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TEACHER COLLABORATION AND STUDENTS' ACADEMIC PERFORMANCE IN MATHEMATICS SUBJECT IN PUBLIC SECONDARY SCHOOL IN RWANDA A CASE OF GATSIBO DISTRICT

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Abstract: This research examines how teacher cooperation influences the scholastic achievement of students in mathematics at state secondary schools. The specific objectives were to identify the attributes of collaboration present among teachers to enhance students' academic performance in mathematics subjects, to assess the academic achievement of students in mathematics subjects, resulting from the collaboration among teachers, and to determine the correlation between teachers' cooperation and students' achievement in mathematics disciplines in Rwanda. The targeted population consisted of 188 students, 45 teachers, 7 head teachers, and 13 deputy head teachers in charge of studies. For this study, participants and key informants were chosen through a combination of purposive and random selection methods. A sample size of 145 respondents was determined using Yamane's formula. Data was analyzed using the Statistical Package for the Social Sciences (SPSS) version 26.0, which generated descriptive statistics including frequency, percentage, mean, and standard deviation. Additionally, inferential statistics such as correlation and regression coefficients were computed, to determine the size of the effect between variables. The findings for the first objective show that 84.6% strongly agreed that the collaboration culture, 92.3% strongly agreed that professional learning communities represent the attributes of collaboration present among teachers, 84.4% strongly agreed that lesson studies indicate the attributes of collaboration present among teachers, and finally, 65.5 strongly agreed that peer education represents the attributes of collaboration present among teachers, therefore collaboration culture, professional learning communities, lesson studies, and peer education are key attributes of collaboration among teachers, with 84.6% and 92.3% agreeing. The findings of the second objective on the academic performance of learners in mathematics subjects It reveals that 65.4% strongly agreed that improved math results for the students indicate their academic performance; 65.4% strongly agreed, and 73.10% strongly agreed that improved students' behavior indicates The mathematical performance of students in academia, which is due to the collaboration of teachers. 69.2% strongly agreed that motivated teachers and students indicate The academic achievement of students in mathematics subjects, resulting from the collaboration among teachers; 73.1% strongly agreed that completion rates improved and indicate The academic achievement of students in mathematics subjects, resulting from the collaboration among teachers; The study found that improved math results, improved student behavior, motivated teachers and students, and improved completion rates are all significant factors in illustrating scholastic achievement in mathematics. The findings on the third objective indicated a correlation between teacher collaboration and students' performance on mathematics subjects in state secondary schools, indicating that most measures were positively associated with each other. Since the degree of significance was less than 0.05, it was recommended that MINEDUC provide enough training intended to boost teachers' ability to teach using CBC. All persons working in the education sector in Gatsibo are encouraged to work together to improve teacher cooperation through a variety of activities such as trainings, workshops, in-service trainings, mentoring meetings, and others. It is proposed that MINEDUC, through the Rwanda Education Board, provide suitable teaching and learning resources that allow instructors to collaborate and All stakeholders in the education sector are encouraged to support teaching and learning activities in Rwanda, since this is the only way to achieve Rwanda's government's objective of creating a knowledge-based economy. Further research can be undertaken to determine the impact of external factors on students' academic performance in mathematics.

Key words: - teacher collaboration; student's academic performance in mathematics subject.

CHAPTER ONE: INTRODUCTION

1. 0: Introduction

Teacher collaboration and student's academic performance has been the topic of debate. Secondary school education in Rwanda is structured into academic divisions to facilitate the exchange of ideas and methods for improving curriculum implementation and educational outcomes. Educators are encouraged to share knowledge gained from various training programs to enhance on-site teacher training. Despite departmental structures and in-service teacher training, effective teacher collaboration for continuous professional development is lacking. This lack of collaboration has resulted in poor academic performance in math subjects among students. Therefore, there is a need for thorough research to explore the connection between teacher collaboration and students' math performance, identifying how collaboration influences teaching practices and student achievement. This research is crucial for informing educational stakeholders about the potential benefits of promoting and supporting teacher collaboration to enhance mathematics instruction and overall student performance. this research emphasizes on the significance of teacher collaboration in enhancing student learning outcomes, particularly in mathematics education. Avila (2016) highlights the correlation between teacher collaboration and higher student achievement, emphasizing its role in creating a positive work environment. Leith wood (2007) underscores the importance of school leadership in improving classroom instruction and student performance. OECD's TALIS Database (2009) emphasizes the prominence of teacher collaboration in education research and practice. David Schleifer and Chloe Rinehart (2017) discuss the advantages of teacher collaboration in improving instructional strategies and student engagement. Saka (2021) emphasizes the detrimental effects of teacher isolation on instructional quality, particularly in developing African countries. In Rwanda, inadequate teacher collaboration hampers student learning outcomes, necessitating further research to understand its impact on academic performance. The research highlights the need for effective teacher collaboration to enhance mathematics instruction and improve students' overall performance in the subject

1.1. Specific objectives:

The following are specific objectives guided the study:

(i) To identify the attributes of collaboration present among teachers to enhance the scholastic achievement of students in mathematics within state secondary schools.
(ii) To assess The academic achievement of students in mathematics subjects, resulting from the collaboration among teachers in Gatsibo District, Rwanda.
(iii) To Determine the relationship between teachers' collaboration and students' performance in mathematics in Gatsibo district, Rwanda.

