INVESTIGATION ON THE USE OF IMPROVISED MATERIALS TO REMEDIATE SCARCITY OF LAB MATERIALS IN TEACHING-LEARNING BIOLOGY IN SECONDARY SCHOOLS OF RWAMAGANA DISTRICT IN RWANDA.

BY

NDAYISHIMYE MARIE PROSPER

A thesis submitted in partial fulfilment of the requirements of the degree of Master of Education in Biology Education

African Centre of Excellence for Innovative Teaching and Learning Mathematics and Science (ACEITLMS)

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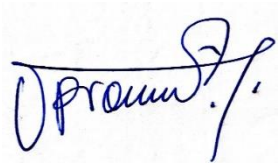
DECLARATION

I declare that this thesis is the result of my own work and has not been submitted for any other degree at the University of Rwanda or any other institution. It passed through the anti-plagiarism system and found to be compliant.



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DEDICATION

This research is dedicated to Almighty God for His grace, mercy and protection upon me throughout my academic journey. It is as well dedicated to my parents for their endless and tireless prayers, love, and moral support. I also dedicate the findings of this research to my son ICYIZERE Christian Réponse.

ACKNOWLEGEMENT

I am very grateful to my supervisor Dr. HABIYAREMYE Jean de Dieu (PhD) for his encouragement, support and working tirelessly until completion of this thesis. I would also thank the ACEITLMS for admitting me into the Masters' program and following me until its completion. My gratitude also goes to the leaders of Rwamagana district and head teachers of schools selected for this research who allowed me to collect data in their schools. I thank deputy head teachers and teachers for their contribution and cooperation during the data collection exercise. They generously responded to my questionnaires and interview.

Finally, I express special thanks to my cousin KIZA Francoise and my bother MANIRAFASHA Samuel Blaise for love and moral support.

God bless you all.

ABSTRACT

In 2014, Ministry of Education (MINEDUC) reported that schools in Rwanda with science laboratory tools and chemicals were rated at 17%. This would mean that teachers in only a few schools would conduct practical activities whereas many other schools would mainly rely only theoretical sessions. To deal with this issue, science laboratory kits have been distributed in some schools by today. Furthermore, educational stakeholders have also started to train a number of science teachers in different districts, on the use of improvisation in teaching and learning as remedy of lack of conventional laboratory materials and reagents. However, in almost all district of Rwanda, including Rwamagana, students still perform poorly in biology national examination. This is associated with inappropriate teaching and learning that relies only on theories.

Three specific objectives guided this study: (1) to explore the status of the use of improvised materials in teaching biology in secondary schools of Rwamagana district, (2) to identify challenges faced by teachers while developing and using improvised materials for biology practical classes in Rwamagana district and (3) to find potential solutions to challenges faced by biology teachers while developing and using improvised materials for biology practical classes in Rwamagana district. The study involved twenty-five biology teachers and four deputy head teachers in charge of studies. It used a mixed research design with explorative and diagnostic approaches. Quantitative data from the questionnaires were analysed using statistical package for social sciences (SPSS) while qualitative data were analysed by inductive content analysis approach.

Findings of this research showed that 66% of secondary school biology teachers of Rwamagana district still frequently use lecturing while teaching under pretext that the conventional laboratory materials are lacking. This was an indication that the improvisation is not applied as it was supposed to be due to numerous challenges.

These include mainly lack of time to prepare improvised materials, large class size that would necessitate a big number of materials, vast content to teach dictating teachers to mainly use lectures and presentation to fully cover the content of the syllabus, and lack of regular teachers' trainings to enhance their improvisational skills.

For potential solutions, many respondents suggested to avail time on timetable for making improvised materials, enhance biology teachers' improvisational skills through regular trainings, encourage biology teachers to use extra time to design improvised materials, and award the teachers who develop and use improvised materials.

This study provides a general picture on the status of the use of improvisation in secondary schools of Rwamagana district and is intended to direct next strategies to conduct biology laboratory practicals even in a case the conventional materials and reagents are missing.

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LIST OF ABREVIATIONS

AIMS: African Institute for Mathematical Science

AIMS-TTP: African Institute for Mathematical Science - Teacher Training Program

CBC: Competence Based Curriculum

CPD: Continuous Professional Development

DOS: Deputy Director in charge of Studies

HEC: Higher Education Council

KBC: Knowledge Based Curriculum

NINEDUC: Ministry of Education

REB: Rwanda Basic education Board

CHAPTER 1: INTRODUCTION

1.1 Background of the study

Etymologically, the word "Biology" originates from two Greek words *bios*, which means life, and *logos*, which means knowledge. Briefly, biology is the study of life (Kenya Institute of Education, 2005 recited by Nyongesa 2012). Thus, biology is immensely relevant to everyday life as it helps comprehend a human being and his surroundings. According to Thierer (2012), biology is an important and significant field of study because it has a significant impact on human's current and future life. Various scientific fields such medicine, agriculture, conservation, food production, home science, and industry are rooted in biology (Ziyadulla, 2019). The same author stated that knowledge and skills gained from learning biology highly contribute to efficient use of natural resources and help to understand environmental changes as well as the factors affecting these changes. In medicine and health related issues, biology helps to understand diseases and to find effective ways of preventing, treating, and curing them. Biology knowledge and skills are also applied to various home management techniques including methods such as improved food preservation, efficient food preparation and care of the family. Last but not least, biology knowledge and skills intervene in improving agricultural yields.

To gaining a deeper comprehension of the natural phenomena and learn how science endeavors to clearly explain and solve real life problems, students need to be exposed to practical work (Gott & Duggan, 1995). This is an answer to many debates among scholars regarding the specific purpose of laboratory practical classes in schools. Furthermore, the use of laboratories in schools that includes mainly different laboratory materials and reagents for practical work is one of the main factors improving students' achievement in science and mathematics subject (Eshiwani, 1993). However, a big number of teachers conduct science classes theoretically, encouraging memorization instead of investigative oriented learning. Such classes decrease students' opportunity to acquire the required skills and to relate scientific concepts to the real life. Also, science classes only conducted theoretically do not allow students to construct their own knowledge of natural phenomena (Hofstein & Mamlok-Naaman, 2007). Eshiwani (1984) gave insight into why students perform so poorly in science subjects. He suggested the following causes: insufficient time allotted for learning science satisfactorily; inadequate instructional materials; poor quality and inadequate teacher

preparation; and the nature of the science curriculum, which is highly abstract and seems unrelated to the students' immediate environment. As a result, students develop negative attitude toward science.

Biology, one of the science subjects demands active students' participation, including the use of resources in hands-on activities, much more than any other science topic (Nwagbo, 2008).

This author sees biology as a student-centered and activity-based subject. This means that effective teaching and learning biology necessitates enough resources, including mainly laboratory facilities and equipment. These include models, chemicals, and various biology lab instruments (Ityokyaa, 2010). However, laboratories are lacking in many schools, and this negatively affects biology students' learning if nothing is done for remedy (Daba et al, 2016).

One of the ways to deal with the scarcity of lab materials and other appropriate instructional resources is to use improvisation (Mushimiyimana et al. 2022). Eshiet (1996) defined improvisation as the sourcing, selection, and deployment of locally available materials in the teaching/learning process in the absence or scarcity of the certified teaching/learning equipment. As scarcity or total lack of the certified teaching/learning equipment is the situation in most of the developing countries, including Rwanda, improvisation can still help to achieve the learning goals (Lingam and Lingam, 2013).

Since 2009, the former Rwanda examination council has begun to assess practicals in science subjects in Rwandan secondary schools. Since then, schools have begun to enhance the use of laboratory equipment, but many schools are still lacking enough adequate lab materials.

However, a survey conducted by MINEDUC (2014) showed that availability of science tools and chemicals in schools was rated at 17%. This implies fewer practical activities in schools.

Ndihokubwayo (2017) identified lack of laboratories and teachers' improvisational skills among factors that prevent biology practical activities from being fully performed in Rwandan schools. To deal with scarcity or total absence of the modern lab materials in many Rwandan secondary schools, different improvisational trainings were organized to train science and mathematics teachers on how to use improvisation in making teaching resources (Sibomana et al. 2023).

Even though a quite number of science teachers of Rwanda secondary schools are trained on improvised teaching and learning materials and have already started using them in teaching, their poor quality and uneven development and utilization among teachers and schools are

still interfering with their effectiveness. Thus, the ultimate goal of this study to investigate the use of improvised materials in remediating scarcity of lab materials in teaching-learning biology in secondary schools.

1.2 Statement of the research problem

Ability of the students to develop awareness of the environment, to acquire significant and relevant biology knowledge required for a successful life in a technologically and scientifically advanced word, and to make room for the development of new technologies are among the objectives of teaching biology at the secondary school level (Fatima, 2021). However, a lot of biology teachers in secondary schools still use the lecturing style while teaching the subject, a challenge to achieve both the objectives and the academic success of the students. Abdussemiu (2022) asserts that practical work is a crucial part of teaching and learning biology since it helps biology become more learner-centered, interesting, and understandable for both teachers and students. Besides, Abdussemiu (2022) attested that the academic achievement of students in biology is significantly influenced by the availability of a strong teaching and learning environment, where the practical and theoretical sessions complement each other. According to this view, students' poor performance in biology may strongly be due to their limited exposure to practical work. Students that receive fewer or no biology practical exercises tend to make bad observations, use poor deductive reasoning, and misinterpret problems, as consequence to ultimately acquire inadequate biology knowledge and skills. In the same understanding, students lack the technical know-how to use, maintain, and fix available laboratory equipment. On this important matter, Ogbe and Omenka (2017) lamented that in some schools there is a total or partial absence or inadequacy of the science teaching resources because of no financial capabilities to purchase them. According to Branchaw (2020), absence of a biology laboratory, lack of biology teachers' practical skills necessary to put the available laboratory equipment to effective use, and the absence of improvised instructional materials are all reasons why biology teachers are unable to organize practical work for their students.

