

Contribution Of Teacher Continuous Professional Development To Biology Practical Experiments In The Ordinary Level Of Secondary Schools In Rwanda

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Abstract – The professional development process is thoughtfully organized, continuous, and extends over an extended period, thereby improving teachers' teaching competence and classroom assessment skills. The present study aimed to exploring the contribution of teachers' continuous professional development on biology practical experiment lessons in the ordinary level of secondary schools in Rwanda. Its specific objectives were to examine the effectiveness of the lesson planning of biology practical experiments and to assess the effectiveness of delivering biology lessons on the practical experiment in the ordinary level. A qualitative research design was conducted in 32 schools, it involved a population of 32 biology teachers in the ordinary level who have been trained by the Flemish Association for Development Cooperation and Technical Assistance (VVOB) and Rwanda Quality Basic Education for Human Capital Development (RQBEHCD) by University of Rwanda College of Education (UR-CE) trainers. Information was gathered through interviews, questionnaires and classroom observation. Thematic analysis was used to analyze the data. The findings demonstrated that continuous professional development (CPD) training assisted teachers in the preparation and presentation of biology practical experiments. We conclude that through CPD training the teachers' attitudes, skills and knowledge on planning and conducting biology practical experiments has increased. Further, CPD has improved the confidence of teachers. Even though teachers identified the contribution of CPD training there is a gap in the finding resources (materials and reagents) and no well-equipped laboratories to offer hands-on activities and this can be addressed through the strengthening of teachers' capacity of using improvisation skills.

Keywords – Continuous professional development, lesson planning, lesson delivery, practical experiments, improvisation skills.

I. INTRODUCTION

Continuous professional development (CPD) is the practice of consistently learning and enhancing one's skills and knowledge throughout their career with the aim of improving their performance. (REB., 2015). Taking this perspective into consideration, individuals across different occupations engages in continuous professional development (CPD) to obtain and utilize new

knowledge and skills, primarily with the goal of improving their job performance. (Ihejiama et al., 2020). Studies show that an employer who offers favorable CPD opportunities and fosters a positive learning atmosphere for employees tends to be more appealing to clients and achieves greater success. Moreover, CPD functions or plays a crucial role in fostering the personal and professional development of staff members. CPD provides benefits such as enhancing skills, adopting new methods, retaining previously acquired knowledge, and fostering the stimulation of creativity and the promotion of innovation. (Chikari, 2015)

According to Fraser (2005) suggests that the CPD in the education sector has three primary objectives. The primary objective is to verify that teachers' methods align with policies related to education. The second purpose is to assist teachers in enhancing students' learning outcomes, and the third is to elevate the overall teaching profession. Furthermore, Nwagbo (2016) points out that effective teaching is frequently linked to the efficient use of resources like laboratory experiments, diagrams, charts, models, fieldwork, and tangible real-world objects to elucidate the subject matter. Practical work has proven to be effective in promoting positive attitudes among students and enhancing motivation for effective learning in science, as described by Okam and Zakari (2017). Therefore, a positive attitude towards the importance of practical work significantly influences students' achievement in science. (Hinne, 2017). Additionally, practical activities in plays a pivotal role in solidifying the theoretical concepts learned in the classroom, making the learning experience more tangible, and igniting students' enthusiasm for studying biology.

The CPD has been implemented in various countries, including Ethiopia, Uganda, and Pakistan. In Pakistan, its primary objective has been to improve the overall quality of the teaching and learning experience, elevate professional competencies, improve the standard of education, and boost the motivation and accountability of educators or instructors. The CPD framework in Pakistan was constructed for in-service primary teachers. In this regard, school mentors had the task of guiding teachers based on their needs at school level (Osborne, 2015). However, despite the initiative, research conducted by Osborne (2015) indicated that Pakistan was confronted with problems in provisioning facilities susceptible to help teachers putting in practice what they have received from the CPD programs at school level.

