



Effect of Continuous Professional Development on Teaching Biology in Nine Year Basic Education Schools of Gicumbi District, Rwanda

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Abstract: *This study was conducted to determine the effect of continuous professional development on teaching biology in 12 Nine Year Basic Education schools of Gicumbi district. This study is a mixed research and used a descriptive research design to determine the effect of CPD in 9YBE schools of Gicumbi district. The population of this study was 3235 people, including school head teachers, biology teachers and students while the sample size was 356 people. A questionnaire and an interview protocol were used as data collection instruments. Data were analyzed by using the thematic method. Chi-square test and Karl Pearson product moment correlation coefficient were used to establish the relationship between variables. Findings from this study showed that CPD has a significant effect on teaching biology as long as teachers and head teachers are accountable to effectively conduct it in order to improve teachers and school leaders' capability which enhances biology teaching and learning outcomes. It was observed that CPD significantly increase students' learning outcomes $p < 0.05$. Teachers, education authorities and education partners should organize and implement CPD in 9YBE schools to improve teaching and learning biology.*

Keywords: *Continuous professional development, nine-year basic education, teaching, biology, Twelve Year Basic Education, Teaching – Learning Process*

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1. Introduction

For a country to develop, education is a requirement. Education plays a major role in enabling people to gain a thorough understanding, positive attitudes, and values, as well as the capacity to make wise decisions and contribute to the welfare of society (Yoon et al., 2007).

The study of living things is known as biology, and it is broken down into a variety of specialist subjects that include their morphology, physiology, anatomy, behavior, origin, and distribution. It is also the study of life, or living things,

in all its manifestations and occurrences, particularly in relation to their development, growth, reproduction, structure, and behavior (Harrison, 1907).

In India, the teacher is both the cornerstone of the educational system and the social architect. The caliber of a school's instructors determines how far it may advance. Tomorrow's citizens are today's children. Nothing can compare to or surpass a teacher's superb work in fostering a child's future (Selvaraj et al., 2018). Teachers must continually be at the top of their field in order to prepare effective prospective teachers for the twenty-first century. It

entails ongoing, diverse (formal, non-formal, and informal) activities with the goal of fostering teachers' intellectual abilities (cognitive domain), self-confidence, attitudes, values, and interests (affective domain), as well as skills and competencies (psychomotor domain), for the purpose of enhancing personality and carrying out the duties of the teaching profession properly in accordance with the changing times and needs of the potential teachers as well as society (Tsung-Jui & Ya-Chun, 2015)

Teachers are encouraged to work on their knowledge, skills, and practice as part of a planned, ongoing, and lifelong process known as continuous professional development (CPD), which is meant to help them become more empowered, improve their agency, and help their organization as well as their students. In Zimbabwe, it plays an important role in teaching the four areas of pedagogy such as planning and sequencing activities in a lesson, managing a lesson and pupils, assessing learning, questioning strategies, using relevant tasks and available resources aligned with cognitive development (Richardson, 1997)

In New York, Further training can help teachers improve their interactional skills and acquire methods for assisting these students to reach their full potential. CPD offers teachers the ability to sharpen existing abilities and learn new ones that aren't taught during teacher training (Berliner, 1996). CPD is defined by Borko (2004) as the process of engaging in activities that advance one's abilities as a teacher, including knowledge, expertise, and other traits.

In Rwanda, the Ministry of Education (MINEDUC), Rwanda Basic Education Board (REB) and other partners in education have established a framework for CPD through which teachers gain enough knowledge and skills constantly (MINEDUC, 2018). For instance, through the University of Rwanda-College of Education (UR-CE), teachers are trained on pedagogical aspects and material development and they are given chance to upgrade their education level. Rwanda Basic Education Board and its partners like Flemish Association for Development Cooperation and Technical Assistance (VVOB), Building Learning Foundations (BLF), Laterite, Right to Play, Save the Children, United States Agency for International Development (USAID) Soma Umenye; Inspire, Educate and Empower Rwanda (IEE Rwanda), among others deliver pre-service and in-service training, workshops, materials like textbooks and online learning platforms for teacher's self-study. At school level, the school heads are encouraged to have regular CPDs on weekly basis for teacher development purpose (Opfer & Pedder, 2007).