2. 0 Review of related literature

2.1 Empirical Review and theoretical literature

This section discusses the findings of relevant studies:

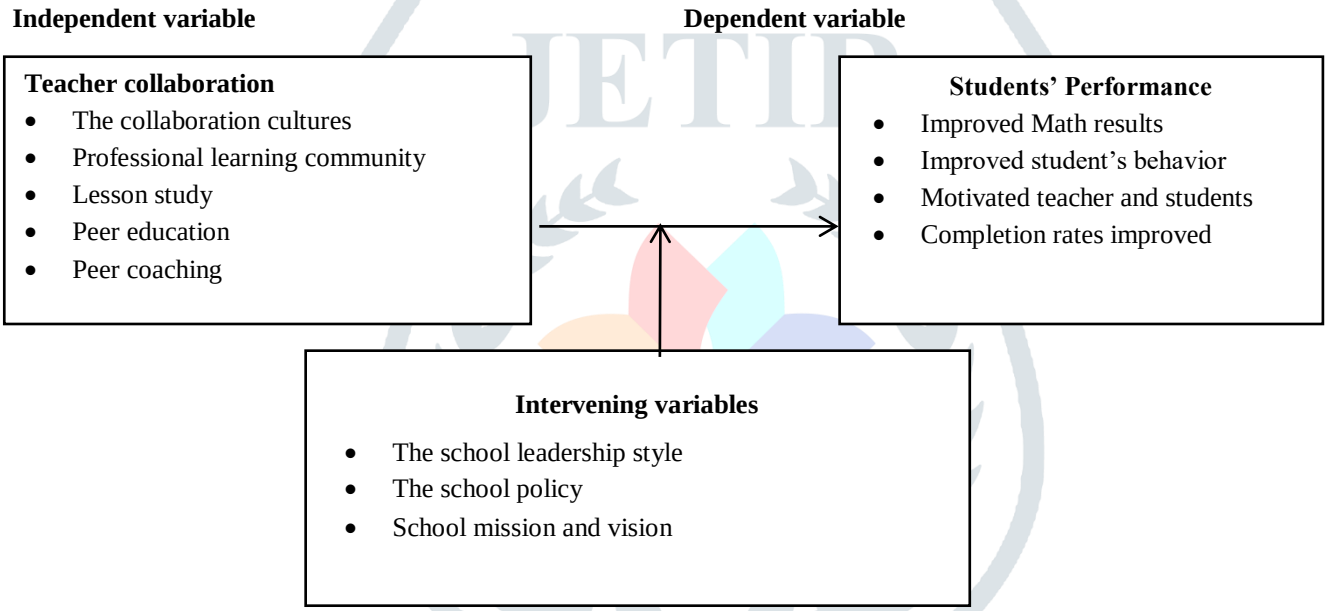
The researcher explores how teacher collaboration impacts students' academic performance, drawing on previous studies and theories. They discuss the constructivism and social learning theories by Vygotsky, highlighting the importance of social interactions in knowledge construction. Various forms of collaborative learning, like cooperative learning and team learning, are emphasized (Surif, 2002; Peterson, 2006). Haskins (2006) mentions the significance of social-oriented learning and mentorship. Teacher collaboration aids professional development, changing teacher attitudes and improving learning outcomes (Guskey, 2002). This collaborative approach, rooted in social and adult learning theories, aims for sustainable improvements in teaching and student performance.