In 2015, the Rwanda Basic Education Board (REB) and the Ministry of Education introduced a competence-based curriculum (CBC) and recommended its implementation in all Rwandan schools to replace the previously used Knowledge-Based Curriculum (KBC) (Nsengimana, 2021). This was done to ensure that students reach their maximum potentials in terms of

relevant knowledge, skills, and appropriate attitudes, preparing young Rwandans to integrate in society and exploit employment opportunities (REB, 2015). If schools have labs and students effectively complete practicals, this goal in science topics would unquestionably be accomplished. Ndihokubwayo et al., (2018) asserted that many schools especially these of the status of Nine and Twelve-Years Basic Education in Rwanda and specifically in Rwamagana still lack laboratories and laboratory equipment. That is the reason why African Institute for Mathematical Science -Teacher Training Program (AIMS-TTP) has offered trainings on conducting experiments using improvised materials and the usage of science kit components to achieve the CBC goals (Sibomana et.al, 2023). In this view, as practicals must be done, teachers and students are required to improvise resources from locally available raw materials because schools cannot always afford to supply all the required resources (Sibomana et.al, 2023), making improvisation a sure and effective mean of applying the CBC in many of our schools. Thus, this research to investigate the level of the use of improvisation in schools of Rwamagana district as a way to remediate scarcity of conventional laboratory materials in teaching and learning biology within secondary schools of the district.

1.3 Objectives of the study

The overall aim of this study was to investigate the use of improvised materials to remediate scarcity of conventional laboratory materials in teaching and learning biology in secondary schools of Rwamagana district of Rwanda. Specifically, the study was conducted to:

1. Explore the status of the use of improvised materials in teaching biology in secondary schools of Rwamagana district.
2. Identify challenges encountered by teachers while developing and using improvised materials for biology practical classes in Rwamagana district.
3. Find potential solutions to challenges encountered by biology teachers while developing and using improvised materials for biology practical classes in Rwamagana district.

1.4 Research questions

The present study was guided by the following research questions:

1. What is the status of the use of improvised materials in teaching and learning biology in Rwamagana district?

2. What are the challenges faced by teachers while developing and using improvised materials for biology practical classes?
3. What are the potential solutions to challenges encountered by biology teachers while developing and using improvised materials for biology practical classes in Rwamagana district?

1.5 Significance of the research

The study will provide an insight on the use improvised materials in teaching and learning biology in Rwamagana district schools. The findings will enable teachers and students to appreciate the usefulness of their surrounding environment materials to increase performance in teaching and learning biology subject.

The study will also direct next measures or strategies in relation to a better teaching and learning biology, especially in running practical sessions even in case the conventional teaching and learning equipment are totally absent or scarce.

Finally, stakeholders of Rwanda education system (decision makers, beneficiaries, etc.) will benefit from findings of this study in the formulation of future science education policies via enhancing the use of improvisation in teaching science to remediate the scarcity of conventional equipment for biology practical classes.

1.6 Limitation of the study

This research faced numerous limitations. These are mainly lack of enough funds that could permit the researcher to reach many respondents and lack of previous related research papers on teaching and learning science in Rwamagana district schools.

1.7 The scope of the study

This study involved twenty-five biology teachers and four deputy head teachers in charge of studies within ten secondary schools of Rwamagana district.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This review of literature comprises role of biology lab practicals in teaching and learning biology, teachers' attitudes towards improvisation, factors limiting design and development of improvised materials and impacts of improvisation on student's academic achievement. It also elaborates dependent and independent variables alongside theoretical and conceptual frameworks of this study.

2.2 Role of biology lab practicals in teaching and learning biology

In secondary schools, biology subject is supposed to be effectively taught both theoretically and practically, including the use of laboratories (Hofstein and Lunetta, 2004). Biology laboratory, like any other science laboratory is defined as a place where students acquire new knowledge, concepts and skills, in order to achieve better understanding of rules, processes, principles, laws, theories and natural phenomena (Uche, 2018). Tobin (1990) wrote that "laboratory activities serve as a way of allowing students to understand and, at the same time, engage in a process of constructing knowledge by doing science". This is the reason why Hofstein and Mamlok-Naaman (2007) emphasized that teaching science lessons only theoretically encourages memorization instead of sound investigative-oriented learning and fails in affording students' chance in planning inquiries and performing own experiments, manipulating materials and apparatus to enhance the construction of own knowledge of phenomena and related scientific concepts by students.

In addition, Edison and Lwazi (2017) are of the view that there is a need to enhance practical works for students to understand science processes and structures, develop skills in manipulation, process science information and conduct scientific investigations. Goldey et al. (2012) agree that through practical works, science students develop practical and generic skills that include higher-order cognitive processes such as hypothesis testing, reading primary literature, analyzing data, interpreting results, writing in disciplinary style, and working in teams. Nwagbo (2016) believes that teaching biology practical classes is required to produce students who have the necessary knowledge, skills, and competence. Barrie et al. (2015) view laboratory-based practical activities as bedrock of science studies because they provide students with an opportunity to develop critical thinking skills necessary to become a

scientist. Salaudin et al. (2020) expressed that secondary school students do not fully understand most of biological concepts when taught without instructional materials. As a study of life and living things, biology must also be taught practically for it to be meaningful, enjoyable, understandable, and appreciated by students. It is therefore reasonable to anticipate that biology teachers will place a significant emphasis on understanding of biology rather than information gathering or memorization.

Even though laboratories have several advantages, like providing a foundation for science instruction and helping students acquire concepts in a more concrete way, Hunde and Tegegne (2010) found that students were not given the chance to use them. On this matter, Fafunwa (1981) identified major challenges faced by teaching practical classes. He sees quality of teachers, approaches to science teaching, adequacy of laboratory apparatus and equipment and class size in science teaching as areas that if well addressed will improve the teaching and learning of practical biology classes. Also, lack of proper laboratory facilities could be one of the causes for the students' lack of opportunity to biology practical activities.

Dahar (2011) agrees that secondary school are fundamental in preparing students for science education where students should be exposed to laboratory equipment, activities, precaution and safety rules, but he reported lack enough facilities for teaching science. As a result, students are not sufficiently exposed to hands-on teaching; instead, they merely observe the teacher's demonstration. The practicals while teaching and learning science in secondary schools should go hand in hand with theoretical instruction. According to Stephens and Winterbotton (2010), biology as a practical science provides students opportunity to apply, explore, and develop their knowledge and understanding of biology in investigative situations, which can help learning and memory retention, and stimulate curiosity. Like all science students, biology students would be taught in small classes held in well-equipped laboratories. In absence of those well-equipped laboratories, the place of practical activities cannot be over emphasized, yet there is an alarming lack of the materials needed to teach and learn sciences including biology. Reference to this, Adebimpe (1997), recited by Ogbe Alphonsus Okori and Omenka Jerry in 2017, lamented about complete or partial lack of science teaching materials and insufficient funds, particularly for the purchase science equipment, poor maintenance culture and at times some school leaders' attitudes on science and scientific equipment in an attempt to transform science instruction into what it is supposed to be. In addition, Balogun (1982) emphasized that schools are usually not able to

provide all required science equipment, no matter how rich they are. Therefore, one of the most effective strategies would be the use of improvised materials in the concerned schools.

2.3 Teachers' attitude towards improvisation

Improvisation is the process of producing and using locally available instructional materials and resources in the shortage or absence of conventional ones (Bassey, 2002). This was supported by Akinmoyewa (2012) who defined improvisation as the art of creating a replica of something out of readily available materials that performs a similar function to the original material. In the same view, Eriba and Regina (2011) defined improvisation as the creation of educational materials using materials that are readily available nearby and can properly substitute or serve in place of the original materials, which may otherwise be very expensive, in short supply, or unavailable. According to Okebukola (2002), improvisation in biology should be understood as the process of utilizing alternative resources for bettering biology instruction when there aren't any available. Eshiet (1996) defined improvisation as the sourcing, selection, and utilization of appropriate instructional components of the teaching and learning process in the absence or scarcity of the accredited teaching and learning element in order to meaningfully realize certain educational goals and objectives. Obviously, the lack of instructional material urges the teachers to start the process of creating the alternative resources. Students could help the teacher invent some of the needed instruments or materials as well. Fajora (2008) views improvisation as arising from creativity. Substitution of conventional teaching and learning materials by the improvised ones merely refers to the process whereby an already existing local material is used in place of a piece of equipment that is not readily available. In a similar way, construction of the improvised materials involves constructing a new instrument to serve in place of the unavailable original one, when substitution is not possible.

