

Effect of Continuous Professional Development (CPD) Program Implementation on Students' Academic Performance in Mathematics in Public Secondary Schools in Rwanda a Case of Ngoma District

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Abstract:- This study examined the effect of Continuous Professional Development (CPD) programs on the academic performance of students in mathematics at public secondary schools in Ngoma District, Rwanda. The research aimed to evaluate the CPD activities, assess students' performance in mathematics, and explore the connection between CPD programs and student outcomes. A mixed-methods approach was used, surveying 140 participants, including teachers, school leaders, and students, from both day and boarding schools. The data were analyzed using SPSS and Microsoft Excel. Findings revealed that CPD activities significantly improved students' performance in mathematics. 89.58% of school leaders, 83.75% of teachers, and 80.33% of students agreed that CPD positively impacted student learning. Before CPD implementation, student performance was low, but it improved once the program was introduced. A strong positive correlation ($r = 0.887$, $p = 0.01$) was found between CPD participation and student academic performance in mathematics. The study also identified challenges such as low teacher motivation, absenteeism, and poor assessment scores due to inadequate CPD. To address these issues, the research recommended incorporating technology in teaching, adopting personalized learning methods, and enhancing teacher training. The findings highlighted the important role of CPD in enhancing teaching quality and student performance.

Keywords:- Continuous Professional Development (CPD) Program, Academic Performance in Mathematics Subject, Public Secondary Schools, Rwanda.

I. INTRODUCTION

Continuous Professional Development (CPD) plays a crucial role in enhancing teaching effectiveness, improving student outcomes, and maintaining educational quality globally. In England, CPD is integral to improving teaching practices and student learning, with an emphasis on collaboration and ongoing professional renewal (Borg, 2015; Saleem & Dogar, 2020). In higher education institutions,

CPD ensures teachers stay current with new pedagogical approaches, contributing to institutional effectiveness (Claudius Komba & Japhet Mwakabenga, 2020).

In Luxembourg, CPD is mandatory and aligns with national curricula to address teachers' evolving needs (Luxembourg, 2014). In contrast, Tanzania struggles with poorly coordinated CPD programs, leading to fragmented access and inconsistent opportunities for teachers (Claudius Komba & Japhet Mwakabenga, 2020).

Rwanda, on the other hand, has integrated CPD into its educational reforms. The Teacher Development and Management Policy, implemented in 2015, aligns with the Competence-Based Curriculum (CBC) and emphasizes structured professional development. CPD in Rwanda includes a range of activities such as school-based training, Communities of Practice, and formal programs through the Rwanda Education Board (REB). These initiatives aim to improve teachers' Content Knowledge (CK), Pedagogical Content Knowledge (PCK), and Technology Content Knowledge (TCK), essential for effective teaching in the 21st century (MINEDUC, 2015; Nsabayeze et al., 2022). Studies show that teachers' subject knowledge and technological skills significantly impact student performance, making CPD vital for sustained teacher development (Blazar & Kraft, 2017; Keller et al., 2017).

In summary, CPD is essential for maintaining high teaching standards and improving student outcomes. While countries like England and Luxembourg have well-established CPD frameworks, nations such as Tanzania and Rwanda are refining their approaches to meet the demands of modern education, particularly in STEM and ICT subjects (MINEDUC, 2019; Mabena et al., 2021).

II. LITERATURE REVIEW

Research on Continuous Professional Development (CPD) highlights its positive impact on teacher professional growth, teacher efficacy, and student outcomes. A study by Saleem & Dogar (2020) in the United States found that sustained, content-focused professional development

improved both teachers' instructional practices and student performance. Their research on **Professional Learning Communities (PLCs)** showed that teachers participating in PLCs demonstrated significant improvements in teaching, leading to higher student achievement (Botham, 2018). Additionally, **Bahriadi et al. (2022)** and **Abakah (2023)** emphasized the relationship between teacher self-efficacy and student outcomes, with collective teacher efficacy further enhancing student achievement. This underscores the importance of collaboration and shared beliefs among educators (Borg, 2018).