The emergence of digital tools and a variety of other reasons have caused a dramatic change in the profession of teaching in the 21st century. As a result, among other things, the complexity of the 21st century necessitates that teachers pursue ongoing professional development to avoid becoming irrelevant and alienated (MINEDUC, 2019).

Thus, with reference to Economic Development Poverty Reduction Strategy III (EDPRS III), Vision 2050, Millennium

Development Goals (MDGs), Rwanda government set policies based on national priorities and aspirations through MINEDUC and REB for becoming knowledge-based economy and science-led country in all corners aligned with enhancing quality of life at all levels for becoming middle income country as wealthy nation. The assessment of the effect of CPD on biology teaching in Rwanda 9YBE is necessary.

In Rwanda, CPD has been embraced in all domains. In education, different approaches of CPD have been developed, which can help in quick learning and teaching activities. Ministry of Education through Rwanda Basic Education Board (REB) and education partners have planned and implemented CPD framework in all secondary and primary schools, with the aim of equipping teachers and learners' competencies in teaching and learning.

Thus, today, in some schools, many MINEDUC reports illustrate the major issue which have been identified as the lack of adequate CPD and some teachers are behind in teaching and learning which prevents them to help learners during biology content learning, assimilation and understanding. The absence of a culture around the use of CPD also prevented the widespread adoption of such approach in education. This was attributed to the limited availability of CPD content, and expertise, especially in rural areas of the country (MINEDUC, 2016).

Despite the fact that the government provides CPD tools, there are some schools which are still lagging behind in having CPD implementation for biology teaching. So, every teacher must understand the effect of continuous professional development in biology teaching development. Therefore, the present study was conducted to determine the effect of continuous professional development on teaching biology in selected schools of Gicumbi district. It is in this regard that this study sought determines the effect of continuous professional development on teaching biology in Rwanda.

2. Literature Review

The phrase "continuous professional development" refers to further education that professionals pursue. Typically, CPD aids in improving their talents at work. However, it goes much beyond merely learning (Guskey, 2002). To improve personal abilities for use in the business, CPD transforms learning into something deliberate and proactive as opposed to passive and reactive. Additionally, a range of approaches, including professional gatherings and online courses or e-learning, are used (UNESCO, 2008). CPD refers to the learning activities that professionals do to advance and improve their skills. It is the professionals' all-encompassing dedication to improving their own abilities and competence throughout their employment (Malmberg-Heimonen et al., 2016)

Several studies on effect of CPD on teaching biology have been conducted. In line with this, this section provides an empirical review of CPD effect on teaching and learning

process. This provides background information for undertaking this study about the effect of CPD on acquisition of Biology subject in the schools of Gicumbi district. According to Caena (2020), CPD involves gathering and determining the progress that the teaching staff has made with regard to improving their professional expertise in comparison to their previous training.

Digital technology has significantly impacted the teaching profession in the 21st century. It is therefore crucial for teachers to incorporate this technology into the teaching of biology. Teachers are hence expected to upgrade their professional skills so that they can keep updated in their respective fields of specialization (Dooner et al., 2008)

There are therefore various benefits of CPD to teachers. These include continuous training of teachers, being updated about recent innovations in their fields, enhancing professional experience, improving teachers' digital competences so that they can be able to navigate digital sets and links of knowledge. This therefore enables teachers to acquire new skills using recent and modern digital technologies. CPD assists in developing their abilities to prepare and conduct professional meetings. In this regard, teachers are enthusiastic about assisting their future colleagues to the new teaching profession. Moreover, CPD increases teachers' competences to design different educational materials, including textbooks and curricula. It also enhances teachers' abilities to conduct different types of assessments, especially e-evaluation. CPD improves teachers' confidence in fulfilling various educational roles, ranging from being a trainer, a research agent and material producer, just to mention few (Burnaford et al., 2007).