Without interaction between teachers, students, and environmental resources, biology cannot be taught effectively. Due to insufficient instructional materials in many secondary schools, new, creative methods of making instructional materials available for efficient teaching and learning are required (Sallau at al. 2019).

Chukwunyeremunwa (2013) views teaching materials as a wide range of tools and resources used by teachers to facilitate learning and encourage student initiative.

Bello and Olowonefa (2004) pointed out that instructional materials broaden students' perspectives and comprehension beyond the basic informational prerequisites for the lesson. Additionally, improvisation can influence students' views toward science (Zarewa, 1991). Zarewa views students to stand a better chance of developing a positive attitude toward sciences if teachers can encourage them to take part in the improvisation exercise. Therefore, students should be involved in collecting, constructing, fixing, etc. of some fundamental and safe objects for improvisation. This will relate abstract biological concepts, theories, laws, etc. to real life situation (Zarewa, 1991).

A study conducted in Nigeria provides insights that biology teachers have a positive attitude towards improvisation for teaching and learning of biology (Nuhu et al. 2021). Teachers see improvisation of teaching materials as a good technique to fill the gap when conventional instructional materials are scarce or unavailable (Mboto et al. 2011). They added that for an improvised material to be valid, the material should provide the desired results as expected, improve the lesson effectiveness and reduce to minimum the risks associated with the lack of the modern equipment. Biology teachers regard improvisation as an opportunity to demonstrate their creative skills as they develop low cost teaching materials that would help them to achieve instructional objectives (Sallau et al. 2019). The same authors also opinioned that improvisation equips teachers with the ability of thinking the best teaching methods that are cheaper, better and faster to make students learn easier. On the contrary, a study conducted by Isaac et al. (2018) revealed that biology teachers' attitude towards development and use of improvised materials was not good. Biology teachers agreed that producing and improvising materials is not expensive but increases the work load as it requires more time and extra attention. In addition, some biology teachers believe that finding raw materials for producing improvised materials is difficult while other teachers lack creativity or feel lazy of improvising. Others biology teachers lack improvisational motivation because some improvised materials do not last long while other teachers associate improvised materials with low standards.

2.4 Factors hindering production and use of improvised materials

Nnenna (2018) listed several factors that hinder effective improvisation of instruction materials. These factors are: (a) big class sizes very difficult to control and therefore discouraging some teachers to make improvised materials. In addition, there is no time to get

well organized to improvise instructional materials in such big classes. (b) Some teachers find difficult to use money from their salaries to improvise instructional materials due to their low incomes. (c) The design and development of instructional resources requires perseverance, creativity and inventiveness which are qualities that many teachers do not yet have. (d) Features of improvisable materials such as size, weight, etc., make it difficult for classroom teachers to improvise some teaching tools. (e) Insufficiency of the trainings. A teacher needs to be resourceful, imaginative, and initiative in order to improvise. In addition, the teacher must be patient. These qualities are gained through systematic training which are still very few. (f) Lack of support from school leaders. In the majority of cases, the school leaders display no interest, they hesitate to invest in improvisation even though the expenses are minimal compared to conventional materials. (g) Teachers are not exposed to educational technologies. As a result, teachers only have a limited understanding of how to improvise materials. (h) Teachers aren't really motivated (poor motivation). (i) Teachers feel frightened of unsafe improvisation. (j) The material that is improvised may not be accurate and precise. (k) Mindset of students who willingly prefer real conventional materials over local ones and risk losing interest in lessons taught with utilization of improvised resources. (l) Financial limitations that impedes the purchase of some of the materials required for developing improvised materials. Last but not least, (m) making improvised instructional materials sometimes requires assistance from personnel such as carpenters, metal workers and artisans who are sometimes difficult to find in the school environment.

2.5 Impact of improvisation on students' achievement

To be learned effectively, science subjects including biology could be learned by doing rather than learning theoretically the concepts (Mushimiyimana et al., 2022). According to the same authors, learning only through theories results in forgetting the concept while learning by doing helps students grasp the concept more quickly and perform well in tests and exams. Therefore, learning by doing is the greatest technique to study science subjects such as biology. In addition, schools with more instructional materials perform better than those with fewer resources (Adeogun, 2001). Thus, there is a link between academic performance and the quantity of instructional materials the school possesses. According to Nwagbo (2006) and George (2008), lack of instructional tools when teaching biology can certainly result in unsatisfactory academic performance. Without using instructional materials that the students are familiar with, the mastery of biology concepts might not be fully attained.

On the use of improvisation, Mboto, et al (2011) concluded that the use of improvised material in teaching and learning science including biology provides the students with proper knowledge and the practical skills required for significant performance. Therefore, students should be exposed to the utilization of improvised materials because without the use of such instructional materials some science concepts would remain abstract. Esu (2004) opinioned that improvisation helps students integrate their abstract and practical experiences of teaching and learning. That agrees with Abanikannda (2021) who associated great students' achievement with availability and use of improvised materials. In a study conducted by Olaware (2020) on the impact of improvised materials on students' achievement, biology students who were taught using improvised materials performed better than those who were taught without it. These results lead to him concluding that students who are taught using improvised instructional materials achieve higher than those who are not because the use of improvised instructional materials enhance science learning in general and biology learning in particular.

2.6 Theoretical framework

Grant & Osanloo (2014) defined theoretical framework as the "research's blueprint or guidance". It is an outline that is based on an existing theory in an area of research that is relevant to and/or represents the study's hypothesis (Dickson et al. 2018). Dickson et al (2018) added that the research is centered on the theoretical framework, which is connected to the research problem that is being studied. As a result, it influences a researcher's decision about research design and data analysis strategy. The theoretical framework also influences the type of data that needs to be gathered for a certain study (Lester, 2005).

This study was underpinned on Gagne's theory of learning and social constructivism theory of learning. Gagne's theory stipulates that there are many different types or levels of learning. The significance of these classifications is that each different type requires different types of instruction. Gagne (1985) identifies five major categories of learning: verbal information, intellectual skills, cognitive strategies, motor skills and attitudes. Different internal and external conditions are necessary for each type of learning. For example, for cognitive strategies to be learned, there must be a chance to practice developing new solutions to problems; to learn attitudes, the learner must be exposed to a credible role model or persuasive arguments.

In learning biology, students should be exposed to resources for effective learning. Biology teachers and students should be able to create appropriate, adequate, and relevant material resources by improvisation so gaining appropriate intellectual skills regarded as ways of critically thinking and solving problems.

On other hand, constructivism is a theory of how the learner constructs knowledge from experience, which is unique to each individual (Sunita and Sangeeta, 2015). Mwanda et al. (2016) put that in constructivist learning, learners can develop meaningful concepts through repeated manipulation of objects and ideas, which can then be formalized and applied to logical reasoning. In science practical classes, constructivist epistemology assumes that students build their own knowledge through interactions with their surroundings. Constructivist learning has assumptions that: "Students who participate in active learning construct knowledge physically; students who make their own representations of actions construct knowledge symbolically; students who communicate their meaning-making to others construct knowledge socially; and finally, students who try to explain concepts they don't fully understand construct knowledge theoretically" (Sunita and Sangeeta, 2015). In line with the present study, effective biology teaching and learning requires students to work together and interact with resources some of which should be improvised to construct knowledge.

2.7 Conclusion

This chapter discussed teachers' attitudes towards improvisation, where improvisation has been defined and also cleared three components of effective teaching of biology: teachers, students and environmental resources. It also discussed different factors that hinder development of improvised materials and how improvisation affects students' achievement. The empirical review also looked at challenges faces by biology teachers due to inadequate or scarcity of lab materials and emphasizes improvisation as a solution to that challenge. The theoretical framework discusses the theories on which the researcher underpinned this study.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

The current research aimed at investigating the use of improvised materials to remediate scarcity of lab materials in teaching-learning biology in secondary schools of Rwamagana district in Rwanda. This chapter presents the methods and procedures used during this study. Specifically, it discusses the research design, describes the sampling strategies, instruments of data collections, validity and reliability of the research instruments, data collection procedures and analysis as well as ethical consideration.

3.2 Research design

Maxwell (2005) defines research design as the basis upon which all other aspects of the study depend. Inaam (2016) defines research design as the "glue" that holds all the elements in research. It provides a framework for the collection and analysis of data (Bryman, 2012). The research design specifies the procedures to be used for collecting and analyzing the necessary data as well as how all of this will be used to address the research question (Grey, 2014). This study used a mixed research design. According to Dawadi (2021), the mixed-research design involves both qualitative research approaches that use tools such as interviews to explore and derive objective findings and quantitative approaches that use instruments like questionnaires to help fully understand the issue through suggestive results. This study involved explorative approach. According to Daniel Katz (1953), exploratory approach attempts "to see what is there rather than to predict the relationships that will be founded". The questionnaires and interview were designed to help understand more about the status of the use of improvised materials in teaching and learning biology and how biology teachers manage to use the improvisation to conduct practical classes in scarcity or absence of laboratory materials. The study also used diagnostic design. According to Velu (2023), diagnostic research design is an approach that identifies and analyses the root causes of a problem and the factors that contribute to that specific problem and helps in providing effective solutions. In this research, diagnostic design was used to explore and find out solutions to the challenges faced during development and utilization of improvised instructional materials.

