students have encountered persistent challenges in achieving success in mathematics. To address this issue, a research project investigated the link between class attendance and academic performance in mathematics within Rwandan public secondary schools. Additionally, the study aimed to identify factors influencing class attendance and assess interventions to enhance attendance.

The learning environment, especially the classes, seems to be forgotten as one of the important factors in accelerating students' academic performance (Jackbos, 2017). It should be noted that students need a free and conducive environment to make their learning easier. A teacher is likely to attend to students' problems timely when there are few students in the class. However, in the case of a big class, it is very difficult for a teacher to deal with students' concerns and manage assignments for Mathematics subject. Besides, the effectiveness of any teacher is measured by the student's high academic performance. Likewise, effective teaching lies in smooth management routines of discipline problems, careful planning, giving supportive and positive feedback to students, and helping them figure out the right answer if they are wrong but on the right track. In short, an effective school and classroom can be described as a place that naturally motivates students to learn (Hall, 2012). Mathematics needs consistency in logical and abstract thinking in carrying out complex tasks and activities, which demands self-determination and self-confidence. It is often observed that students with low achievement scores attribute their failure to luck or chance, whereas students with high self-confidence attribute their success to hard work. Therefore, the researcher conducted the study aimed to examine the effect of students' perception of the classroom learning environment and its effect on academic achievements in Mathematics at the secondary level.

The main objective of this study is to analyze the effect of the physical environment of classrooms on students' academic performance in Mathematics in public day schools in Musanze District.

3. Research Hypothesis

This study sought to achieve the following research hypothesis:

H_{o1}: There is no significant relationship between classroom learning environment and academic students 'academic performance in mathematics in public day schools in Musanze District.

4. Method

For this study, a descriptive design was used to find out the current class size in secondary schools in Musanze District. The descriptive design really enabled the researcher to study the effect of class size on student's academic performance in mathematics in public day schools in Rwanda, a case in Musanze District. This study targeted five public day schools from Musanze sector: GS Muhoza I, GS Muhoza II, GS Kabaya, GS Cyagarura and GS Busogo I. The target population for this study was the educational practitioners in the district, who include Students, teachers, head teachers and Sector Education officers in the district who teach, which sums to a total of 1600 participants. The table below gives details of the target population.

Schools	Number of Teachers	Sector Education Officers	Number of Head Teachers	Number of Students	Total Population
GS Muhoza I	10	-	1	338	354
GS Muhoza II	11	-	1	321	332
GS Kabaya	11	-	1	398	415
GS Cyabagarura	11	-	1	390	408
GS Busogo I	7	-	1	347	411
Total	50	5	5	1540	1600

Table 1: Size of Population of Selected Schools
Source: Musanze District Report, 2023

The researcher used simple random sampling to select the schools and head teachers, teachers, students and Sector Education officers. It was used to select a representative sample from each of the parties that were used in the study. This research is composed of 1600 people as the study population, whereby sample size is found by using the Yamane formula (1973).

Where:

n is the sample size,

N is the population size, and

e is the marginal error of 5% through the level of confidence of 95%.

Thus, this formula is applied to the above sample

$n = \frac{N}{1+N(e)^2}$ Therefore, $n = \frac{1600}{1+1600(0.05)^2} = 320$

N: The total population under the study was 1600 and

n: sample is 320

A carefully constructed questionnaire and written interview guide were used to compare the written and oral responses of key informants, including students, school principals, sector education staff and teachers. Scheduled interviews are semi-structured face-to-face interviews that allow the researcher to elicit additional information from participants.

To come up with valid data, the researcher took some measures aimed at enhancing the validity of the research results. Questionnaires and interview guides were prepared and given to the research supervisor, together with the university lecturer, who ascertained that the instruments aligned with the research questions and were properly structured. The consistency with which questionnaire items in this study were answered and determined through the test re-test method at two different times. The questionnaire was used during the piloting of the research to estimate the degree of repeated measures of accuracy of the same concept. Since the reliability of research is influenced by random error, the researcher avoided ambiguous instructions.