Calleja (2018) and **Mansour et al. (2014)** also found that sustained, content-focused CPD programs had a lasting, positive impact on both teaching practices and student success. These findings are supported by **Darling-Hammond et al. (2016)**, who conducted a large-scale study in the U.S. and found a significant correlation between math-specific CPD and improved student scores in mathematics. Similarly, **Ingersoll and Strong** showed that teacher participation in CPD led to more effective teaching strategies and better student outcomes in various subjects, including mathematics (Byungura et al., 2022).

Reflective practices are essential components of CPD. Schön suggests that when teachers evaluate and reflect on their teaching approaches, it results in more effective strategies and enhanced student learning, especially in subjects such as mathematics (Mwila et al., 2022). These empirical studies offer compelling evidence of the beneficial impact of CPD on teacher effectiveness and student achievement, highlighting the importance of focused, subject-specific, and reflective professional development programs to enhance academic performance, especially in mathematics.

➤ *Continuous Professional Development (CPD)*

The concept of Continuous Professional Development (CPD) has evolved over time, with various scholars and institutions offering different definitions. According to Nicholls (2001), CPD, originally called in-service education and training, was first introduced in the 1960s in Great Britain to address teaching quality concerns. The NCERT (2022) describes CPD as a combination of natural learning experiences and planned activities aimed at benefiting individuals, groups, or schools. These activities contribute to enhancing the quality of classroom education. Wolde (2021) emphasizes that CPD is a process where teachers, both individually and collaboratively, reflect on and strengthen their commitment to teaching, while developing essential knowledge, skills, and emotional intelligence throughout their careers. Additionally, Kitto et al. (2018) highlight that CPD includes various educational experiences such as courses, workshops, and conferences, focusing on subjects like pedagogy, teaching methods, and current educational challenges.

➤ *Student Academic Performance*

Academic performance has traditionally been linked to evaluation test scores, often reflecting students' IQ levels, while other personal factors have been overlooked (Noemy et al., 2017). However, numerous studies have explored the various factors influencing students' academic success. According to Wolde (2021), these factors can be broadly categorized into two groups: internal and external influences. Internal classroom factors include the medium of instruction, class size, textbooks, test results, learning resources, homework, classroom environment, subject difficulty, teacher-student relationships, and exam procedures. External factors encompass extracurricular activities, family issues, work-related concerns, and financial, social, and other personal challenges. Research has also shown that factors such as gender, age, and the learning environment can play a significant role in shaping academic performance (Yang Jong-seo, 2019).

➤ *Influence of CPD on Student Academic Performance.*

Teacher efficacy, which includes both self-efficacy and collective efficacy, is a key factor in the teaching process. Teachers with higher self-efficacy are more likely to adopt effective teaching methods, which in turn can positively affect student academic performance (M. Aurah & J. McConnell, 2014). Brendefur et al. (2016) found that students in schools where teachers received professional development in mathematics performed better than those in schools where no such training occurred. Research has also shown that attending various CPD sessions helps teachers stay updated, benefiting both their own careers and their students' performance (Migabo et al., 2023). Furthermore, integrating information and communication technology (ICT) and modern classroom practices into teacher training is crucial to better prepare students for global competition (Nkundabakura et al., 2023). Bindu (2016) highlighted that using ICT in teaching can enhance academic performance and create a more motivating learning environment, an idea further supported by Ndiokubwayo et al. (2020), who demonstrated that using tools like PhET simulations and online videos helps students improve their conceptual understanding.

➤ *CPD Activities*

Continuing Professional Development (CPD) includes various learning activities designed to enhance knowledge, skills, and competencies in areas such as personal growth, civic engagement, social development, and employment (European Commission, as cited in Calleja, 2018).

The literature identifies two main types of CPD activities: traditional and reformed. Traditional CPD activities, such as workshops, conferences, and courses, are often criticized for being ineffective. These activities tend to be one-time, decontextualized sessions that do not align with teachers' needs and fail to provide sufficient time or depth for meaningful improvements in teaching practices (Borg, 2018; Rugambwa & Bahiya, 2021; Mwila et al., 2022).