3.3 Population of the study

According to Creswell (2012), a population is a group of individuals who share common characteristic that a researcher can study. Alex (2014) in Encyclopedia of Quality of Life and Well-Being Research, defines study population as a subset of the target population from which the sample is selected. The current study involved twenty-five biology teachers from ten secondary schools selected in Rwamagana district.

3.4 Sample size and sampling strategies

To select the respondents for data collection, the researcher used purposive sampling in data collection. According to Pooja (2019), purposive sampling also called deliberate sampling is a sampling where members for a sample are selected according to the purpose of the study. Since all schools whether having laboratory rooms or not are required to improvise instructional lab materials in absence or shortage of conventional ones, this study selected randomly ten secondary schools.

These are G.S Rwamagana A, G.S Gishari, Collège Marie Reine de la Paix, Groupe Scolaire Saint Aloys Rwamagana, G.S Rutonde, G.S Sovu, G.S Karenge, Ecole Secondaire Rwamashyongoshyo, G.S Rwamagana Protestant and G.S Nyarusange. Since the purpose of the study was to investigate the use of improvised materials to remediate scarcity of lab materials in teaching-learning biology, only biology teachers in the selected secondary schools of Rwamagana district participated in this study. For this end, 25 biology teachers were selected as indicated in the table 1. In the same line, 4 Deputy Head teachers in charge of Studies (DOSs) who studied sciences education were selected to provide their beliefs and understanding on the use of improvisation in teaching and learning biology in their respective schools. Their selection was dictated by the fact that their responses were thought to contribute much more than those that might be provided by non-scientist DOSs.

Table 1: Target population

School	Number of respondents	Gender
G.S St Aloys Rwamagana	2	M
G.S Rwamagana A	2	F
	1	M
G.S Rutonde	2	M
G.S Gishari	1	F
College Marie Reine de la Paix	4	M
G.S Sovu	2	F
Ecole Secondaire Rwamashyongoshyo	1	F
G.S Rwamagana Protestant	4	M
G.S Karenge	1	F
	2	M
G.S Nyarusange	2	F
	1	M
DOSs	1	F
	3	M
Total respondents	Biology teachers: 25	
	DOSs: 4	

3.5 Data collection instruments

Syed (2016) defines data collection as the procedure of gathering on variables of interest. This research used questionnaires and interview for data collection.

Questionnaire

Nigel (2023) defines a questionnaire is an instrument of gathering data from people by asking them a series of questions. According to him, questionnaires can collect both quantitative and qualitative data which provide a deeper understanding of the research topic. In this research, the questionnaire was designed to help the researcher collect both quantitative and qualitative

data simultaneously. The questionnaire consisted of structured and unstructured questions. The structured questions consisted of Likert's scale type with five responses: strongly agree, agree, neutral, disagree whereas unstructured questions required the respondents to provide their own views. Appendix 2 shows the questionnaire given to biology teachers to collect data for this study.

Interview

An interview is defined as a face-to-face conversation between two people conducted specifically to get data relevant to the research objectives (Anupama, 2022). In this study, interview was used to collect accurate data from the interviewees. The current study opted structured interview using open-ended questions administered to DOSs. This provided clarification which complemented data gathered by using the questionnaires. The interview guiding questions of this study are found in appendix 3.

3.6 Validity and reliability of research instruments

Drost (2011) defined validity as "how well a measure corresponds to the underlying concept that it is intended to represent". He also defines reliability as "the extent to which measurements are repeatable when conducted by different individuals on various occasions, under various conditions, and presumably with alternative tools that measure the construct or skill". According to Rosnow and Rosenthal, (1991), the reliability coefficient, which measures the relationships between tests, items, and raters, is the best method for estimating reliability.

In this study, to validate the research instrument, a draft copy of the research questions was given to the supervisor for examination. The supervisor examined the research questions for relevance, convenience and coverage of the scope of the study. The suggestions and comments from the supervisor were addressed to produce the final research tool approved by the supervisor. To test for reliability, the same questionnaire was administered twice to the same respondents and the correlation coefficient between responses was computed. In addition, the Cronbach's alpha coefficient was computed using statistical a package for social sciences (SPSS) to determine the reliability correlation of the results. The Cronbach's alpha was found to be 0.727 for the first questionnaire and 0.752 for the second. The values of Cronbach's alpha $0.7 \leq \alpha \leq 0.8$ are acceptable (Nurul at al. 2015).

3.7 Data collection procedure

Questionnaires were given to biology teachers in the selected schools. All biology teachers in those schools were requested to respond. After their completion, the questionnaires were returned to the researcher for data analysis. The researcher and the DOSs agreed on appropriate day and time when the interview could be conducted. The researcher visited DOSs' offices on day and time as per agreement for interview. The interviews were recorded by a voice recorder device from where they were transferred to the research's personal computer for storage and further analysis.

3.8 Data analysis

Likert scale data type from the questionnaire was coded to help obtain a manageable summary. Strongly agree, agree, neutral, disagree and strongly disagree were given numerical values 5, 4, 3, 2 and 1 respectively. The coded data was quantitatively analyzed with help of the computer software known as Statistical Package for Social Sciences (SPSS) using descriptive statistics and helped to present data in a form of frequency table. Responses on open-ended questions were grouped into the content of related research questions. Interview data was analyzed by inductive content analysis approach. Data analysis from both quantitative and qualitative data helped in discussions, drawing conclusion as well as recommendations.

3.9 Ethical consideration

Before commencing data collection involving human participant, it is a must to get approval at different administrative levels (Fleming, 2018). In this line, before conducting this research, the researcher obtained a recommendation letter from university of Rwanda college of education to present to authorities of Rwamagana district, then after the researcher sought for the permission from the district to conduct his research in the selected schools. The researcher presented an introductory letter to head teachers before starting the data collection. All participants were explained the purposes of the research and were asked to willingly participate. The researcher ensured participants to keep their answers confidential and to use them for only the research purpose. He also explained that participant reserve the right to ask anything they want before and during research, to hide their identity and to withdraw from the research anytime they feel uncomfortable with it.

CHAPTER 4: PRESENTATION OF FINDINGS

4.1 Introduction

This chapter presents the findings of the study carried out to investigate the use of improvised material to remediate the scarcity of lab-materials in teaching and learning biology in secondary schools of Rwamagana district of Rwanda. The findings presented reflect the objectives of this study which were (1) to explore the status of the use of improvised materials in teaching Biology in secondary schools of Rwamagana district, (2) to identify challenges faced by teachers while developing and using improvised materials for biology practical classes in Rwamagana district and (3) to find potential solutions to challenges faced by biology teachers while developing and using improvised materials for biology practical classes in Rwamagana district.

To come up with the mean for Likert scale data, the researcher assigned the values 5, 4, 3, 2 and 1 to strongly agree, agree, neutral, disagree and strongly disagree respectively. The mean helped the researcher to generalize the responses. Findings from interview were presented in a narrative form.

4.2 Demographic presentation of respondents

Demographic data in this research include gender of respondents, their teaching experience, levels in which they teach, and their academic qualifications.

4.2.1 Gender of respondents

The researcher reached a total of 29 respondents of both sexes. The table below shows the number and gender of respondents.

Table 2: Gender of respondents

Sex	Frequency	Percentage
Male	19	65.5%
Female	10	34.5%
Total	29	100%

The table 2 above shows that the research involved both male and female respondents. The number of female respondents is fewer than the number of male reflecting fewer female biology teachers than male biology teachers within secondary schools of Rwamagana district.

4.2.2 Teaching experience of teacher respondents

In this research, teaching experience means interval of time in years that respondents have spent teaching biology.

Table 3: teaching experience of respondents

Teaching experience range	**Frequency**	**Percentage (%)**
1-5 years	9	36%
6-10 years	9	36%
11-15 years	7	28%
16-20 years	0	0%
21 years and above	0	0%
Total	25	100%

The table 3 shows that 64% of our respondents have been teaching biology for six years and above. Their enough experience provides insight that their answers to the questionnaire would reflect the reality to meet the research objectives.

4.2.3 Levels where respondents teach biology

In the current research, it has been recorded that respondents teach in different levels. Some respondents teach only in O' level, others teach biology only in A' level. There are also respondents who teach biology in both levels.

Table 4: Teaching levels of respondents

Level	**Frequecy**	**Percentage**
O' level only	14	56%
A' level only	4	16%
Boh levels	7	28%
Total	25	100%

As shown by the Table 4, most teachers (56%) teach only in ordinary whereas 44% teach biology in advanced level. With this, we are confident that the information provided by the respondents covered both ordinary and advanced levels of secondary schools in Rwamagana district.

4.3 Status of the use of improvised materials in teaching and learning biology in Rwamagana district.

This section presents researcher's findings on how both teachers and DOSs see the status of use of improvised materials within their respective schools.

4.3.1. Status of the use of improvised materials in teaching and learning biology within secondary schools of Rwamagana district

The table 5 below provides biology teachers' view on the status of the use of improvised materials in teaching and learning biology within secondary schools of Rwamagana district. The abbreviation Freq. stands for frequency and % for percent.

Table 5: Teachers' response on the status of the use of improvised materials in teaching and learning biology within secondary schools of Rwamagana district.