However, this section reviews previous studies on teacher collaboration and its impact on students' academic performance about the attributes of collaboration present among teachers to enhance students' academic performance in mathematics. Sariola (2011) emphasizes sharing resources and expertise among teachers. Tinto (2007) stresses teamwork for improving student behavior. Michael (2010) highlights the role of well-equipped instructors in creating conducive learning environments. Tshui and Cai (2011) find significant effects of teacher collaboration on student behavior and achievement. Usha (2017) notes how collaboration addresses disciplinary issues and enhances pedagogical discussions. Secondary school environments, as noted by Sariola (2011), influence learning outcomes and behavior. Effective collaboration correlates with positive feedback from students, teachers, and parents (Tshui and Cai, 2011). Academic performance, influenced by various factors, is enhanced through collaborative efforts (Alabi, 2011; Asiabaka, 2008; Adediwura and Tayo, 2007). Overall, collaborative activities among teachers, especially in mathematics education, contribute positively to students' academic performance. Professional Learning Communities (PLCs) foster collaborative learning among teachers, aiming for sustainable change (Wendy, 2017). They facilitate ongoing dialogue to enhance instructional practices and student outcomes (Darling-Hammond, 2019). PLCs have shown success in improving student achievement, especially in low-performing schools (Morrissey, 2010). Unlike traditional professional development, PLCs involve site-based collaboration, enhancing teacher effectiveness (Calabrese et al., 2012). They provide a platform for continuous dialogue, driving improvements in teaching practices (Ministry of Education Singapore, 2010). Building a professional community enables teachers to maintain high expectations for all students (Wheelock, 2010). Collaborative teaching enhances effectiveness by providing expanded resources (Helen, 2017). The activities within these communities include sharing experiences, analyzing pedagogy, and experimenting with new methods (Muzaffar, 2010). Studies have found that while teacher experience affects student performance, certification does not necessarily correlate with student success (Kosgei et al., 2013). This section explores the relationship between teacher collaboration and students' academic performance in mathematics. Alabi (2011) defines academic performance as encompassing various skills and critical thinking abilities. Justice and Daniel (2015) identify factors like teacher quality and resources influencing math performance. Collaborative efforts, as highlighted by Cohen (2016) and Khalid (2016), enhance instructional practices and positively impact students' math performance. The studies underscore the importance of collaborative learning environments in promoting student success (Fakomogbon and Bolaji, 2020; Uwizeyimana et al., 2018; Nkechinyere et al., 2018). Collaboration not only improves academic outcomes but also fosters a culture of shared responsibility and continuous improvement within schools (Valentine, 2016).

To foster collaboration, schools must establish structures, norms, and shared visions focused on student success (Atkinson, 2011). Moreover, the relationship between teachers' collaboration and students' performance in mathematics is explored through various concepts and practices. Communities of Practice (CP) facilitate sharing of knowledge and experiences among peers (Beitler, 2015; Wenger, 2017). Professional Learning Communities (PLCs) enable teachers to collaborate on improving instructional practices (Atkinson, 2011). Collaborative efforts among teachers lead to the spread of effective teaching practices and improved student outcomes (Barnett, 2019). Building effective teacher teams is crucial for enhancing student performance (Atkinson, 2011). Peer coaching and lesson study are effective methods for professional development and improving teaching practices (McDougall, 2011; Pamela, 2004). Trust and relational trust are fundamental for successful collaboration (Hargreaves, 2012; Schneider, 2012). Building a collaborative culture requires commitment and leadership from school leaders (Atkinson, 2001). Lesson Study involves collaborative design and testing of lesson sequences to enhance learning (Tall, 2018). Overall, collaborative practices and networks play a vital role in improving student performance in mathematics.

2.2. conceptual framework

In this part the relationship between variables is presented for further understanding of the concept of collaboration and related variables. The conceptual framework of this study connects the independent variables with the dependent variables, as well as the intervening variables depicted in the figure.



Source: Researcher Developed (2023)

Figure 2. 1: The Conceptual Framework

3.0: Research methodology

This study, as described by Creswell (2011), employed a mixed-methods research design, combining quantitative and qualitative approaches. This combination, as advocated by Creswell and Plano Clark (2011), enhances the study's robustness by offering unique insights not attainable with either method alone. Rooted in pragmatism, as articulated by Rossman and Wilson (2009), the research prioritized the problem over specific methods. Utilizing the concurrent embedded strategy, the study collected quantitative and qualitative data simultaneously, guided by a primary method with a secondary method nested within it. This approach, according to Creswell (2011), enables the exploration of diverse facets of the research question. Specifically, the quantitative phase addressed targeted research inquiries, in alignment with the chosen methodological approach.

3.1. Target population

Mugenda and Mugenda (2003) define a study population as the entire group with common characteristics that the study focuses on. Kothari (2004) describes it as the universe from which data is collected. The target population for this study was educational practitioners in Gatsibo district, including students, teachers, head teachers, and deputy head teachers in charge of studies, totaling 253 participants. Denscombe (2008) states that it's crucial to meticulously choose a sample that accurately reflects the entire population and offers data suitable for scientific scrutiny. In this research, random sampling was utilized to guarantee a representative sample from each group. The study includes 253 individuals as the study population, and the sample size was calculated using Slovin's formula (Tejada et al., 2012), where 'n' represents the sample size, 'N' the population size, and 'e' the margin of error (0.05). as follows: $n = \frac{N}{1+N(e)^2}$ Thus, the researcher sampled 145 respondents in the district of Gatsibo.