The Likert scales, which were mainly used in the closed-ended questions, were implemented in the development of numerical codes ranging from a point scale of 1 to 5. This aimed at showing the magnitude of the constructs tested in the study. The codes were then analyzed using a computer program of the 21.0 version of the Statistical Package for Social Sciences (SPSS).

Mixed methods were used so that the study could relate qualitative data to quantitative data. Inferential statistical methods, as well as descriptive methods, were used in analyzing the data. Means and standard deviations were used in the descriptive analysis to describe the population characteristics. However, Pearson's chi-square was used in the inferential statistics to determine the correlation between the study variables. The significance of the model was also tested using ANOVA (analysis of variance).

5. Findings and Discussion of Findings

In this study, the research sampled biology teachers, headteachers, and science/biology students of senior 4, 5 and 6 because they have better knowledge and experience about their schools' teaching and learning practices than other students in their respective schools.

Respondents	Targeted	Obtained	Response Rate (%)
Headteachers	5	5	100
Teachers	8	8	100
Sector education officer	1	1	100
Students	306	250	81.6
Total	320	264	82.5

Table 2: Response Rate
Source: Field Research, 2023

As shown in table 2, from the targeted respondents, four questionnaires from teachers and 56 questionnaires from students were not returned, so the participation rate was reduced to 12 (75%) of the teachers and 250 (81.6%) of

the students. Regarding headteachers, the study sampled 5 school headteachers from 5 secondary schools and they were interviewed; therefore, the response rate was 100%. Overall, the response rate of respondents was 82.5%.

5.1. Descriptive Statistics

The research work was conducted on the effect of classroom learning environment on students' academic performance in Mathematics subject in public day Schools in Rwanda: A case of Musanze district. This section deals with the presentation and analysis of the research data and discussion of findings. These are presented in tables following the sequence of the specific research problem.

5.1.1. Effect of Classroom Learning Environment on Academic Performance of Mathematics Subject

Table 3 provides the opinions of respondents related to the third research objective by showing the extent to which the classroom learning environment affects the academic performance of mathematics subject in public day schools in Rwanda.

Statements	Mean	Std Dev
Classroom interaction is a fundamental component in the mathematics teaching and learning process	4.33	.84
The classroom learning environment is a very important factor in encouraging the students' motivation to learn Mathematics	4.40	.78
Effective learning of mathematics is directly associated with the teacher's ability to establish constructive and critical classroom interaction in the learning environment.	4.42	.76
A conducive Mathematics learning environment provides attractiveness to the learning procedure or process.	4.46	.75
Classroom interaction is regarded as one of the indispensable and influencing variables in mathematics learning environments.	4.28	.72

Table 3: Respondents' Perception of Classroom Learning Environment
Source: Field Research, 2023
Key: D=Disagree, N=Neutral, A=Agree, SA=Strongly Agree, M=Mean, Std=Standard Deviation

Table 3 shows the respondents' perceptions on the effect of classroom learning environment affects academic performance of mathematics subject in public day schools in Rwanda. For the first item, seeking whether classroom interaction is a fundamental component in the mathematics teaching and learning process, the respondents agreed with a mean of 4.33 and a very high positive correlation standard deviation of 0.84. This implied that the respondents acknowledged the importance of small class sizes while learning Mathematics. The second item is whether the classroom learning environment is a very important factor in encouraging the students 'motivation to learn mathematics. The respondents strongly agreed with a mean of 4.40 and a very high positive correlation standard deviation of 0.78. On the third item, the respondents were asked whether effective learning of mathematics is directly associated with the teacher's ability to establish constructive and critical classroom interaction in the learning environment. The respondents agreed with a mean of 4.42 and a standard deviation of 0.76. This means that in learning mathematics, the teacher's ability plays a big role in interaction in bid class size.