S/N	Statement	Strongly agree		Agree		Neutral		Disagree		Strongly disagree	
		Freq	%	Freq.	%	Freq.	%	Freq.	%	Freq	%
1	The school encourages teachers to use improvisation in daily teaching and learning of biology.	15	60%	9	36%	1	4%	0	0%	0	0%
2	The school facilitates biology teachers to get updates on the use of improvised materials [for example offering (or allowing the teachers to go to) trainings on improvisation and other modern teaching methodologies].	15	60%	3	12%	7	28%	0	0%	0	0%
3	As the school does not have laboratory and any modern teaching and learning aids (or the school does not have a well-equipped lab and the modern teaching and learning aids are not enough), I spend most of the class time giving lectures or presentation, the students only have to memorize.	3	12%	11	44%	0	0%	11	44%	0	0%
4	Anytime I miss lab materials to concretize content of a given biology unit, I just explain the concept by only using drawings that I directly make in front of the students	3	12%	7	28%	5	20%	8	32%	2	8%
5	Most of time I use available resources in the surrounding and/or real-life examples anytime I am teaching biology	15	60%	3	12%	2	8%	3	12%	2	8%
6	I mostly use plastics, tin and woody materials to improvise instructional materials for teaching Biology.	12	48%	6	24%	5	20%	2	8%	0	0%
7	When it comes about laboratory reagents, I mostly use plant extracts.	11	44%	6	24%	6	24%	2	8%	0	0%
8	When it comes about heating, I use charcoal stove instead of Bunsen burner	6	24%	0	0%	2	8%	5	20%	12	48%

The table 5 above summarizes teachers view on the status of improvisation in Rwamagana district.

On the matter that schools encourage the teachers to use improvisation in daily teaching and learning of biology, twenty-four respondents out of twenty-five representing 96% of total respondents agreed with the assertion with only 4% of respondents were neutral as shown by the figure 1.

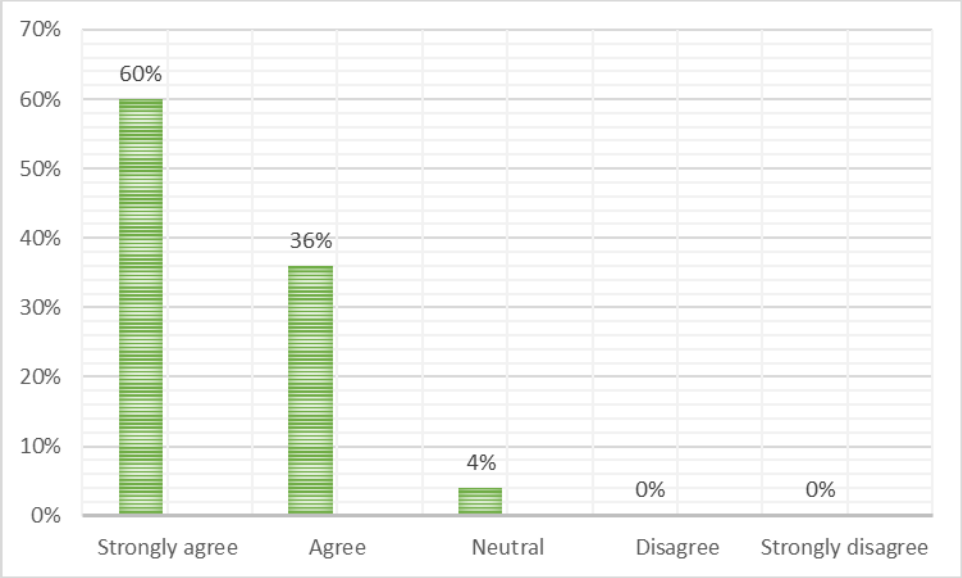

Figure 1: Responses on schools' encouragement to use improvisation.

Findings of this study reveals that schools facilitate biology teachers to get updates on the use of improvised materials as indicated by 72 % of the respondents who have agreed that schools facilitate them to get updates. However, 28% of respondents neither agreed nor disagreed whether their schools facilitate getting updates on the use of improvisation.

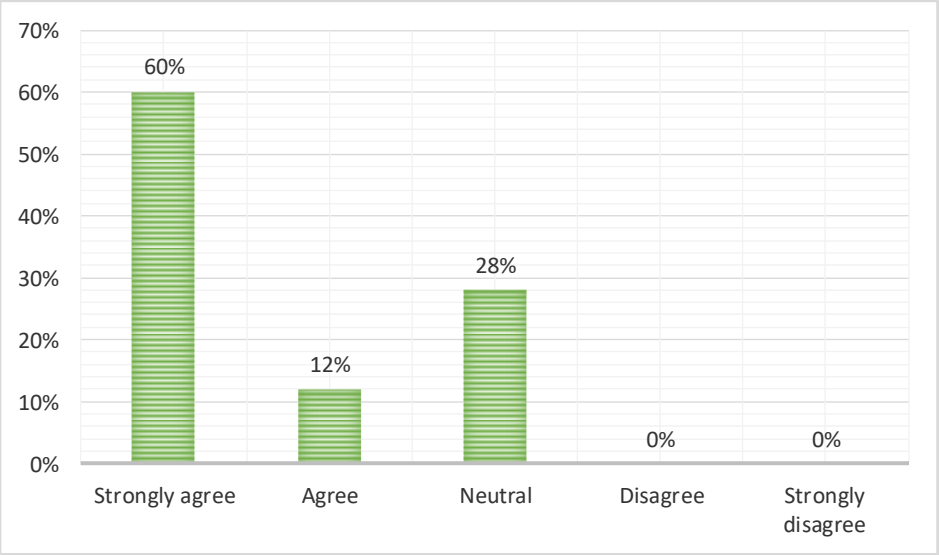

Figure 2: Responses on schools' facilitation to get updates on the use of improvised materials.

About spending most class time lecturing due to lack or insufficiency of laboratory and modern teaching and learning aids, a total of 56% of the respondents agreed that they only use lectures and presentation while 44% of respondents disagreed with the assertion as shown by figure 3. This implies that biology teachers in many secondary schools of Rwamagana district mostly use theoretical sessions to teach biology subjecting learners to only memorization of contents.

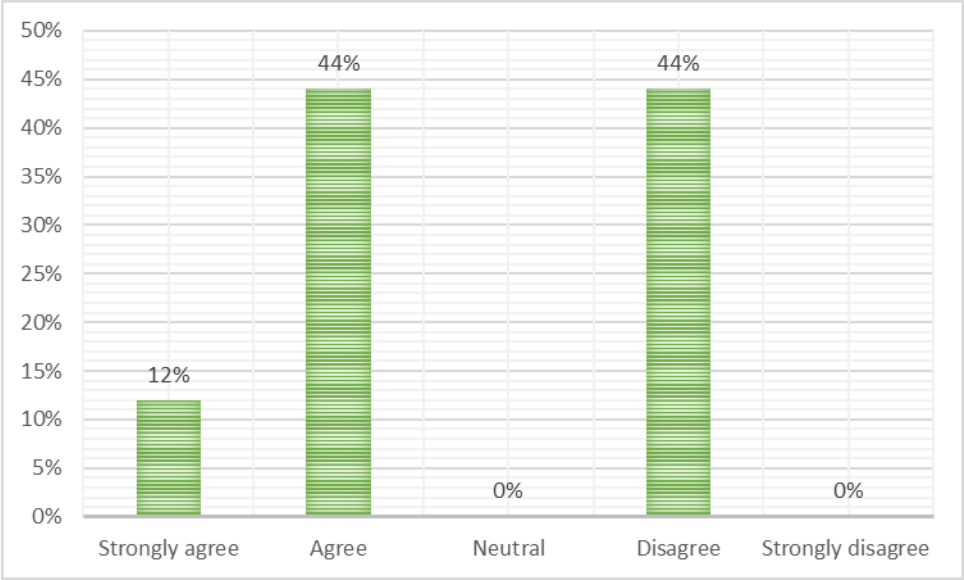

Figure 3: Responses on the use of lectures and presentation in absence of conventional teaching resources.

On the only use of drawings directly made in front of the students to explain the concept when teachers miss lab materials to concretize the content of a given biology unit, 40 % of respondents accepted that it is what they do anytime they miss materials. Other 40% responded that they don't only use drawing, implying that they have other means of concretizing the content. Moreover, 20 % of the respondents decided neutrality on the same question.

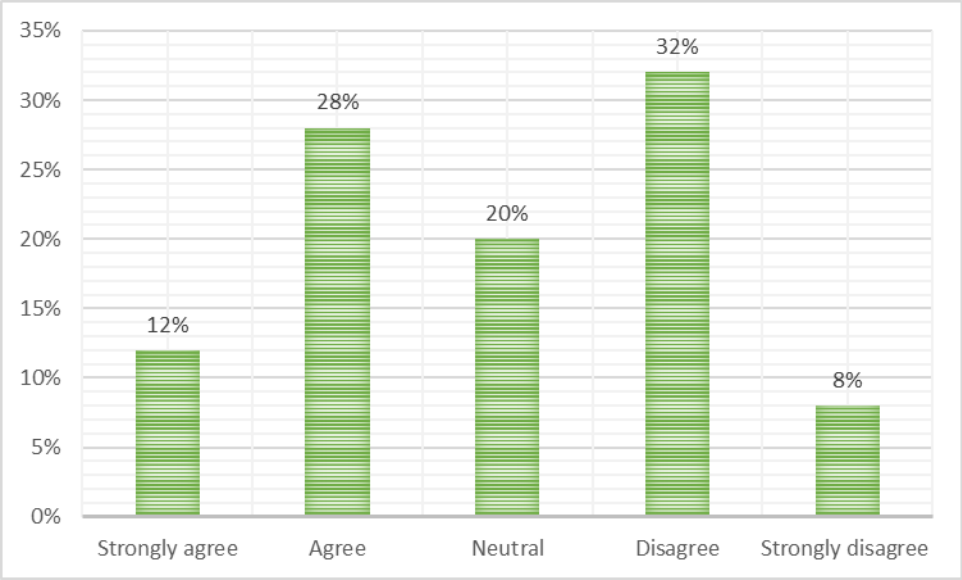

Figure 4: Responses on the use of drawing to concretize biological concepts in absence of lab materials.