Table 3.1: Respondents' Distribution

No	Category of respondents	Target population	Sample size
1.	Head teachers	7	4

2.	Head-teachers in charge of studies	13	7
3.	Teachers	45	26
4.	Students	188	108
	Total	**253**	**145**

Source: Researcher (2023)

3.3 Data collection Methods and Analysis procedures

The data collection process entails a careful and methodical approach to obtaining information relevant to the research objectives and aims, as outlined by Burns and Grove (1993). In this study, the researcher utilized a combined methodology involving both descriptive surveys and interviews. The choice of a descriptive survey was made due to time constraints within the research project, particularly in managing the extensive scope encompassing numerous public secondary schools, teachers, and parents. The data analysis incorporated various techniques, including questionnaires and documentation research.

3.3.1 Data collection instruments

The study utilized a mixed-method approach, employing a structured questionnaire with both open-ended and closed-ended questions, along with interviews, to gather qualitative primary data. The questionnaire, designed to meet the study's objectives, was complemented by interviews to delve deeper into research inquiries. Key informants, including students, head teachers, Deputy of Study (DOS), and teachers, were targeted for data collection. Interview schedules were semi-structured to allow for in-depth exploration of perspectives. Interviews were chosen for their ability to provide detailed qualitative data and immediate feedback, enhancing thematic depth. Triangulation was employed to verify questionnaire responses for data consistency and validity. Pre-testing was conducted to address any challenges, and research instruments were approved by the supervisor. Questionnaires were distributed in person, and interviews mainly focused on educational officers and head teachers from Gatsibo District.

3.3.2 Data analysis procedure

Kothari (2013) defines processing and analysis as the procedures of organizing, manipulating, and summarizing data to derive insights in response to research inquiries. Data processing encompassed rectifying any discrepancies in raw data resulting from misunderstandings of research questions and scrutinizing responses to rectify any inaccuracies or misplacements. Subsequently, the data underwent coding and categorization into relevant groups, facilitating its presentation in tabular format for analysis. Quantitative data underwent examination through descriptive statistics, while qualitative data was subjected to content analysis. Both analyses were conducted in alignment with the research questions and objectives. Statistical software such as SPSS version 26.0 facilitated the data analysis process, with the results presented using pie charts and tables in Microsoft Word for reporting purposes

4.0 Research findings, interpretation and discussions.

Chapter four examines the questionnaire and interview responses, divided into four sections. Firstly, demographic characteristics like age group and academic level are analyzed. Secondly, the collaboration attributes among teachers and its impact on student performance in mathematics are assessed. Thirdly, the academic performance of students in mathematics subject that is due to the collaboration of teachers Lastly, the relationship between teacher collaboration and student performance in Rwanda is explored.

4.1 Characteristics related to the demographics of the participants.

Demographic variables including age group, academic year, and school status were assessed as potential factors influencing the study outcomes. Analyzing the demographic profile of respondents encompassed all necessary components to gather meaningful insights. Despite distributing 145 questionnaires, only 143 were accurately The surveys were filled out and submitted, yielding a response rate of 97.8%.

4.1.1 Age Group of Respondents.

The participants' level of maturity is an important factor that enables the researcher to ascertain the reliability of the data, a crucial aspect for this study. The age composition of respondents in Gatsibo District played a significant role in evaluating their professional capabilities

Table 4. 1 Age Group of Respondents.

Age group	Frequency	Parentages
18-20 years	12	8.27
21-25 years	71	48.9
26-30years	31	21.37
26-30 years	20	13.79
35 and above	11	7.67
Total	**145**	**100.0**

Source : Primary Data (2022)

Based on the results of the current study, 12 (8.27%) participants fell within the age range of 18 to 20, 71 (48.9%) were aged between 21 and 25, and 31 (21.37%) were aged between 26 and 30, and 11(7.67%) respondents were over the age of 35. This means that a large proportion of responders were experienced teachers and head teachers who might give trustworthy information for the present study. (Eliard, 2022) conducts research by empirically evaluating the influence of shifts in population age distribution on overall consumption, highlighting noteworthy life-cycle consistency. Controlling for age structure effects in consumption functions is uncommon, yet doing so stabilizes other variables and reveals significant ramifications for real interest rates.

4.1.2 Year of Study

The researcher through questionnaires has requested respondents to indicate their class in order to investigate whether the respondents' level has influence on responses provided.

Table 4. 2 Year of Study

Levels	Frequency	Percentage
Ordinary level	108	74.48%
Advenced level	0	0%
Bachalors Degree	34	23.44%
Masters Degree	3	2.08%
PhD	0	0%
Total	**145**	**100.0%**

Source: Primary Data (2022)

The table 4.2 According to the data, 108 of the 145 respondents completed the ordinary level (74.48%), 34 completed a Bachelor's Degree (23.44%), and three completed a Master's Degree (2.08%). This assisted the researcher in obtaining information that was not based on a primary or advanced educational level.

4.2 Presentation of Findings

The research presents and analyzes data using tables of frequencies and percentages. Information was presented and discussed based on the attributes of collaboration present among teachers to enhance students' academic performance in mathematics subject, the academic performance of students in mathematics subject that is due to The cooperation among educators and the correlation between teachers' teamwork and students' achievements in the field of mathematics in Rwanda.