In Ethiopia, educators are encouraged to practice introspection and be receptive to change to meet the government and public's expectations for a high standard of education. They are required to take into account the changing dynamics of both students and society at large. This highlights the significance of continuous professional development (CPD) in Ethiopia, with the aim of enhancing the quality of teaching and learning processes and improving the overall quality of education. The literature regarding quality education in Ethiopia emphasizes a significant link between the professional development of teachers and enhancements in the standard of education. This connection is particularly evident in fields like teachers' beliefs and methods, student learning outcomes or academic achievements, and the execution of educational reforms. (Cuseo, 2007)

In Uganda, the level of professionalism among teachers has not significantly improved due to various challenges. This is mainly due to the fact that the quality of pre-service teacher training remains insufficient, and numerous in-service training initiatives have fallen short of achieving their intended objectives for educators, as emphasized by Menon (2015). Recent reports indicate that a significant proportion of teachers exhibit inefficiencies in their classroom practices. For example, a recent report from the Uganda National Examinations Board (UNEB), which assessed educational progress, indicated that over 90% of primary school teachers in Uganda lacked fundamental knowledge of Mathematics and English language concepts, and they also encountered challenges in evaluating students. These reports highlighting insufficient teacher performance emphasize the critical necessity for ongoing professional development (CPD) to bridge the divide between initial teacher education and continual career growth.

In addition to continuous professional development (CPD), practical experiments have been identified as essential for the effective teaching and learning of biology. As suggested by Malik (2017), biology practical activities offer students a valuable opportunity to utilize the knowledge and skills they have recently acquired. The practical experiment is mainly supported by the inquiry-based teaching and learning (IBTL). In this regard, the IBL as defined by (Loonng, 2018) as an approach in which learners are required to follow processes of scientific discovery in the same way that professional scientists do during the learning process to effectively construct knowledge and justify sources of knowledge. Various studies have explored the impact of continuous professional development (CPD) on practical experiments using Inquiry-Based Learning (IBL) approaches. These studies have consistently demonstrated that thoughtfully designed PD experiences that involve teachers in genuine investigations can significantly improve teachers' subject matter knowledge (Huang, 2012)

In Rwanda, the government has implemented measures to improve the qualifications and performance of teachers by revising

the education policy. This policy aims to encourage teachers to develop a strong commitment to their teaching activities and to adopt strategies that can improve their performance. The Education Sector Strategic Plan (Hramiak, 2013) emphasizes that the improvement of students' completion rates, grades, and scores is closely linked to the quality and usefulness of education, this, in turn, relies on the excellence and proficiency of the teaching staff. In pursuit of this goal, Rwanda has established the National Teacher CPD Framework under the Rwanda education board, specifically within the Department for Teacher Development and Management and Career Guidance and Counselling (TDMCGC). This framework was developed in collaboration with input from the Teacher Professional Development Technical Working Group (TPD TWG).

In Rwanda, the application of continuous professional development (CPD) began in the period from 2014 to 2016. During this time, University of Rwanda, College of Education in collaboration with the Rwanda Education Board partnered with the Flemish Association for Development, Cooperation, and Technical Assistance (VVOB) to launch a certified CPD program, the program was aimed at primary schools leaders, with a focus on enhancing effective school leadership, as well as sector education officers, with an emphasis on facilitating professional learning communities for head teachers. Concurrently, the program also catered to tutors in teacher training colleges and trainers responsible for pre-primary teacher education, all with the objective of enhancing learner-centered pedagogy (REB, 2020). As of the end of 2021:

- A total of 809 Headteachers, along with 545 Deputy Headteachers, and 20 district officials have undergone training in the principles and practices of Effective School Leadership.
- A comprehensive training effort has resulted in the preparation of 228 Sector Education Inspectors, 1,253 School-Based Mentors, and 1,522 STEM School Subject Leaders and Math School Subject Leaders in the field of Educational Mentorship and Coaching.
- Within the primary education sector, the program also offered training to 48 Teacher Training College tutors in the area of Educational Mentorship and Coaching. This training specifically focused on the facilitation of induction programs for new teachers, ensuring they receive effective mentorship and support.
- Significantly, numerous sectors have established Professional Learning Communities (PLCs), fostering collaborative learning among educators. Furthermore, each of the targeted schools now arranges a minimum of two Communities of Practice (CoP) sessions annually. These initiatives promote professional development and knowledge-sharing among teachers and educational leaders.