On using available resources in surrounding and/or real-life examples while teaching biology, respondents reported that they use available resources and/or real-life examples in teaching biology. 18 respondents out of 25 standing for 72% of respondents agreed that they use resources found in their surroundings and give real life examples while teaching biology. This would mean that many teachers take advantages of locally available resources and use them in place of modern laboratory equipment and modern teaching and learning materials. This is however conflicting with some of the previously provided answers that 56% of the same respondents only use lectures and 40% of them intend to concretize a given biology concept by only using drawings anytime they miss materials. On this important matter, the researcher's personal observations in the visited schools is most teachers deliver content by lectures and presentation. However, at some occasions they use readily available resources in the environment. A few respondents do not use available resources in environment during biology teaching. This was shown by a total of 20% of respondents disagreeing that they use surrounding resources and real-life examples anytime they are teaching biology. These

teachers have no idea of improvisation or simply neglect the importance of improvisation and prefer their students to rely on memorization of concept anytime they don't have laboratory and modern teaching resources.

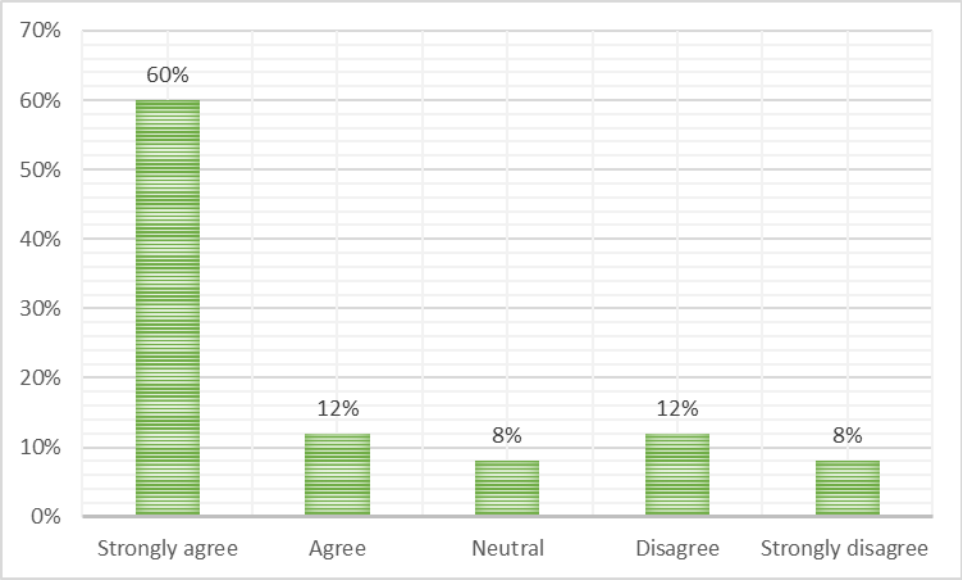

Figure 5: Responses on the use of resources available in the surrounding.

Regarding instructional materials mostly improvised for teaching biology, a total of 72% respondents agreed that their improvisation relies on the use plastics, tin, and woody materials as raw materials. While 20% have been neutral on the statement and 8% disagreed the use those materials. This informs that teachers mostly fabricate most of their improvised teaching materials out of plastics, tin and woody materials. A few numbers of teachers who do not use these materials might not be in position to improvise instructional materials or have other means of obtaining improvised materials.

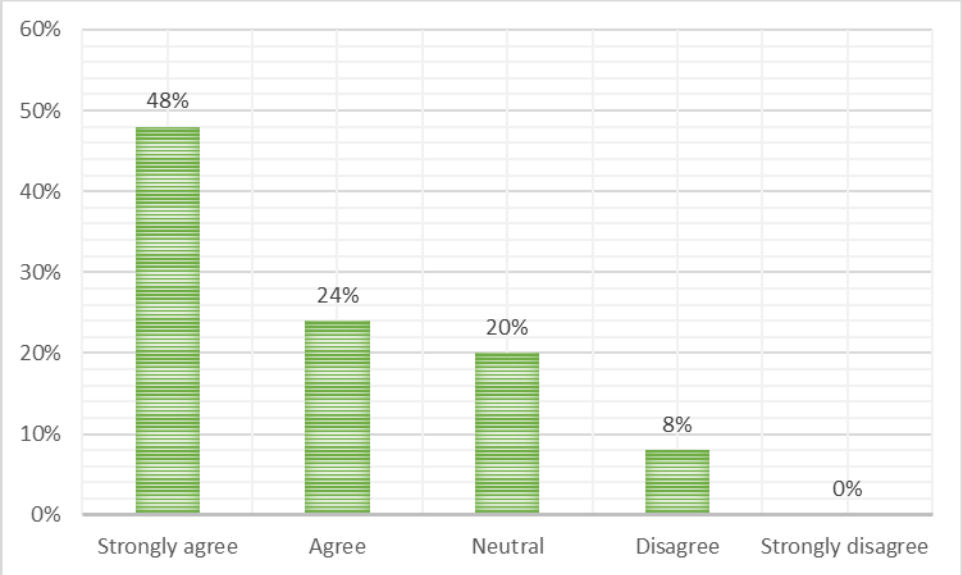

Figure 6: Responses on the use of plastics, tin, and wood to improvise teaching materials.

When it comes to improvisation of laboratory reagents, respondents said they mostly use plant extracts to replace some chemicals. This was proved by 17 respondents out of 25 representing 68% of respondents who agreed with the assertion that when it comes about laboratory reagents, they mostly use plant extracts.

This brings an idea that respondents appreciate plant as sources of some chemicals that might be used in biological experiments. Six respondents (24%) who have been neutral, and two (8%) who disagreed reflect that they might not give value to plants and plant extracts as sources of some chemicals.

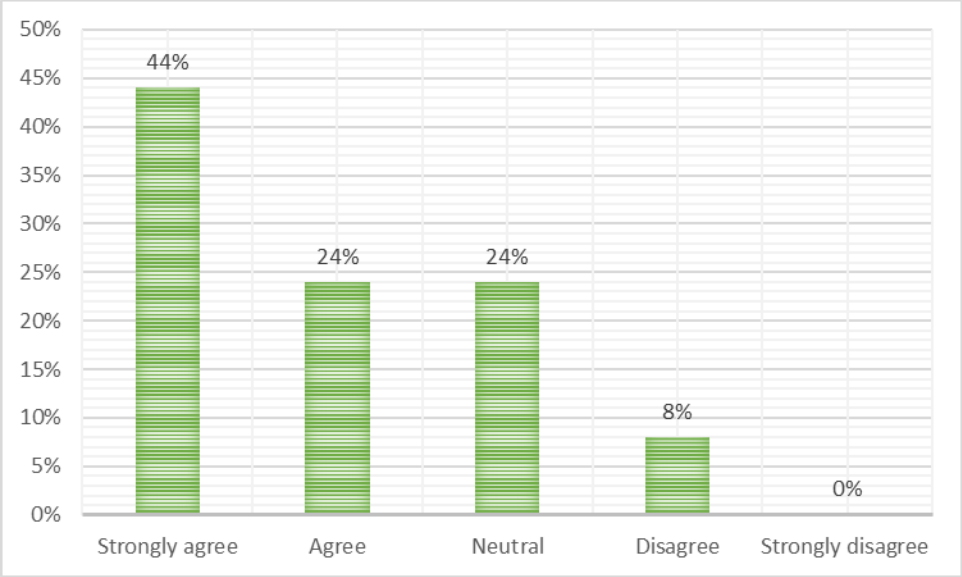

Figure 7: Responses on the use of plants extracts.

To improvise the source of heat, respondents denied the use use charcoal stove instead of Bunsen burner as shown by a total seventeen respondents (68%) who disagreed with the given assertion. However, six respondents equivalent of 24% affirmed that they use charcoal stove instead of Bunsen burner when they are conducting experiments involving heating while two respondents (8%) remained neutral. This might mean that most schools have appropriate heat sources such as Bunsen burner or heating panels whereas few schools do not have them, teachers in schools without conventional heat sources use charcoal stove for heating when required in biological experiments.