4.2.1. The attributes of collaboration present among teachers to enhance students' academic performance in mathematics subject.

The table below illustrates how collaboration among teachers is perceived in public secondary schools in Rwanda, focusing on its attributes.

Table 4. 3. Perception of teachers on attributes of collaboration present Among educators to enhance students' academic performance in mathematics.

	Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree				
	N	%	N	%	N	%	N	%	N	%	Total	Mean	Sdv
The collaboration culture indicates the attributes of collaboration present among teachers	0	0.0	0	0.0	0	0.0	4	15.4	22	84.6	26	1.153	.367
Professional learning community represent the attributes of collaboration present among teachers	0	0.0	0	0.0	1	3.8	1	3.8	24	92.3	26	1.115	.431
Lesson study indicate the attributes of collaboration present among teachers	0	0.0	0	0.0	1	3.8	3	11.5	22	84.6	26	1.192	.491
Peer education represents the attributes of collaboration present among teachers	0	0.0	0	0.0	2	7.7	7	26.9	17	65.5	26	1.42	.643

Source: Primary Data (2023)

Results Shown that the collaboration culture indicates the attributes of collaboration present among teachers, 84.6% strongly agreed. Results indicated that Professional learning community represent the attributes of collaboration present among teachers, with 92.3% strongly agreeing, 84.4% strongly agreed that Lesson study indicate the attributes of collaboration present among teachers, and finally, 65.5 strongly agreed that Peer education represents the attributes of collaboration present among teachers. From this result, it was proved The collaboration culture, Professional learning community, Lesson study, Peer education and Peer coaching are indicating the attribute on teacher's collaboration. According to (Saka, 2021) study on The impact of teacher collaboration on the academic advancement of students in mathematics within secondary schools in Nigeria. The study employed a pretest-posttest-control group quasi-experimental design along with a 2x2 factorial matrix. The results indicated that students instructed by collaborative teachers demonstrated superior performance compared to those taught by individual teachers. Age or instructor group did not significantly affect students' academic achievements. Based on the findings, school administrators are advised to adjust schedules for teacher collaboration activities and facilitate teacher workshops.

4.2.2 The scholastic achievement of students in the field of mathematics that is due to the collaboration of teachers

Before conducting the study to explore the correlation between teacher collaboration and students' mathematics performance in Rwanda, the researcher initially focused on gathering descriptive statistics to provide insights into the academic performance of learners in mathematics subjects within state secondary schools.

Table 4. 3 The teacher's perceptions on The scholastic achievement of students in the field of mathematics that is due to the collaboration of teachers

Statement on Students' academic performance in mathematics	Strongly Disagree		Disagree		Not Sure		Agree		Strongly Agree				
	N	%	N	%	N	%	N	%	N	%	Total	Mean	Sdv

Improved math results for the students indicate their academic performance.	2	7.7	3	11.5	0	0.0	4	15.4	17	65.4	26	1.8	1.357
Improved students' behavior indicates that the academic performance of students in mathematics is due to the collaboration of teachers.	3	11.5	2	7.7	1	3.8	1	3.8	19	73.1	26	1.8	1.470
Enthusiastic teachers and students suggest to me that the academic success of students in mathematics results from the teamwork among teachers.	1	3.8	3	11.5	1	3.8	3	11.5	18	69.2	26	1.69	1.22
Better rates of completion suggest that the progress of students in math academically stems from teachers working together..	0	0.0	2	7.7	2	7.7	3	11.5	19	73.1	26	3.53	1.5

Source: Primary Data (2023)

Table 4.4 indicated that improved math results for the students indicate their academic performance; 65.4% strongly agreed, 15.4% agreed, and 73.10% strongly agreed that improved students' behavior indicates The scholarly achievements of students in math, which is due to the collaboration of teachers. 69.2% strongly agreed that motivated teachers and students indicate The scholarly achievements of students in math, that is due to the collaboration of teachers; 73.1% strongly agreed that completion rates improved and indicate The academic achievement of students in mathematics resulting from teachers collaborating. (Algani, 2021) see how collaborative learning affects students' educational achievement in math for primary school children in northern Israel. The experimental group tried collaborative learning, whereas the control group tried traditional learning. The research employed several tools, including a questionnaire designed to evaluate educators' perspectives on the impact of collaborative learning on students' academic achievement, as well as the methods utilized. Additionally, the study analyzed the post-test math performance of both experimental and control groups. The findings revealed that students' academic performance in math was better when using the collaborative learning approach compared to the traditional teaching method.