The CPD was also implemented under the Rwanda Quality Basic Education (RQBE) project supported by the World bank, REB and the University of Rwanda College of Education. Both primary and secondary school teachers were trained in utilization of ICT for teaching and learning mathematics, science for the ordinary level teachers, and science and elementary technology for primary teachers. In the same subjects, the training also covered selected topics for both the understanding of the theory of the subject content and for laboratory activities. The training focused also on the utilization of the inquiry-based teaching and learning. However, less is known about how the CPD contributed to the effective teaching and learning of biology, particularly using practical experiment.

The Rwandan government considers education as a pillar to achieve the country's envisioned socio-economic transformation. The education sector analysis of 2018 (MINEDUC, 2018) outlines key challenges in education. Inadequate teacher proficiency in subject matter, teaching methods, and the languages used for instruction pose a significant risk to the effective delivery of the curriculum and the inclusion of all students in the educational process. Ultimately, these shortcomings can have a detrimental effect on student learning outcomes. Moreover, research has indicated correlations between inadequate academic achievement among students in Rwanda and a range of factors, including the inadequacy of laboratory equipment, as highlighted by Ndiho Kubwayo (2017). This highlights the significance of tackling these issues to enhance the overall quality of education and boost student performance. In a similar vein, Rubagiza et al. (2016) have noted that untrained and demotivated teachers constitute another significant factor that has contributed to a decline in the quality of teaching. This decline in teaching quality, particularly prevalent in many rural areas 12-year basic secondary schools in Rwanda, has subsequently had a negative impact on students' academic performance. Addressing teacher training and motivation is crucial in improving the overall educational landscape and student outcomes, especially in these rural areas.

To address these challenges, the Rwanda Education Board (REB) developed the national teacher CPD Framework. Technical assistance for this initiative was given by the UNESCO East Africa office, supported by financial assistance from organization of petroleum exporting countries (OPEC) Fund for International Development (OFID). This partnership resulted in the initiation of the "enhancing standards of teaching and learning for Education for All in Eastern Africa" project in 2015. Additionally, VVOB, in partnership with the University of Rwanda - College of Education (UR-CE) and the Rwanda Education Board (REB), initiated a CPD program in 17 districts of Rwanda as part of VVOB's five-year program called "Leading, Teaching and Learning Together" (2017-2021). Subsequently, the Rwanda Quality Basic Education (RQBE) extended CPD opportunities to teachers in eight districts outside of those initially trained by VVOB. These initiatives reflect a coordinated and determined effort to enhance the professional growth of educators and enhance the educational standards in Rwanda.

Similarly to many developing nations, laboratory work in Rwanda encounters difficulties due to science teachers' inadequate practical abilities, time constraints for planning scientific activities and experiments, and an examination system that places greater emphasis on theory rather than practical application (Nsengimana, 2022).

Moreover, the scarcity of financial resources results in a shortage of laboratory equipment and educational materials, causing teachers to conduct laboratory activities infrequently or undervalue the importance of practical work in cultivating positive attitudes toward science (Ndihokubwayo, 2017). The main objective of this study was to investigate the contribution of teachers' continuous professional development on biology practical experiment lessons in the ordinary level of secondary schools in Rwanda. In spite of all of the above-mentioned initiatives, there was no scientific study that assessed the contribution of the CPD programs to the effective planning and conducting practical experiments in the ordinary level of the secondary schools of Rwanda using the inquiry-based teaching and learning. Specifically, less is known about how the CPD contributed to effective teaching biology content through laboratory activities. The objective of the study was to evaluate how teacher continuous professional development impacts the implementation of biology practical experiments in secondary schools at the ordinary level in Rwanda.

II. METHODOLOGY

2.1 Research design and population study.

This study used a qualitative research design as it helped to record and analyze the perceptions of the respondent concerning variables under the study. For the current research, there was a need of verifying the contribution of teacher continuous professional development on biology practical experiments in ordinary level.

Participants were biology teachers teaching biology in ordinary level of Rwanda secondary schools who had trainings of VVOB and RQBEHCD by UR-CE trainers. The ideal was to have at least one biology teacher from each school participating in this study. However, in case the school had more than one biology teachers teaching biology in ordinary level, all these teachers participated in the study.