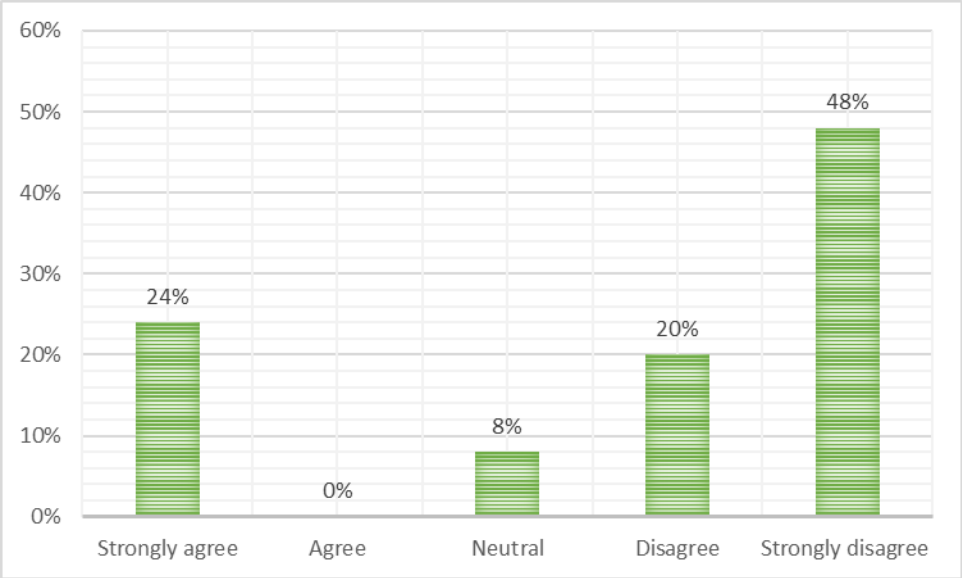

Figure 8: Responses on the use of charcoal stove for heating.

By conclusion, schools encourage biology teachers to use improvisation in teaching and try to facilitate them getting updates on improvisation. Nevertheless, a significant number of biology teachers spend most of their time lecturing and subjecting students to memorization of theories while others try to illustrate by drawings. These findings also provide information about most improvisational raw materials which are plastics, tin, and wood. At some occasions, teachers also use plants extracts in place of some chemicals. However, some of the answers provided by the teacher-respondents were conflicting. On my view, the cause of encountered contradictions might be that some teachers responded on the basis of what they know they can do to improvise materials but not what they really do.

4.3.2 DOSs' view on the status of improvisation

The researcher conducted an interview with four DOSs to collect qualitative data on how DOSs see the status of the use of improvised materials in their respective schools. The responses were recorded and here presented in a narrative form.

Two questions were asked in line to the specific objective of exploring the status of the use of improvised materials in teaching Biology in secondary schools of Rwamagana district. These questions are: (1) Briefly describe the use of improvised materials in your school. (2) How and what ways does the school help the teacher to develop and use improvised materials to remediate scarcity of conventional laboratory and teaching/learning materials?

On the first interview question, the DOS 1 answered:

"*The school provides manila papers and markers for teachers to draw teaching aids that may help them in class. Another thing, there are lessons that not necessarily require the use of laboratory, for instance teaching plant morphology does not necessary require being in laboratory, because the teacher can find the plants he/she want to use as teaching aid or asks students to bring them. On other hand, for materials that cannot be found in the school vicinity, the school facilitates the teacher find them. In that line, the students can use what they see for better understanding what is taught to them*."

On the matter of how the school helps the teacher to develop and use improvised materials to remediate scarcity of convenient materials, the DOS 1 responded: "*The school provides financial means of buying raw materials to develop the improvised materials*."

On the same questions, the DOS 2 reacted: "*like other schools here in Rwanda, our school face many problems related to scarcity of teaching resources. This is the reason why*

teachers are sometimes obliged to use improvised materials in teaching biology. With help of the school, the teachers use the local materials that we buy from the market to create their own teaching materials."

On the second interview question, the same DOS reacted: "*The first thing we do is to ask teachers to plan. At the beginning of each term, we ask teachers to plan according to their needs. We ask every teacher of biology to identify activities and experiments he will conduct and mentions materials that he will need. Then after, in collaboration with the bursar, the school manages to find some materials one day before the day of experiment.*"

During the interview while describing the use of improvised materials in his school the DOS 3 said: "*Our teachers work together with students to develop teaching materials that replace unavailable ones. They mostly obtain some materials from the school surroundings and use them as raw materials to make instructional materials relevant to their lessons*." On how the school helps the teacher to develop and use improvised materials to remediate scarcity of convenient materials, the DOS 3 replied: "*The school helps teachers to obtain teaching aids though it is expensive. At the end of the term, teachers identify and present materials they will need for the next term and the schools buys some of them it could afford. In addition, teachers organize CPDs in their departments in which one of the items to discuss on is how to design and use improvised materials in teaching and learning sciences, including biology*."

The fourth interview DOS replied: "*in reality, because we don't have enough materials, it sometimes happens to find means of improvising needed materials. In biology specifically, teachers use materials from our school garden and in case the school garden fail to provide, we buy them from the market. The important thing is having the students understand the lesson without using costly materials*."

On how the school helps the teacher to develop and use improvised materials to remediate scarcity of convenient materials, the DOS 4 answered "*As the Ministry of Education urges, we reserved three periods of CPD every week. Sometimes the Ministry of Education and the district send trainers or we just visit other schools to learn from them. In reality we reinforce CPDs to keep teachers updates.*"

In conclusion, the responses from the interview show that the schools lack materials and all DOSs appreciate improvisation as a solution to scarcity of materials.

4.3.3 Improvised materials and chemicals in secondary schools of Rwamagana district

In this research, respondents were asked to list the materials and reagents they mostly improvise in biology lessons. The table 6 below shows materials and reagents (solutions) as listed by respondents, standard lab materials replaced and use of materials / reagents.

Table 6: Some improvised materials and chemicals in teaching and learning biology within secondary schools of Rwamagana district.

Materials		
Improvised materials	**Replaced conventional lab material**	**Use**
Charcoal stove	Bunsen burner	Heating
Used water bottle, straw, plastic sac.	Spirometer	Demonstration of inspiration and expiration.
Chalk boxes	Plastic blocks	To demonstrate the effect of surface area to the rate of diffusion
Graduated feeding bottle	Measuring cylinder	Measuring liquids
Piece of plastic bottle	Funnel	Liquid transfer
Plastic bottle, straws, balloons, rubber sheet	Breathing model	Demonstration of breathing
Pieces of plastic bottles	Beakers	Containing liquid
Plastic bottles	Flasks	Storing solutions
Irish potato	Visking tubing	Demonstration of osmosis
Transparent plastic bag, plastic bottle, rubber band, straw, ruler	Potometer	Measuring the rate of transpiration
Solutions/Reagents		
Lemon juice	Ascorbic acid	Testing for vitamin c
Table salt	Sodium chloride	Preparation of sodium chloride solution
Maize flour, irish potatoes	Starch	Testing starch in foods
Milk, white eggs, ground nuts	Proteins	Testing proteins in foods
Sugar cane extract	sucrose	Testing non-reducing sugars in foods

The table 6 above presents the most used improvisational raw materials by biology teachers in Rwamagana district. As the table shows, most materials are improvised from used plastic materials. Materials for storing, measuring and transferring solutions are improvised as well as models such as breathing models and osmometer. On the other hand, a few reagents are also improvised, these are mainly extracted from plants and used for testing food components.

4.4 Challenges faced by teachers while developing and using improvised material for biology practical classes.

This section presents what biology teachers meet as challenges in developing and using improvised materials. It also presents what DOSs see as barriers that the biology teachers face during development and utilization of improvised materials within their respective schools.

4.4.1 Teachers' view on challenges faced while developing and using improvised materials

The teachers' responses on challenges faced by teachers while developing and using improvised material for biology practical classes are summarized in the Table 7 below. The abbreviation Freq. stands for frequency and % for percent.

Table 7: Challenges faced while developing and using improvised materials for biology practical classes

S/N	Statement	Strongly agree		Agree		Neutral		Disagree		Strongly disagree	
		Freq	**%**	**Freq**	**%**	**Freq**	**%**	**Freq**	**%**	**Freq**	**%**
1	I understand well the use of improvisation and its role in teaching and learning biology but I don't find time to prepare the improvised materials because I have a very heavy teaching load/the timetable is full.	5	20%	12	48%	0	0%	6	24%	2	8%
2	I don't master how to use improvisation in teaching biology	0	0%	2	8%	4	16%	14	56%	5	20%
3	I find it difficult using improvisation in teaching biology concepts and principles	0	0%	3	12%	6	24%	10	40%	6	24%
5	Trainings on improvisation are rare.	5	20%	7	28%	4	16%	3	12%	6	24%
6	The surrounding environment does not provide enough tools to be used in improvisation	0	0%	7	28%	8	32%	7	28%	3	12%
7	Some improvised instructional materials for teaching Biology are expensive	0	0%	13	52%	1	4%	6	24%	5	20%
9	Students are not interested in helping to develop improvised materials	0	0%	3	12%	5	20%	7	28%	10	40%
10	Some instructional materials and chemicals cannot be replaced by improvisation	10	40%	11	44%	0	0%	4	16%	0	0%
11	Developing improvised materials is time consuming	10	40%	11	44%	0	0%	4	16%	0	0%
12	Students are less motivated when conducting practical classes using improvised materials	0	0%	3	12%	5	20%	10	40%	7	28%
13	The school does not provide funds for buying relevant components for improvisation materials.	0	0%	5	20%	8	32%	2	8%	10	40%

The table 7 above depicts findings on the challenges that teachers face while developing and using improvised materials.