Table 4. 4 The student's perceptions on the educational achievement of students in mathematics

Statement on Students' academic performance in mathematics	**Strongly Disagree**		**Disagree**		**Not Sure**		**Agree**		**Strongly Agree**				
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**Total**	**Mean**	**Sdv**
My Improved Math outcomes as students demonstrate my high academic achievement	3	2.9	4	3.8	2	1.9	12	11.5	83	79.8	104	1.34	.927
Improved behavior indicates that The academic achievement in mathematics has improved as a result of teacher cooperation	4	3.8	4	3.8	3	2.9	3	2.9	90	86.5	104	1.355	.994
My motivation as a student indicates the academic success of pupils in mathematics owing to teacher collaboration	3	2.9	3	2.9	4	3.8	12	11.5	82	78.8	104	1.394	.918
My completion rates increased as students indicated greater academic achievement in mathematics topic owing to teacher collaboration	2	1.9	2	1.9	4	3.8	8	7.7	88	84.6	104	1.288	.796

Source: Primary Data (2023)

Findings obtained from Table 5.5 indicated that improved math outcomes as students demonstrated their high academic achievement; 79.8% strongly agreed, 86.5% strongly agreed that improved behavior indicates their academic achievement in mathematics; 78.8% strongly agreed that the motivation of a student indicates the academic success of students in mathematics owing to teacher collaboration; and 84.6% strongly agreed that improved completion rates indicate scholarly achievements of students in mathematics subject which is due to the collaboration of teachers. (Mari and Al-Haila, 2012). Collaborative learning distinguishes itself by categorizing pupils as high, middle, or poor achievers (Al-Saadi, 2010). It is also known as a teaching strategy that incorporates a small group of students working together to optimize each student's educational experience as students work in various groups to attain a shared educational goal (Al-Omar, 2000). A group of researchers believes in collaborative learning.

4.2.3 The correlation between teachers collaborating and students' performance in mathematics in Rwanda.

Table 4. 5 Correlation Analysis between independents variables and dependents variable

		The collaboration culture	Professional learning community	Lesson study	Peer education	Peer coaching	Improved Math results	Improved student's behavior	Motivated teacher and students	Completion rates improved
The collaboration culture	Pearson Correlation	1	.317**	.163*	.115	.197**	.796**	.736**	.770**	.317**
	Sig. (2-tailed)		.000	.029	.125	.008	.000	.000	.000	.000
	N	143	143	143	143	143	143	143	143	143
Professional learning community	Pearson Correlation	.426**	1	.596**	.591**	.263**	.272**	.197**	.243**	.576**
	Sig. (2-tailed)	.000		.000	.000	.000	.000	.008	.001	.000
	N	143	143	143	143	143	143	143	143	143
Lesson study	Pearson Correlation	.046	.531**	1						
	Sig. (2-tailed)	.594	.000		.000	.000	.000	.000	.008	.001
	N	143	143	143	143	143	143	143	143	143
Peer education	Pearson Correlation	.393**	.354**	.190*	1	.495**	.156*	.211**	.182*	.118
	Sig. (2-tailed)	.000	.000	.028		.000	.037	.005	.015	.116
	N	143	143	143	143	143	143	143	143	143
Peer coaching	Pearson Correlation	.306**	.638**	.480**	.436**	1	.217**	.367**	.254**	.224**
	Sig. (2-tailed)	.000	.000	.000	.000		.003	.000	.001	.002
	N	143	143	143	143	143	143	143	143	143
Improved Math results	Pearson Correlation	-.149	-.132	-.180*	-.218*	-.021	1	.205**	.357**	.339**
	Sig. (2-tailed)	.056	.027	.037	.012	.806		.006	.000	.000
	N	143	143	143	143	143	143	143	143	143
Improved student's behavior	Pearson Correlation	.060	.219*	.476**	.657**	.460**	.346**	1	.766**	.700**
	Sig. (2-tailed)	.042	.011	.002	.001	.000	.000		.000	.000
	N	143	143	143	143	143	143	143	143	143
Motivated teacher and students	Pearson Correlation	.656**	. .376**	.194*	.349*	.766**	.577**	.647**	1	.795**
	Sig. (2-tailed)	.000	.001	.025	.000	.003	.000	.001		

	N	143	143	143	143	143	143	143	143	143
Completion rates improved	Pearson Correlation	.329*	.786**	.678**	.546**	.746**	.487**	.856**	.215*	1
	Sig. (2-tailed)	.001	.014	.000	.003	.000	.051	.183	.013	
	N	143	143	143	143	143	143	143	143	143

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

*. Correlation is significant at the 0.05 level (2-tailed).