With reference to Yoon et al. (2007), there are various programs that can assist teachers to advance their CPD so that they can be able to face the intricacies of teacher-training in the 21st century. These include school-based learning where experienced teachers can mentor fresh teachers by conducting model lessons. There can also be induction for recently recruited teachers in order to support them with the challenges they may face at the beginning of their professional journey. Teachers can also do their CPD by improving their skills and knowledge in their specific subject-content. Moreover, CPD can be organized in form of conferences, seminars, symposium, where teachers can present and discuss their innovative ideas, present their research findings, and have exhibitions about various educational initiatives. There are also programs for brainstorming about issues in education, programs for professional affiliations and organizations that provide various digital training skills and participating in different public lectures.

A recent graduate of teacher education programs in Kenya typically believes that they are fully prepared to work as professional educators. He or she has cultivated an idea of the teaching profession, the role of instructors in the classroom, and has had numerous opportunities to observe teaching in action. The difficulties arise when a graduate of such a program is required to stand in front of a group of

students, give up the position of a student, and assume the position of a teacher. The once-familiar setting has abruptly changed into something foreign, leaving the novice feeling alone in an unfamiliar and unpleasant circumstance (Mushtaq et al., 2014).

During their first teaching experiences, beginners' conscious and unconscious expectations of the profession and of themselves may not be satisfied and are likely to stay unsubstantiated (Ling & Mackenzie, 2015). The graduates may begin to think unfavorable things like that they have not acquired the required and relevant skills from their colleges as they find that their daily duties are far different from what was learnt while they were still students and hence, they start doubting their vocations to become teachers. There is a risk that new teachers could "rest on their laurels" and approach their work in a monotonous, unimaginative manner even after they have adjusted to school life, grown accustomed to their teaching job, and mastered the necessary skills (Carpenter et al., 1988)

It was stated in the report titled "Learning: the treasure within" by the Committee for Education in the 21st Century, which was established by the United Nations Educational, Scientific, and Cultural Organization (UNESCO), that by the year 2020, knowledge in various scientific subjects is expected to be restructured every 76 days (International Commission, 1996). School administration, school assessment, ICT, and most importantly, learners themselves, are all changing at the same time due to cultural variety, changes in learning methodologies, changes in methodologies in the sciences, etc (Odden et al., 2002).

Consequently, it's crucial that pre-service teachers learn the significance of lifelong learning, as well as what possibilities are available to them once they graduate and begin working, where they can go for requesting support, and evaluating the worth of various educational courses (Lam, 2015). In some nations, the same organizations that give pre-service training also conduct in-service teacher training, but in other nations, colleges play a much smaller role in continuous in-service training, which is instead accessible on the open marketplace (Goddard et al., 2000)

In the context of Rwanda, the government is ambitious to become knowledge- based economy country through science development, thereby promoting quality of education at all levels and the teacher placed at centre since Rwanda aspires to promote quality of teaching and learning different subjects including biology, through regular CPD sessions whereby the CPD plays a medium role (EDPRS III, Vision 2050). The impact of CPD progress is observed worldwide, and when the time for curriculum development comes, the CPD point plays an important role in its design, development, and dissemination. Science teachers including biology teachers, cannot ignore the CPD progress, especially in teacher development and the effect it presents. CPDs may be applied to biology teaching development in several ways "as a plan for the systematic use of various pedagogical areas (Sherin & Han, 2004; Desimone, 2009 & Bautista et al., 2016).