In contrast, reformed CPD activities are designed to be more practical and sustainable. These activities are typically school-based, involve mentors or coaches, and focus on connecting professional development with classroom teaching. CPD programs are designed to address the specific needs of teachers and encourage lasting improvements in their teaching methods (Ivanova, 2017; Chval et al., 2008). Another approach to CPD is paired professional development, in which two teachers work together over an extended period on a common area of interest (Gakwerere et al., 2024). These reformed activities are seen as more effective in fostering teacher growth and improving classroom practices by providing relevant, context-driven support.

➤ *Research Objective*

This study explored how the implementation of continuous professional development (CPD) programs impacts students' academic performance in mathematics in public secondary schools in Rwanda

➤ *Research Question*

- How are Continuous Professional Development activities helping mathematics teachers of Rwandan public secondary school to grow professionally?
- How a professional teacher affects students' achievement in mathematics subject in public secondary school in Rwanda?
- What is the relationship between the participation of mathematics educators in CPD programs and the academic performance of students in mathematics in Ngoma district, Rwanda?

III. METHODOLOGY

A. *Research Design; Study Population; Sample Size; Data Collection Tools*

➤ *Research Design*

Research design is a structured plan outlining the procedures and methods used in a study to avoid a random approach. It also provides the rationale for how researchers draw conclusions at the end of their work (Tichapondwa, 2013). This study used both qualitative and quantitative methods to explore the causes, effects, and relationships between dependent and independent variables. A survey research design was employed to gather insights from students, teachers, and school leaders through questionnaires, capturing their beliefs, attitudes, and understanding. The study found that the implementation of teachers' continuous professional development (CPD) programs in Ngoma District's public secondary schools directly impacts students' performance in mathematics.

➤ *Target Population*

The target population refers to the entire group of individuals, events, or objects that a researcher aims to generalize the findings to (Sekaran, 2003). In this study, the target population consisted of head teachers, deputy head teachers responsible for studies, teachers, and students from

four secondary schools in Ngoma District. The total population for the study was 216 respondents, from which a sample was selected.

➤ *Sample Design*

The sample size indicates the sampling design, where the researcher randomly selects a group of respondents from a target population to represent the entire population. This group of individuals chosen for observation is referred to as a sample (Ary et al., 2006).

➤ *Sample Size Determination.*

The study's sample size of 140 respondents, including 124 students, 8 mathematics teachers, 4 deputy head teachers, and 4 head teachers, was selected from three sectors and four public secondary schools in Ngoma district. The sample was determined using Taro Yamane's formula (1967), with both random and purposive sampling techniques employed. The final sample size was calculated to be approximately 140.

➤ *Sampling Technique*

The sample for this study includes respondents from three sectors of Ngoma district, selected using purposive and simple random sampling methods. Teachers, deputy heads, and head teachers were purposively selected due to their knowledge of continuous professional development programs. Students studying mathematics in the selected schools were randomly chosen, ensuring equal probability for each participant.

➤ *Sample Techniques and Procedures*

The study used purposive sampling to select knowledgeable respondents, such as head teachers, deputy head teachers, and teachers, based on their expertise. Simple random sampling was employed for students to ensure equal selection chances and avoid bias. Data was collected using questionnaires administered to respondents from four public secondary schools in Ngoma district, including head teachers, deputy head teachers, teachers, and students.

➤ *Instruments for Data Collection*

Data was gathered through questionnaires and interviews to probe unobservable factors like opinions and emotions in this study

IV. ANALYSIS AND FINDINGS

➤ *Software used to Analyze Data.*

• *SPSS Version 21*

SPSS Version 21 is a powerful and widely-used statistical software for data analysis and visualization. It supports a wide range of analytical techniques, from basic procedures like descriptive statistics and t-tests to more advanced methods such as factor analysis and non-parametric tests. Its intuitive interface makes data manipulation easier and offers tools for visualizing and reporting results. However, users need to be careful when interpreting outcomes, especially if they lack a solid understanding of statistical principles. The accuracy and quality of the input data are vital, as SPSS relies on dependable data for

meaningful analysis. Additionally, for more complex or specialized analyses, users might need to use additional tools to meet specific research needs. In this study, SPSS Version 21 was employed to analyze data collected to address the research question: "How are Continuous Professional Development activities helping mathematics teachers in Rwandan public secondary schools grow professionally?"