2.2 Selection of schools

This study was conducted in 32 schools purposively selected in southern province of Rwanda and the school selection criteria included having biology teachers who teach biology subject in ordinary level, being in southern province, and who had received the CPD training either by VVOB or by Rwanda Quality Basic Education for Human Capital Development (RQBEHCD). Specifically, a number of the schools was chosen based on the number of trained participants in the districts and were representative of the entire population and schools were in the following districts; in Nyanza (2 schools), Gisagara (2 schools), Muhanga (11 schools) and Huye districts (17 schools).

2.3 Research instrument and validation

The questionnaire determined three sections: personal information: experience in teaching, attended the CPD activities; effectiveness in lesson planning and delivering biology practical experiment lesson, pedagogical documents observation and lesson delivery observation.

The tool was composed by open-ended questions where the participants described their views and thoughts about the CPD training. Interview were narrated to how the CPD equipped with skills and knowledge in planning and delivering a biology

practical experiment Lesson and challenges in relation with delivering a biology practical experiment lesson effectively in terms of pedagogy, ICT, Improvisation and laboratory equipment.

The questionnaire was adopted from similar studies and adapted to Rwanda context. To ensure reliability of questionnaire, the pilot study was done with secondary school 10 teachers in Huye district. Questions were the same and undertaken in the same way and after collecting questionnaires and analysis, results were obtained. In this study, the researcher conducted an interview while making field notes and later compared the results from all fields.

1. 2.4 Data collection and analysis

A permit to conduct the data collection was obtained from University of Rwanda, then submitted to four southern Districts: Muhanga, Huye, Gisagara and Nyanza District for official reception, then the letter was submitted to the head teachers of all selected secondary schools. The qualitative data was gathered from teachers using interview guide, questionnaires and class observation. During the observation the researcher has collected the preliminary data like, steps of Inquiry-Based Learning, the organization of the content, planning of resources, planned learning activities with specification of teachers' and learners' activities, management of the practical experiment and planning the evaluation conducted at the end of the lesson.

Thematic analysis method was used to analyze the qualitative data. Data collected from interview was sorted and recorded, and data have been converted, interpreted and inspected with the purpose of discovering the important information, and helps the researcher to make clear decision and concluding the data clearly (Were et al., 2011). Data collected from questionnaires and observation were reviewed, cleaned, coded and identified to uncover themes and it is a dynamic process that involves the researcher's subjective engagement in interpreting the data to make sense of it (Blatchford et al., 1998).

III. RESULTS

3.1 Data Presentation

This chapter goes in deep by presenting findings based on the order according to the formulated two objectives, viz. to examine the effectiveness of the lesson planning and delivering of biology practical experiment lesson in the ordinary level of the secondary schools in Rwanda. The data collected and analyzed are from 32 schools.

3.1.1. The effectiveness of the practical lesson plan on biology practical experiments in the ordinary level of the secondary

Some teachers emphasized that lesson plans have a significant impact not only on their instructional delivery but also on classroom management. A well-prepared lesson plan for practical experiments is seen as crucial for fostering deep student engagement in experiments. This level of engagement becomes achievable when students have clearly defined roles and goals, which are typically provided in a well-structured lesson plan. They have also said that CPD helped them to become professional teachers to integrate 5 Es instructional model in the lesson planning. In turn, these helped learners to understand the lesson step by step. Furthermore, teachers reported that the CPD helped them to improve the planning, arranging materials and chemicals in the laboratory as a result of the discussions they have had during the CPD training.

However, other teachers from another school reported that "after CPD training they started organizing the activities at school level like coaching and mentoring of their peers about lesson planning of science subjects, use of improvisation, and they also commented that they have gained the knowledge about the using of virtual laboratory during teaching and learning biology subject.

A colleague from the same school stated that CPD improved their teaching in biology practical experiment lesson where he said that through CPD training he gained the skills and knowledge of following the procedures and steps of lesson planning of biology practical experiments. This feedback was supplemented by another teacher who indicated that "*CPD contributed more on planning pedagogical documents as it helped them to plan for examples a lesson plan which engage learners in teaching and learning process where they are now able to integrate the 5 E^s in the lesson planning*". Moreover, teachers commented that "*CPD helped them to planning in advance and check the availability of materials and effectiveness of the requirements for practical experiments and its protocol and understand each step before carrying out the experiments and how to connect the laboratory skills with the real life*".