3. Methodology

Mixed research method (qualitative and quantitative) was utilized in this study. This study was carried out in 12 selected 9 YBE schools which are GS Kinishya, GS Byumba Catholique, GS Kagamba, GS Nyagakizi, GS Munyinya, GS Gaseke, GS Nyabishambi, GS Mukono, GS Kaniga, GS Nyagatoma, GS Kibali and GS Kageyo. For examining the effect of continuous professional development on teaching biology in Nine Year Basic Education schools of Gicumbi district, it took two months.

The target population of the study was 3202 ordinary level students studying biology plus, 21 biology teachers and 12 head teachers from twelve 9YBE schools of Gicumbi district, from the stated above selected schools, among which ten schools performed well in biology in 2020/2021 national examinations and other ten schools which performed poorly in the same exams. The total number of target population was 3235 students. Ordinary level students were used in this study since these students are the only ones who learn biology as a subject.

Table 1: Structure of the targeted population for the selected schools in Gicumbi district

Schools	Number of students (S1-S3)	Number of teachers (S1-S3)	Number of head teachers	Total
GS Mukono	309	2	1	312
GS Nyabishambi	427	2	1	430
GS Kaniga	103	1	1	105
GS Nyagatoma	307	2	1	310
GS Kageyo	163	2	1	166
GS Kibali	365	2	1	368
GS Kagamba	210	2	1	213
GS Munyinya	395	2	1	398
GS Byumba Catholique	202	2	1	205
GS Kinishya	323	1	1	325
GS Gaseke	307	2	1	310
GS Nyagakizi	91	1	1	93
Total population	3,202	21	12	3,235

Source: Primary data collected in March, 2022

All students, biology teachers, and head teachers from the nine-year basic education schools in the Gicumbi composed the population for this study. Purposive and simple random sampling methods were used in this study by considering student results in biology from national examinations of the academic year 2020/2021. Twelve schools were purposively selected as six top performers and six others as low performers.

Yamane formula was used to determine the sample size. The symbols which are used in the formula are explained as follows: n stands for sample size, N represents the population while e denotes error

By using 95% confidence interval and 3235 as a number to represent the population, the sample size was calculated in this way:

$$n = \frac{3235}{1+3235(0.05)^2} = 356$$

Sample size = 356 respondents

Thus, the sample size of 356 respondents was considered as representative of the total population. It included 323 students, 21 biology teachers and 12 head teachers as shown in table below.

Table 1: Sample size

Schools	Number of students (S1-S3)	Number of teachers (S1-S3)	Number of head teachers	Total
GS Mukono	27	2	1	30
GS Nyabishambi	27	2	1	30
GS Kaniga	27	1	1	29
GS Nyagatoma	27	2	1	30
GS Kageyo	27	2	1	30
GS Kibali	27	2	1	30
GS Kagamba	27	2	1	30
GS Munyinya	27	2	1	30
GS Byumba	27	2	1	30
Catholique				
GS Kinishya	27	1	1	29
GS Gaseke	27	2	1	30
GS Nyagakizi	26	1	1	28
Total sample size	323	21	12	356

Source: Primary data collected in March, 2022

During the research, a letter was written to the Mayor of Gicumbi district requesting for permission to conduct interviews with biology teachers and school head teachers and administer questionnaires to students of 12 nine-year basic education schools of Gicumbi district on the effect of continuous professional development on teaching biology. Before conducting interviews and administering questionnaires, the researcher introduced himself and gave clear explanations to the respondents about the research purpose. During the interview, the researcher used interview protocol with close-ended questions.

On one hand, qualitative data collected from interview were analyzed using SPSS, Chi-square and Pearson correlation tests. This involved data coding, editing and tabulation. Data coding, editing, and tabulation were required for this. On the other hand, quantitative data were analyzed using descriptive statistics.

4. Results and Discussion

4.1 Student awareness about how often biology teachers attend CPD

Students perceive CPD differently depending on their school organization and performance. For instance, in this study, statistics revealed that no respondent (0%) strongly disagreed with whether their biology teachers attended CPD regularly while 21 respondents (6.5%) disagreed with the statement. 128 respondents (39.6%) were not sure of CPD occurrence and 166 respondents (51.4%) agreed while 8 respondents (2.5%) strongly agreed.