• *Microsoft Excel*

Microsoft Excel is a commonly used spreadsheet tool that offers basic data analysis features, such as formulas, pivot

tables, and charts for simple tasks like calculating mean and standard deviation. While it works well for basic statistical analysis, Excel is less effective for more complex analyses and is prone to user errors. It struggles with large datasets and lacks the precision of specialized statistical software, making it less reliable for advanced tasks. As a result, researchers often turn to more robust tools like SPSS for complex analysis, though Excel can still be used for simpler tasks in conjunction with SPSS.

➤ *Findings.*

Table 1 Distribution of Teachers based on their Gender

Gender	Frequency	Percentage
1. Male	6	75
2. Female	2	25
Total	8	100

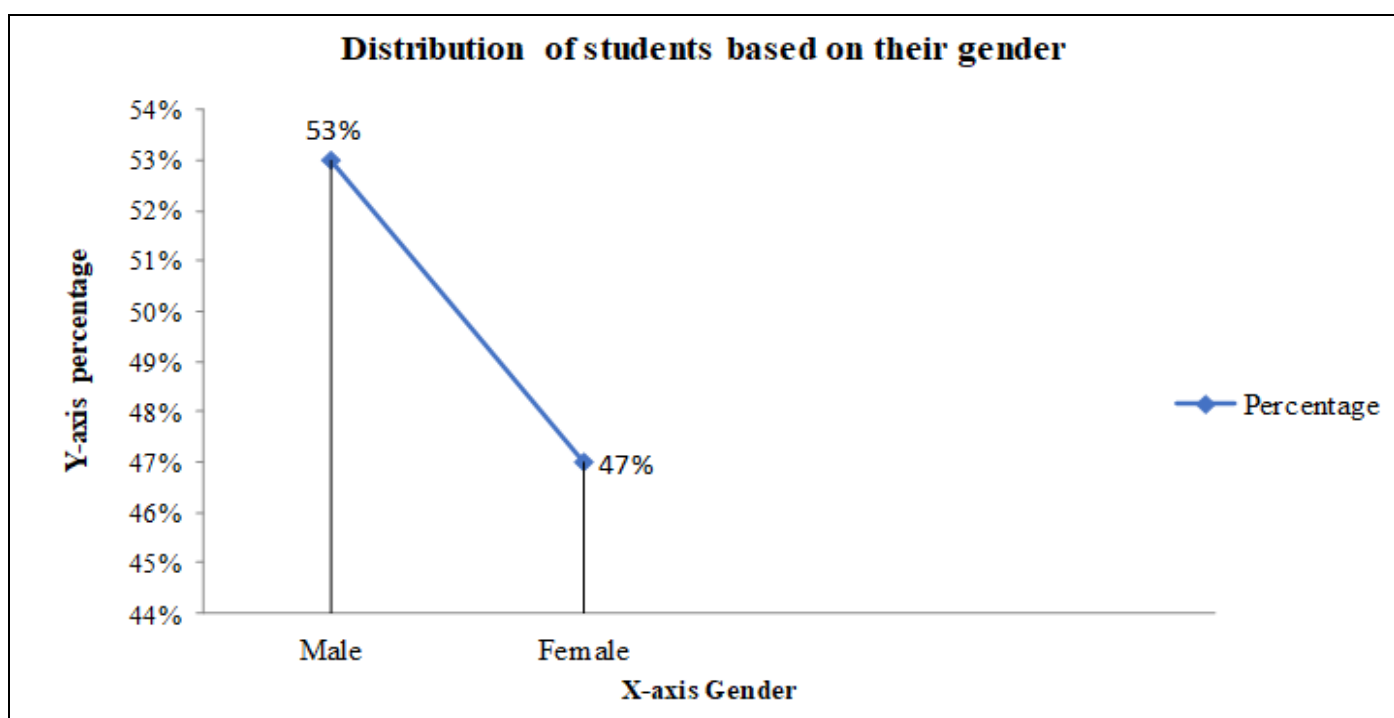


Fig 1 Distribution of Students based on their Gender

Table 2 Head teachers and Deputy Head teachers' awareness about the implementation of CPD Program in their schools.