Source: Primary Data (2023)

The information presented in Table 4.6 Indicated a connection between research factors, there was a statistically notable link between enhanced math outcomes and peer coaching with the collaboration culture (r =-.149, p-value =.056), improved math results and the professional learning community (r =-.132, p-value =.027), as well as improved math results and lesson study (r =-.180*, p-value =.012). These associations were positively linked as the p-value was < 0.5. Among motivated teachers and students, there exists a statistical correlation between enhanced math outcomes and the culture of collaboration (r =.656**, p-value =.000), motivated teachers and students with the professional learning community (r =-.132, p-value =.027), and motivated teachers and students with the lesson study (r =-.180*, p-value =.037). Finally, a statistical correlation was found between improved math results and peer education (r = -.218*, p-value =.012). Results on teaching materials indicated a significant correlation between motivated teachers and students and the collaboration culture (r =.306**, p-value =.000), motivated teachers and students with the professional learning community (r =.376**, p-value =.001), and motivated teachers and students with the lesson study (r =.194*, p-value =.025). Finally, a correlation was found between the motivated teacher and students and peer education (r =.349*, p-value =.000), as well as the peer education showing a statistical correlation with the motivated teacher and students (r =.766**, p-value = 0.003). For completion rates improved, there is a statistical association between completion rates improved and the collaboration culture (r =.329*, p-value =.001), completion rates improved with the professional learning community (r = -.786**, p-value =.014), and completion rates improved with the lesson study (r = -.678**, p-value =.003). Finally, a correlation was found between completion rates, improved results, and peer coaching (r = 746**, p-value =.000 The findings suggest significant correlations were found, indicated by a p-value below 0.05, indicating that the independent variable influences the dependent variables. This aligns with Harerimana's (2016) study, which explored the effects of academic collaboration among teachers on student academic performance in selected schools in Gatsibo, Rwanda. The findings suggested that changes in the independent variable discussion based on pedagogical issues, collaborative teaching, internal seminars, student inspection, teacher monitoring, and team investigation can affect academic performance variables such as improved grades in national exams, improved class participation, improved homework competition, and improved attendance at 93.3%. This also means that the remaining 6.7% is susceptible to other factors. The study did, however, find a statistical association between instructors' academic collaboration and student achievement, with r =.108 and P-value =.000.05. The study suggests that everyone working in the education sector in Gatsibo collaborates to improve teacher cooperation through different activities like trainings, training sessions, in-service trainings, mentoring meetings, and others.

Table 4. 6 Regression Coefficients between Independents variables and Peer coaching

		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	T	Sig.
1	(Constant)	-.060	.167		-.360	.720
	The collaboration culture	.018	.088	.015	.202	.840
	Professional learning community	.517	.100	.442	5.163	.000
	Lesson study	.252	.097	.200	2.607	.010
	Peer education	.344	.103	.235	3.331	.001

a. Dependent Variable: Peer coaching

Source: Primary Data (2023)

The data depicted in Table 4.7 demonstrated that regression coefficients associated with peer coaching and collaboration culture were not statistically significant (B =.015, p-value =.840). However, there was a positive and significant relationship found for peer coaching and the professional learning community (B =.442, p-value =.000). Additionally, the results revealed a positive correlation between peer coaching and lesson study (B =.200, p-value =.010), as well as between peer coaching and peer education (B =.235, p-value =.001).

Table 4. 7 Regression analyses between independents variables and Improved Math result

		Unstandardized coefficients		Standardized coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(constants)	2.888	.309		9.348	.000
	The collaboration culture	-.166	.162	-.603	-1.023	.008
	Professional learning community	.105	.186	.365	.567	.002
	Lesson study	-.311	.179	-.179	-1.732	.046
	Peer education	-.335	.191	.266	-1.754	.000

a. Dependent Variable: Improved Math results

Source: Primary Data (2023)

Data presented in Table 4.8 indicates regression coefficients for Improved Math results and The collaboration culture were negatively significant (B = -.603, p-value =.008). The result indicated that Improved Math results and Professional learning community were positively significant (B =.365, p-value =.002). The findings indicate a significant negative association between Enhanced Math outcomes and Lesson Study (B = -.179, p-value =.046), and conversely, a significant positive correlation between Enhanced Math outcomes and Peer Education (B =.266, p-value =.000).

Table 4. 8 Regression analyses between independents variables and improved math results

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	2.013	.304		6.631	.000
	The collaboration culture	-.129	.160	-.081	-.810	.419
	Professional learning community	.599	.182	.376	3.286	.001
	Lesson study	-.370	.176	-.216	-2.098	.038
	Peer education	-.045	.188	-.023	-.241	.810

a. Dependent Variable: Improved student's behavior

Source: Primary Data (2023)

The data shown in Table 4.9 revealed that regression coefficients associated with Enhanced Student Behavior and Collaboration Culture were not statistically significant (B =-.081, p-value =.419). However, there was a positive and significant relationship found for Enhanced Student Behavior and the Professional Learning Community (B =.376, p-value =.001). Additionally, the results indicated a negative significant correlation between Enhanced Student Behavior and Lesson Study (B = -.216, p-value =.038), and finally, the findings suggested that there was no significant relationship between Enhanced Student Behavior and Peer Education (B =.-.023, p-value =.810).