Table 3: Student awareness about how often biology teachers attend CPD

Agreement extent	Frequency	Percentage (%)
Strongly agree	8	2.5
Agree	166	51.4
Not sure	128	39.6
Disagree	21	6.5
Strongly disagree	0	0
Total	323	100

Source of data: Primary data collected in March, 2022

4.2 Student views about how CPD changed teaching and learning biology

Asked whether there was any change to teaching and learning because of CPD activities conducted in schools, 24

respondents (7.4%) disagreed with CPD occurrence within their respective schools while no respondent strongly disagreed; 76 respondents (23.5%) were not sure while 200 respondents (61.9%) agreed and 23 respondents (7.1%) strongly agreed with the statement.

Table 4: Student views about how CPD changed teaching and learning

Agreement extent	Frequency	Percentage (%)
Strongly agree	23	7.1
Agree	200	61.9
Not sure	76	23.5
Disagree	24	7.4
Strongly disagree	0	0
Total	323	100

Source of data: Primary data collected in March, 2022

4.3 Student views about performance increment

For the same purpose of investigating about students' perception on CPD, the researcher asked respondents whether there was any performance increment after biology teachers started sitting for CPD sessions. Numerical data obtained revealed that there was no respondent who strongly

disagreed with the statement while 7 respondents (2.2%) disagreed; 39 respondents (12.1%) doubted about performance increment in biology subject while 118 respondents (36.5%) agreed with it. By calculation, the remaining portion of 159 respondents (49.2%) strongly agreed with such an increment. The researcher observed that data collected from the students may be fairly trustful due to low awareness about CPD since this is mainly a teacher's concern.

Table 5: Student views about performance increment

Agreement extent	Frequency	Percentage (%)
Strongly agree	159	49.2
Agree	118	36.5
Not sure	39	12.1
Disagree	7	2.2
Strongly disagree	0	0.0
Total	323	100.0

Source: Primary data collected in March, 2022

Thus by using SPSS, Chi-squared test resulted to the following:

$\chi^2 = 1.4595$, $df = 1$, $p\text{-value} = 2.23e-06$, which shows that CPD has significant effect on teaching biology in Nine Year Basic Education ($p < 0.05$).

4.4 Perception of biology teachers and school head teachers about the effect of CPD on teaching and learning biology in 9YBE schools

When conducting this survey, the researcher used an interview protocol to collect data from teachers and head teachers of schools involved in the survey. When asked whether schools organize and conduct weekly CPD activities, no respondent strongly disagreed nor disagreed. None of them doubted about the statement while 13 respondents representing 39.4% agreed and 20 participants (60.6%) strongly agreed. Visibly, the majority of respondents asserted that CPD activities were organized weekly and conducted within 9YBE schools selected in Gicumbi district.

For the statement of availability of CPD action plan within schools involved in the sample, no teacher or head teacher strongly disagreed nor disagreed with it while 3 respondents (9.1%) were not sure of CPD action plan availability. 14 participants (42.4%) asserted that schools investigated had CPD action plans while 16 participants (48.5%) strongly agreed with the availability of such a planning. So, as you see, the majority of teachers and heads of schools surveyed confirmed that 9YBE schools of Gicumbi district had CPD action plans.

During the study, the researcher inquired whether teachers attended CPD sessions regularly. None of the participants strongly disagreed with the statement while 4 participants (12.1%) disagreed with it. No participant doubted about regular teacher CPD attendance; 18 respondents (54.5%) agreed while 11 respondents (33.3%) strongly agreed with the statement. Comparing data of table 11 it is remarkable that the majority of respondents representing 54.5% asserted that biology teachers of 9YBE schools of Gicumbi district investigated regularly attended CPD sessions.