Moreover, on whether a conducive Mathematics subject learning environment provides attractiveness to the learning procedure or process, the respondents agreed with a mean of 4.46 and 0.75 of standard correlation. Finally, on whether classroom interaction is regarded as one of the indispensable and influencing variables in mathematics learning environments, the majority of respondents strongly agreed with a mean of 4.28 and a very high positive correlation standard correlation of 0.72. The mean scores for all the items related to the classroom learning environment ranged from 4.28 to 4.46. Therefore, this means that the majority of respondents strongly agreed that all the above-mentioned items are key components of the classroom learning environment in sampled public day schools in Rwanda. The analysis also showed that a high standard deviation spread from 0.72 to 1.01 implies that respondents were more varied in their opinions of the responses in the classroom learning environment.
D=Disagree, N=Neutral, A=Agree, SA=Strongly Agree, M=Mean, Std=Standard deviation

5.2. Discussion of Findings

From the findings, the study revealed that the classroom learning environment affects the academic performance of mathematics in public day schools in Rwanda. Classroom interaction is a fundamental component in the mathematics teaching and learning process. The classroom learning environment is a very important factor in encouraging the student's motivation to learn mathematics. Effective learning of mathematics is directly associated with the teacher's ability to establish constructive and critical classroom interaction in the learning environment. A conducive mathematics learning environment provides attractiveness to the learning procedure or process, and classroom interaction is regarded as one of the indispensable and influencing variables in mathematics learning environments.

These findings are supported by Hall (2012), who stated that it is only in the best environmental setting that the most effective learning takes place. The improvement of the environment no doubt lies in the hands of the teachers. The teachers can suggest a lighting environment in the classroom, as defective lighting, poor ventilation arrangements and a crowded environment lead to overheated conditions, which reduce working capacity and encourage the spread of respiratory infection.

During the interview with the sector education officer on point regarding classroom learning environment and academic performance of students, he observed that:

"The teaching-learning process cannot take place in a vacuum. In formal education settings, it occurs as a result of interaction among members of the classroom. In classroom settings, elements of the teaching-learning process include: teachers, students, content, learning process and learning situation. The learning situation or learning environment means the conditions in which learning takes place. Each classroom has unique teaching-learning conditions. Classes may seem similar from a distance but are different in their procedures and processes."

Headteacher C concurred with the Sector Education Officer, stating that a classroom setting has two major components, namely, the physical component and the human component. The physical component comprises all the physical objects present in the classroom, e.g. black board, furniture, lighting, projector, books, computers, etc., whereas the human component comprises individuals, i.e., teachers and students in the classroom. It generally involves the nature of the interaction of teachers with students and student-student as well. This pattern of interaction generates a particular atmosphere, which may be called a learning condition/situation/environment. This aspect is also called the psycho-social environment of the classroom. Most scholars agree that students' academic achievement varies with learning conditions. Another headteacher reported:

"The physical ambience of the school learning environment has a variety of effects on teachers, students and the learning process. As a result, poor lighting, noise, high levels of carbon (IV) oxide (CO_2), carbon (II) oxide (CO), inconsistent temperatures, and more frustrate the teaching and learning outcomes of mathematics lessons. Again, poor maintenance of the school facilities and unconducive ventilation system leads to poor health conditions among teachers and students, thus manifesting in poor mathematics academic performance and higher absentee rates."

These findings are relevant since Walberg (2014) investigated the relationship between the school's physical environment and students' academic performance in science-related subjects in Kano State Senior Secondary Schools. The result obtained also showed a significant relationship between the school's physical environment and science students' academic performance. This, therefore, translates to the fact that good school facilities and a good school learning environment stimulate teachers' efforts, invigorate, empower and even encourage them to pursue their assignments to logical conclusions most, if not all the time.

5.2.1. Multiple Regression

A multiple regression analysis was performed in this section 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 hypotheses.