In addition, teachers continued saying that CPD activities were very interesting because of the following reasons; it helped them to improve their teaching methodologies, how to motivate learners in the lesson, how to connect the biology practical skills with the real life, inspires scienceteachers and improved their preparation of lessons and experiment skills in biology and they alsopointed the most content of the CPD during training that have found important to them where all of them pointed the same content of biology laboratory experiments because some teachers said that “ *CPD encouraged them to plan the lesson plans that encourage the collaboration among teachers and learners and improved them to do their self-laboratory activities with confidence and able to plan and teach the biology practical experiments with the available materials due to improved improvisation skills*”.

The researcher also visited the teachers’ pedagogical documents where researcher found that all participated teachers were able to have good lesson plans of biology practical experiments by including practical activities to be carried out by learners and activities done by teachers, formulation of the instructional objectives in relation with the practical work lessons and consider inquiry process (Engage, Explore, Explain, Elaborate and evaluate).

Therefore, CPD training equipped teachers with skills and knowledge in planning biology practical experiment lessons and improved them on planning and organizing activities at school level where they started to share some activities with other science teachers and these activities are; community of practices, integration of ICT in planning biology lessons and laboratory experiment activities by performing different biology practical activities.

3.1.2. Assessing the effectiveness in delivering biology practical experiment lesson in the ordinary level of the secondary school in Rwanda.

Firstly, teachers pointed that CPD improved their teaching in biology practical experiment lessons and they work hard to deliver effective biology practical sessions. In this regard, the preparation starts earlier before the introduction of the chapter and focus on the preparation of assessments and delivering content. The results of this research demonstrated that biology teachers employed practical activity-based teaching approaches to enhance students' interest in the subject. Consequently, classroom sessions were deemed relevant and engaging, motivating students to eagerly explore and learn new topics. Some teachers remarked that” *before the CPD training, teaching of biology practical experiments was considered as teacher centered, where teachers would go in front of learners and perform experiments without engaging learners in doing practical activities but after training learners are now engaged in teaching and learning biology practical experiments*”.

Although, others biology teachers pointed that “*CPD has increased their abilities and confidence to carry out the laboratory experiments, following all procedures and steps to deliver the biology practical experiments and not only this but also noted that CPD increased their skills like problemsolving skills, teamwork and collaboration with learners while delivering biology practical experiments and they are able to engage learners in carrying out biology practical experiments*”.

Results have indicated that the CPD increased teachers’ skills specifically in problem solving, teamwork and collaboration learning when they are delivering biology practical experiments. Further, they can engage learners in carrying out biology practical experiment by themselves. The CPD training has increased the knowledge and skills on the integration of ICT while delivering biology lesson related to practical experiments. In this regard, virtual laboratories are used. Furthermore, a colleague from another school stated that CPD activities helped them to deliver lessons effectively where they teach from abstract to concrete and learners are given more time to discuss, carry out experiments and do presentations of the findings from the groups and teachers give them feedback and try to communicate the importance of the experiments in the daily life.

Then from the classroom observation, the researcher has observed that teachers prepare and deliver biology practical lessons related to practical experiments effectively and teachers adhere to the instructional objectives of the lesson during the delivery, teachers helped learners and objectives of the lesson during the delivery, teachers helped learners to work on planned activities, protocols were well formulated and students were more engaged in conducting laboratory practical works, which is a sign of the shift in teaching methods as well as in learning biology, where teachers were no longer applying knowledge based competence.

Moreover, teachers have acquired a more in-depth grasp of the kinds of materials necessary to facilitate effective science instruction. They no longer face difficulties in finding the required materials or concern themselves with shortages of resources, thanks to the improvisational skills acquired through CPD training. Moreover, delivering biology lessons using hands-on

materials has energized students and rendered learning more meaningful, as they engage with concepts and materials actively rather than passively absorbing information. When students encounter new materials or kits in the classroom, they eagerly investigate them, fostering excitement and a desire to discover what they will be doing next. This hands-on approach contrasts with situations where students primarily rely on reading science textbooks rather than actively participating in scientific inquiry.