Table 4. 9 Regression analyses between independents variables and Motivated teacher and students

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	1.276	.250		5.098	.000
	The collaboration culture	-.091	.532	-.070	-.691	.012
	Professional learning community	-.140	.150	-.108	-.931	.035
	Lesson study	.330	.145	.237	2.272	.025
	Peer education	.154	.155	.095	.994	.322

a. Dependent Variable: Motivated teacher and students

Source: Primary Data (2023)

The data displayed in Table 4.10 revealed that regression coefficients associated with Motivated Teachers and Students and the Collaboration Culture were significantly negative (B =-.070, p-value =.012). However, there was a positive and significant relationship found for Motivated Teachers and Students and the Professional Learning Community, albeit with a negative significance (B =-.108, p-value =.035). Additionally, the results indicated a positive correlation between Motivated Teachers and Students and Lesson Study (B =.237, p-value =.025), whereas the association between Motivated Teachers and Students and Peer Education was not significant (B =.095, p-value =.322).

5.0 Discussion

5.1. The attributes of collaboration present among teachers to enhance scholastic achievement in the field of mathematics

The study initially aimed to investigate how teacher collaboration impacts students' math performance. The researcher used statements in a questionnaire to assess respondents' views on collaboration aspects such as collaboration culture, professional learning communities, lesson study, peer education, and peer coaching. The findings revealed high agreement among respondents, with significant percentages strongly agreeing that these aspects represent attributes of teacher collaboration. Specifically, 84.6% strongly agreed on collaboration culture, 92.3% on professional learning communities, 84.4% on lesson study, and 65.5% on peer education. This indicates that these elements indeed reflect the attributes of teacher collaboration.

5.2. Analysis of the students' performance in national exams of mathematics that is due to teacher collaboration

The research's second objective was to evaluate how improvised materials influence academic achievement in mathematics. Statements such as "Enhanced math outcomes among students suggest their academic progress," "Improved student behavior suggests that teachers' collaboration impacts scholastic achievement in the field of mathematics," and "Motivated teachers and students suggest to me that teachers' collaboration influences students' academic performance in mathematics" were utilized. The findings from teachers indicated significant agreement: 65.4% strongly agreed and 15.4% agreed that improved math results denote students' academic performance due to teachers' collaboration, while 73.1% strongly agreed that improved completion rates indicate scholastic achievement influenced by teacher collaboration. From students' perspectives, high agreement was found: 79.8% strongly agreed on improved math outcomes, 86.5% strongly agreed on improved behavior reflecting academic achievement, 78.8% strongly agreed on student motivation indicating academic success, and 84.6% strongly agreed on improved completion rates reflecting scholastic achievement due to teacher collaboration.

5.3 The relationship between using improvised materials and learners 'achievement in mathematics disciplines within public secondary schools in Rwanda'

The third objective of the research was to explore the relationship between teachers' collaboration and students' achievements in mathematics in Rwanda. The study found significant correlations between enhanced math outcomes and various collaborative practices such as peer coaching, collaborative culture, professional learning communities, and lesson study, with p-values < 0.5 indicating positive associations. Additionally, motivated teachers and students were significantly correlated with improved math results and various collaborative practices, including collaboration culture, professional learning communities, lesson study, and peer education. Moreover, completion rates were positively influenced by collaborative culture, professional learning communities, lesson study, and peer coaching**.**

6.0. Conclusions and Recommendations

The study, focused on the relationship between teacher collaboration and students' academic performance in mathematics in Rwanda, yielded several key findings. Firstly, collaboration culture, professional learning communities, lesson studies, peer education, and peer coaching were identified as crucial attributes of teacher collaboration, with 84.6% and 92.3% agreement among respondents. These results underscore the significance of collaboration in education.

Secondly, the analysis of student performance revealed that teachers' collaboration significantly impacts academic outcomes in mathematics. Improved math results, student behavior, teacher motivation, and completion rates were all positively correlated with academic success. Students also acknowledged the influence of these factors, with 79.8%, 86.5%, 78.8%, and 84.6% strongly agreeing with their contributions to academic achievement in mathematics. Overall, teacher-student collaboration emerged as pivotal for students' academic success.

Thirdly, the study established a positive relationship between teachers' collaboration and students' performance in mathematics, as evidenced by the correlation matrix, with p-values indicating significance. Consequently, the researcher proposed several recommendations for stakeholders, including the Ministry of Education (MINEDUC), urging adequate training to enhance teachers' capacity in implementing the Competency-Based Curriculum (CBC) and fostering collaboration. Collaborative activities such as trainings, workshops, and mentoring meetings were encouraged to improve teacher cooperation. Additionally, MINEDUC was urged to provide suitable teaching and learning resources to facilitate collaboration among instructors, while all stakeholders were called upon to support teaching and learning activities to realize Rwanda's objective of a knowledge-based economy. Lastly, collaboration among all stakeholders in the education system in Gatsibo was emphasized to enhance learner performance in mathematics across public and private secondary schools.

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