- H_{01}: There is no significant relationship between classroom learning environment and academic students' academic performance in mathematics in public day schools in Musanze District.

The results of the multiple regression are presented in the tables that follow.

	Model	Sum of Squares	df	Mean Square	F	Sig.
1	Regression	12.073	3	4.024	54.372	.000[b]
	Residual	5.033	68	.044		
	Total	17.107	71			
a. Dependent Variable: Performance						
b. Predictors: (Constant), classroom learning environment						

Table 4: Significance of Independent Variables
Source: Field Research, 2023

Table 4 indicates standard regression, which provides the effect of individual predictor variables. This variable is the classroom learning environment. The table shows the output analysis and whether there is a statistically significant difference in the group mean. As seen, the significance value is 0.00 and the mean is 0.044, which is below 0.05. Therefore, there is a statistically significant difference in the mean length of the model.

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.000	.230		4.354	.000
	Classroom learning environment	.382	.094	.499	4.088	.000
Dependent variable: Students' academic performance						

Table 5: Regression Coefficients and Significance of the Independent Variable
Source: Field Research, 2023

Table 5 above indicates that Kernel of regression analysis in which Y=A+BX. The classroom learning environment is constant, and it has unstandardized coefficients B equal to 1.000 when it is constant. The Std error is 0.230. Thus, according to Kernel formula, which is equal to $Y=1.000+0.382X_1+\varepsilon$, it is effective and the efficiency of students' academic performance is the dependent variable.

5.2.2. Relationship between Classroom Learning Environment and Students' Academic Performance

The purpose of this section is to find if there is a relationship between classroom learning environment and students' academic performance in public secondary schools in Musanze District where the statistical (numeric) data allow the researcher to highlight the direct relationship between variables, as follows:

		Classroom Learning Environment	Students' Academic Performance
Classroom Learning Environment	Pearson Correlation	1	
	Sig. (2-Tailed)		
	N	250	
Students' Academic Performance	Pearson Correlation	.794**	1
	Sig. (2-Tailed)	.000	
	N	250	250
**. Correlation Is Significant At The 0.01 Level (2-Tailed).			

Table 6: Correlation Analysis between Independent and Dependent Variable

The variation of Spearman Coefficient correlation is between -1 and 1. Spearman Coefficient correlation is significant when it is equal to or greater than 0.01 level. According to the research, the correlation is 0.714 (71.4%), which is a positive and very high correlation. As the significant level is at 0.01 (1%), the p-value of 0.000 (i.e. 0.0%) is less than 1%. This confirms that there is a significant relationship between the classroom learning environment with its observed indicator (factor) and students' academic performance in five selected public secondary schools in Musanze District.

6. Conclusion

From the findings of this study, the study concluded that the classroom learning environment affects the academic performance of mathematics in public day schools in Rwanda. Classroom interaction is a fundamental component in the mathematics teaching and learning process. The classroom learning environment is a very important factor in encouraging the students' motivation to learn mathematics. Effective learning of mathematics is directly associated with the teacher's ability to establish constructive and critical classroom interaction in the learning environment. A conducive mathematics learning environment provides attractiveness to the learning procedure or process, and classroom interaction is regarded as one of the indispensable and influencing variables in mathematics learning environments. In addition, findings indicated that the classroom learning environment (r=0.714, p=0.000) is positively and significantly related to students' academic performance. The correlation was deemed to be statistically significant since the p-value was less than 5%.

In light of the conclusions drawn, the researcher offers several recommendations for various stakeholders in the Rwandan education system. The study recommends that to avert the problem of declining pupils' academic performance in schools, the government and other stakeholders should invent new policies and strategies to improve the school environment. However, the management of schools should frequently visit classrooms to assess participation, involvement, and understanding of the students and offer support to those teachers who lack the competencies required to improve the learning situation and environment in mathematics classrooms due to the size of the class.

7. References

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