Further, teachers pointed that the CPD contributed on delivering biology practical lesson where it improved them with carrying out the experiments by respecting the steps involved in delivering of biology experiments, use of improvisation during teaching and learning, relating biology practical experiments carried out with the real life situation, increased the level of competence and confidence, to work on planned objectives during delivery of content, attitudes to conduct and assist learners to perform experiments in the laboratory, utilization of virtual laboratory during teaching and learning, problem solving skills, analysis skills, class management, project based learning in which teacher helps learners to create some projects relating to the lesson and implement them not only at the school level but also to the school environment.

Therefore, CPD training equipped teachers with skills and knowledge in delivering biology practical experiment lesson where they pointed that CPD improved skills in delivering biology experiments and able to organize the biology practicals depending on the content to be delivered and though CPD improved their content delivery but there are still some challenges that are affecting their effective organization of biology practical lesson plan delivery and these challenges are; no well-equipped laboratory, large number of learners, lack of enough time to carry out experiments and teachers pointed how these challenges can be addressed like they should encourage to use local materials, use extra time and building well equipped.

3.2 Discussion

The focus of this study was to explore the contribution of teachers' continuous professional development on biology practical experiment lessons in the ordinary level of secondary schools in Rwanda.

3.2.1 The effectiveness of the practical lesson plan on biology practical experiments in the ordinary level of the secondary

The study's findings confirmed the effectiveness of the practical lesson plan in improving the knowledge of the subject matter and the experiment skills for trained biology teachers. The findings echo what found regarding the attainment of the high-level cognitive capacity of in-service teachers following a training intervention where experiments were used as an educational approach. The findings from Appleton (2007) revealed that in-service teachers had a longer knowledge retention rate when exposed to the training in laboratory work than those without the training about laboratory work. He arrived at a similar conclusion regarding the efficacy of professional development related to practical lesson plans. He observed that students whose teachers had received training in experiment-embedded teacher training performed better academically and engaged more frequently in science projects compared to students whose teachers had not undergone such training. (Harland & Kinder, 1997) highlighted the importance of the Teachers' continuous training to experiment skill development by emphasizing the value of the experimental teaching procedure.

Like many of these findings, the CPD described in the context of the current research involved inquiry-based activities during which the in service teachers were provided with opportunities to get engaged in Practical biology lesson plan, the use of science kits and improvisation. These training packages, in the long run, cultivate many skills other than experiment skills that could produce a teacher confident and competent to deliver biology practical experiments. Responses to the interview questions showed that major challenges to the acquisition of experiment skills were concerned with facility shortages and not well equipped laboratories. Guillame (1995) emphasized that teaching encompasses more than constant verbal communication. Utilizing resources like diagrams, fieldwork, and real objects effectively within a lesson plan can greatly enhance the understanding of subject matter. The laboratory is the ideal setting for conducting practical activities, and in the case of biology, a science subject, effective learning and teaching cannot occur without practical sessions, highlighting the importance of their preparation. The same author also found that students achieve a better understanding when actively involved in practical experiments during these sessions. They not only remember the procedures involved but also take pride in obtaining accurate results, emphasizing the necessity of aligning theory with practical application.

Furthermore, in education, planning is a structured process that entails making decisions regarding what students are expected to

learn and the methods through which they will acquire that knowledge. Typically, this responsibility falls on teachers, who determine the format and content of their instruction. This includes decisions regarding the balance between presenting information, asking questions, and facilitating discussions, the amount of material to be covered within a given time frame, and the depth of the instruction. In the planning process, it is crucial to define clear goals and objectives. Other essential factors in the planning process include an understanding of the learners, familiarity with the subject matter, and knowledge of effective teaching methods (Bryan, 2003).

Stawiński (1986), in discussing the science curriculum in Nigeria, emphasized the importance of integrating theory and practical components. He noted that the practical aspect of biology often receives insufficient attention and, when taught, students tend to focus solely on preparing for the Senior Secondary Certificate Examination. Consequently, this approach leads to students performing poorly in biology on their S.S.C.E. examinations. Confirming this observation, Chukwu (2009) noted that the allocated time for practical sessions, crucial for effective biology study, is insufficient. He stressed the necessity of exposing students to a series of practical activities. Stawiński and Chukwu both underscored the importance of teaching theory and practical aspects of biology as integrated components of the subject rather than treating them as separate entities.