Statements	Strongly disagree		Disagree		Neutral		Agree		Strongly Agree	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
CPD program activities are currently implemented in my school to enhance teachers' skills in teaching mathematics.	0	0%	1	12.5%	0	0%	2	25%	5	62.5%
My school has resources support the implementation of CPD programs in mathematics.	2	25%	2	25%	0	0%	2	25%	2	25%
Mathematics teachers in my school also participate actively in CPD activities	0	0%	0	0%	0	0%	6	75%	2	25%
I have ever assessed the effectiveness of CPD programs in improving teachers' instructional practices in mathematics.	0	0%	0	0%	0	0%	5	62.5%	3	37.5%

I have noticed an effect of CPD programs on students' academic performance in mathematics.	0	0%	0	0%	0	0%	7	87.5%	1	12.5%
I think CPD programs can further enhance students' learning experiences in mathematics.	0	0%	0	0%	0	0%	6	75%	2	25%
Average	0.33	4.16%	0.5	6.25%	0	0%	4.66	58.33%	2.5	31.25%

According to Objective One, the data in Table 4.10 reveals that 4.16% strongly disagreed, 6.25% disagreed, and 0% were neutral. In contrast, 58.33% agreed, and 31.25% strongly agreed with the statement. Table 4.12 presents findings from questionnaires and interviews conducted with 8 respondents (4 head teachers and 4 deputy head teachers in charge of studies) from selected public secondary schools in Ngoma District. The results indicated that the majority of these school leaders observed a noticeable difference between teachers who regularly participated in CPD activities

and those who did not. Head teachers and deputy head teachers reported that teachers who attended CPD sessions regularly showed improvements in their teaching methods, preparation of pedagogical documents, and subject knowledge, all of which contributed positively to students' academic performance. Conversely, teachers who did not attend CPD activities regularly faced challenges with pedagogical documentation, teaching methods, and content knowledge in mathematics.

Table 3 Teachers' feedback on the correlation between teachers' participation in CPD programs and the academic performance of students in mathematics subject.

Variables		Academic performance in mathematics subject	Students' class attendance
Academic performance in mathematics subject	Pearson correlation Coefficient(r)	1	0.887
	Significance. (2-tailed)		0.01
	N	140	140
Students' class attendance	Pearson correlation Coefficient(r)	0.887	1
	Significance. (2-tailed)	0.01	
	N	140	140

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

V. CONCLUSION

The study on Continuous Professional Development (CPD) and its impact on academic performance in mathematics at Rwandan public secondary schools found that CPD activities play a crucial role in the professional development of mathematics teachers, which in turn leads to better student performance.

The first conclusion revealed that CPD helps teachers stay updated with mathematical theories, teaching methods, and technology, improving subject knowledge, teaching strategies, and adaptability to curriculum changes. It also encourages mentoring, leadership roles, and collaboration, contributing to a positive learning environment and higher student attendance, which in turn boosts academic performance.

The second conclusion highlighted the impact of professional teaching strategies on student achievement. Approaches such as integrating ICT, using diverse instructional materials, personalized learning, and fostering teacher-student relationships were shown to improve student performance in mathematics.

The third conclusion highlighted a strong positive correlation (0.887) between teachers' participation in CPD programs and improved student performance in mathematics. It also pointed out challenges such as reduced interest in mathematics, low student scores, and absenteeism, which

were linked to insufficient CPD implementation. The study underscored the critical role of continuous teacher development in enhancing student achievement in mathematics education.

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