The survey continued with the statement four which intended to enquire about the extension of teacher's level of content understanding as a result of CPD attended. Neither biology teachers nor school head teachers sampled strongly

disagreed, while 11 of them (33.3%) disagreed. Eight teachers and head teachers (24.2%) doubted about such an extension of content understanding and 10 participants (30.3%) agreed while 4 participants (12.1%) strongly agreed. In general, the majority of respondents represented by 30.3% agreed that CPD organized and conducted successfully contributed a lot to teacher's level of content understanding. Such results got attained through CoPs where teachers met and discuss biology content in science department.

The fifth statement of the enquiry was about teacher's acquisition of new techniques and skills as school CPD outcome. Evidently, data collected from research field showed that neither biology teacher nor school head teacher strongly disagreed, disagreed or doubted about the statement. A portion of 10 participants (30.3%) agreed on one hand while another portion of 23 participants (69.7%) which represents the majority strongly agreed with the statement.

The last researcher's statement of protocol interview enquired about the extent to which continuous professional development enhanced students' learning outcomes. Ten respondents (30.3%) asserted that CPD contributed to the enhancement of students' learning outcomes while 23 respondents (69.7%) representing the majority strongly agreed with the statement. None of the survey participants strongly agreed or disagreed, or had any doubts about the statement.

Therefore by using SPSS, Chi-square test was carried out and this below was found: $\chi^2 = 83.618$, $df = 1$, $p\text{-value} < 2.2e-16$. This shows that $p\text{-value}$ is less to critical value (0.05) and it shows that CPD has significant effect on the biology teaching and learning in Gicumbi 9YBE schools.

5. Conclusion and Recommendations

5.1 Conclusion

To assess the effect of CPD on biology teaching and learning in 9YBE schools of Gicumbi district, a structured questionnaire was administered to 323 students whilst 21 biology teachers and 12 head teachers were interviewed. The majority of investigated students that is 200 representing 61.9% asserted that CPD activities affected positively biology teaching and learning (table 7). The latter was emphasized by the fact that 49.2% of students strongly agreed and 36.5% agreed with the increment of their performance in biology (table 8). Furthermore, 69.7% of biology teachers and head teachers strongly agreed while 30.3% agreed with the fact that CPD increased biology learning outcomes.

Therefore, a positive correlation between CPD sessions and teaching biology was observed (Fig.6). CPD affects positively biology teaching and learning outcomes in 9YBE schools. Residual standard error: 3.51 on 9 degrees of freedom, Multiple R-squared: 0.9863. Adjusted R-squared: 0.9544. F-statistic: 30.9 on 21 and 9 DF, $p\text{-value}$: 5.412e-

06. The $p < 0.05$, means that CPD has significant effect on teaching biology. As CPD activities are conducted, it also enhances biology teaching as well as biology learning outcomes. Based on the results, the null hypothesis is rejected in favour of alternative hypothesis to confirm that CPD has effect on biology teaching in 9YBE schools in Gicumbi district.

5.2 Recommendations

This study extracted the real situation of the effect of CPD on teaching biology in selected 9YBE schools of Gicumbi district, Rwanda, and it informs different domains. The following recommendations have been made:

1. Education institutions, health, and social and economic sectors should understand what CPD is and how to apply it in capacity building framework for their staffs by using useful information from the current study.
2. NGOs, education partners and civil society have to get tangible facts for fighting against the barriers to continuous professional development on teaching improvement.
3. As leaders of teaching and learning, school administrators are advised to foresee a special budget line for CPD. Also, it would be better whether they initiate monitoring and evaluation on how CPDs are planned, organized and implemented within schools.
4. The government, through Ministry of Education (MINEDUC) and Rwanda Basic Education Board (REB) designed a mentorship program and framework for CPD implementation within schools. Unfortunately, this program and framework are followed and implemented in half way. These two education agencies should do their best to reduce SBM's workload for better mentorship program implementation

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