3.2.2 Assessing the effectiveness in delivering biology practical experiment lesson in the ordinary level of the secondary school in Rwanda

Results of this study showed the contribution of CPD training to biology teachers in delivering biology practical experiments. An effective method for delivering a well-prepared lesson is by incorporating practical resources into the classroom. The use of practical approaches can enhance both lesson planning and delivery techniques. Students tend to retain information more effectively when exposed to such an approach, as the brain retains this information for longer durations. Additionally, it enables more adaptive and personalized learning by addressing areas of the subject that students may struggle to grasp. Numerous researchers in science education emphasize that students benefit from hands-on activities, which promote higher-order cognitive skills (Sayan, 2020). However, the availability of resources to conduct these recommended activities is often limited. Consequently, in some cases, demonstration-laboratories are planned, allowing students to make observations through demonstrations rather than engaging in hands-on laboratory activities (Ocak & Özay, 2005)

Further, teachers pointed that CPD improved their teaching in biology practical experiment lessons but although there is still a gap of shortage of materials and equipments to use while delivering biology practical experiments but they do improvisation in the laboratory because they got trainings on it. In Papua New Guinea, primary teachers are trained to be resourceful during their college education, but they often anticipate having access to conventional science equipment and materials once they start teaching in schools. This situation raises two significant issues. The first issue pertains to the nature of low-cost materials, and the second relates to teacher training. The term "low-cost" is frequently linked to items of lower value and prestige. However, in the context of science kits, "low-cost" means utilizing locally available resources and local technology whenever these are suitable and relevant (Chukwu, 2019).

Furthermore, the results, including classroom observations, indicated that CPD training has enhanced teachers' improvisational skills and increased their confidence in conducting biology laboratory experiments. Teachers who received training in producing their own low-cost apparatus have developed a sense of ownership and an understanding that such equipment can be more relevant and user-friendly compared to expensive imported alternatives. There is a need to raise awareness among teacher educators about the value of low-cost equipment so that they can instill confidence and enthusiasm for its use among future teachers (Kang & Wallace, 2005)

Improvisation serves to minimize educational costs. Regardless of this, many science teachers are either unenthusiastic or incapable of improvising teaching materials for lack of skills. Nonetheless, this behavior on the part of the teachers is comprehensible. Teachers should be adequately compensated for the additional time they invest in creating teaching materials to motivate them in this endeavor. However apart from heavy curriculum to complete at the end of academic year, in developing country classroom is clouded making teachers very busy to take care each student as well as class managing (Johnson, 1998).

IV. CONCLUSION

This study assessed the contribution of teacher continuous professional development to biology practical experiments in the

ordinary level of secondary schools in Rwanda, with a case study of some selected secondary schools in the Southern Province. Its objectives were to examine the effectiveness of the lesson planning of biology practical experiments and to assess the effectiveness of delivering biology lesson on the practical experiment at the ordinary level. Teachers affirmed that before the CPD training in practical experiments in biology, most of them were used to teaching theoretically. They pointed out that there has been a remarkable shift in the methodology of teaching since they have had this training. They gained a lot of knowledge and skills that have helped them teach effectively and conduct lab experiments with more confidence than before. Before the training, they experienced challenges in conducting lab experiments, but now, they do lab experiments with ease.

Lesson plans have a significant impact on both teachers' instruction and classroom management, especially when it comes to practical biology experiments. A well-prepared lesson plan for practical experiments not only helps teachers effectively guide students through the process but also promotes deep engagement in the experiments. This engagement is facilitated when students have clearly defined roles and objectives, which a good lesson plan provides. Furthermore, teachers reported that through the process of preparing lesson plans, they acquired a more comprehensive understanding of the materials needed to enhance science education, which contributed to more effective teaching practices.

V. RECOMMENDATIONS

The results of the study have notable significance for both the Ministry of Education and the school level.

- a) To the Ministry of Education, it is advisable to persist in providing of sufficient CPD trainings and workshops to teachers for making them aware of planning and delivering biology practical experiments.
- b) At school level, teachers are recommended to improvise materials using the cheap and locally available resources where possible without waiting for what the Ministry of Education or other stakeholders in education will provide.
- c) Teachers are also recommended to work together as a team and help each other to improve their planning and delivering biology practical experiments.

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