As shown by figure 9, 68% of respondents understand well the use and role of improvisation in teaching and learning biology but do not find time to prepare the improvised materials because they have a very heavy teaching load. The view of the remaining 38% respondents disagreed the given affirmation.

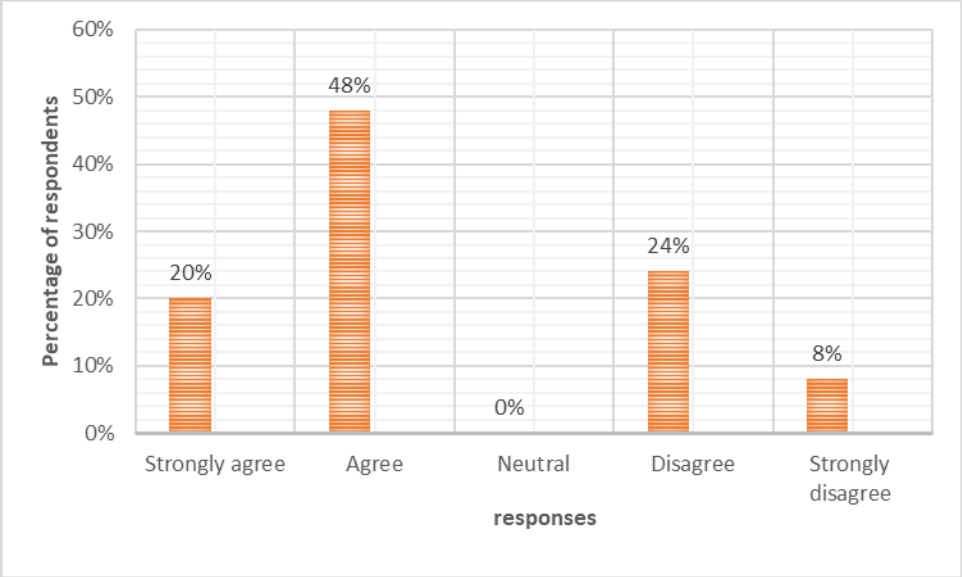

Figure 9: Responses on the challenge of not finding time for improvisation.

On the matter of mastering how to use improvisation in teaching biology, responses show that only 8% of the respondents have agreed that they don't master how to use improvisation in teaching biology, a portion of 16% have been impartial, while 76% testified mastering the use of improvisation by agreeing with the given asseveration. This means that most teachers master how to use improvisation. In the same line, 12% of respondents have agreed that it is difficult for them to use improvisation in teaching biology concepts and principles 24% of respondents remained impartial on the given asseveration.

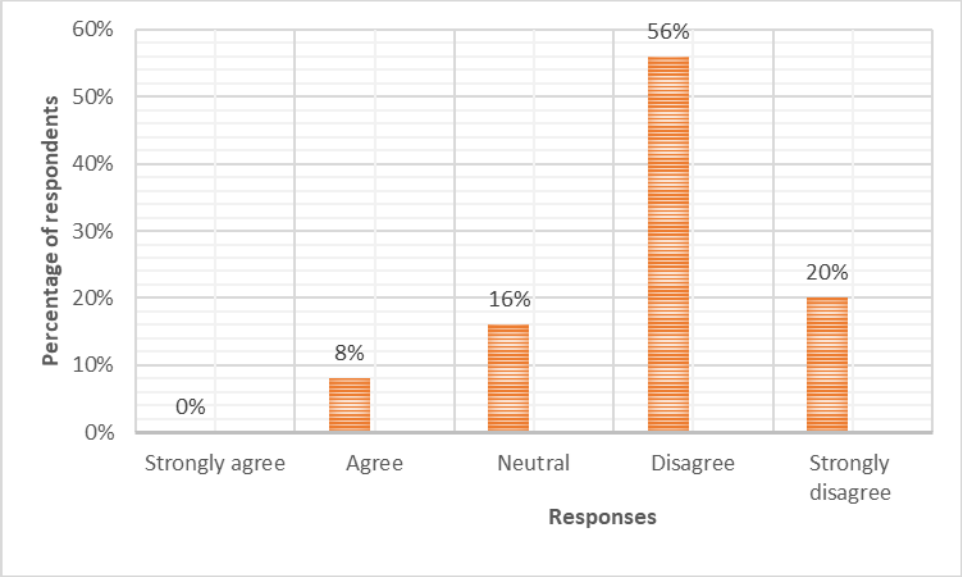

Figure 10: Responses on the challenge of not mastering the use improvisation in teaching biology.

However, 64% respondents testified that they do not have any difficulties in using improvisation in teaching biology. This substantially means that it is not difficult to use improvisation in teaching biology concepts and principles for teachers of biology.

However, responses show that still 12% of respondents still have difficulties in applying improvisation while teaching biology concepts.

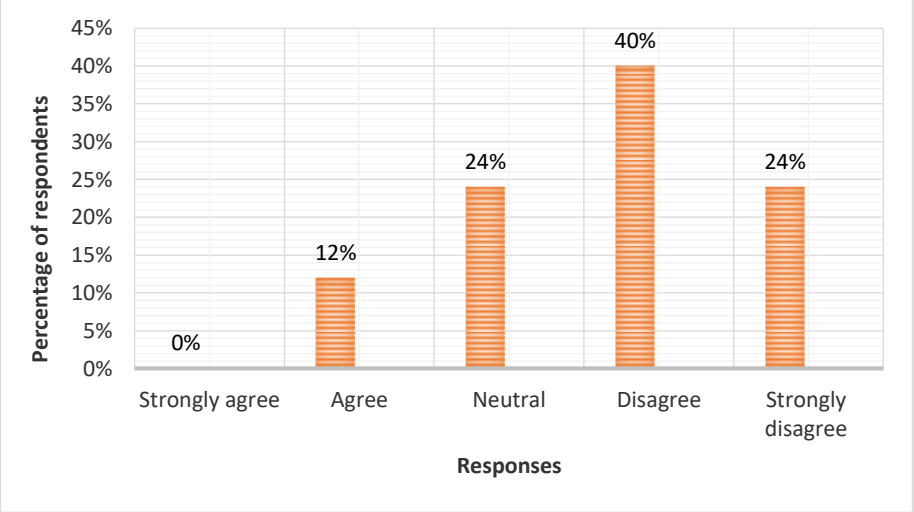

Figure 11: Responses on the challenge of difficulty of using improvisation in teaching biology concepts and principals.

Although 36% of respondents rejected rarity of improvisational trainings as a challenge, it has been observed that trainings on improvisation are rare. 48% of respondents agreed with the statement that trainings on improvisation are rare while 16% remained neutral on the matter. This reflects that some teachers obtained trainings on improvisation while others did not.

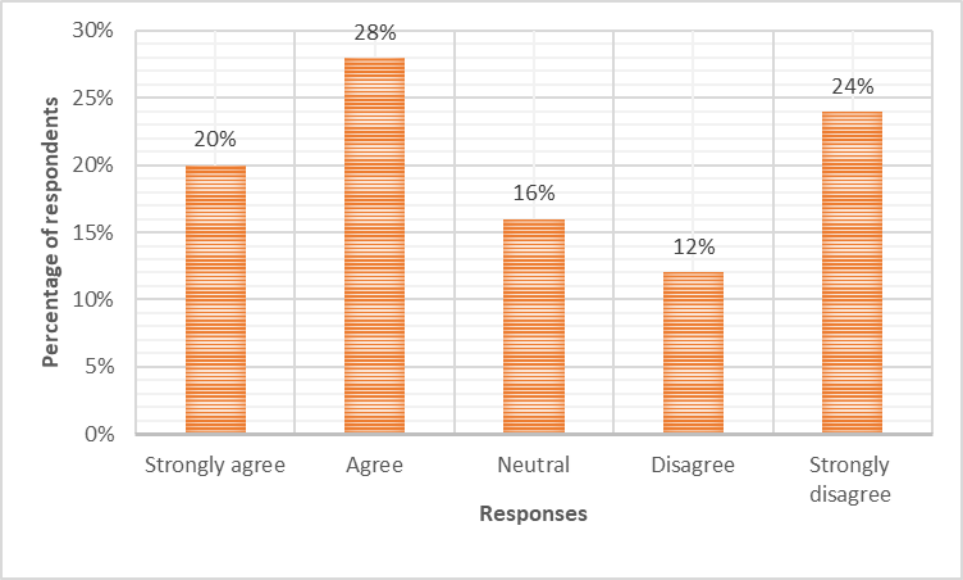

Figure 12: Responses on the challenge of rarity of trainings.

Responses on whether the environment does not provide enough tools to be used in improvisation indicate that the number of teachers who do not accept that assertion is greater than the number of teachers who confirm it. Responses show that 28% of respondents agreed that the surrounding environment does not provide enough tools to be used in improvisation, while 40% denied the challenge. 32% neither agreed nor disagreed the given assertion. This literally means that some teachers find most tools they use to improvise in their school environment while other teachers find less tools in the environment or do not know how to exploit resources in the environment.

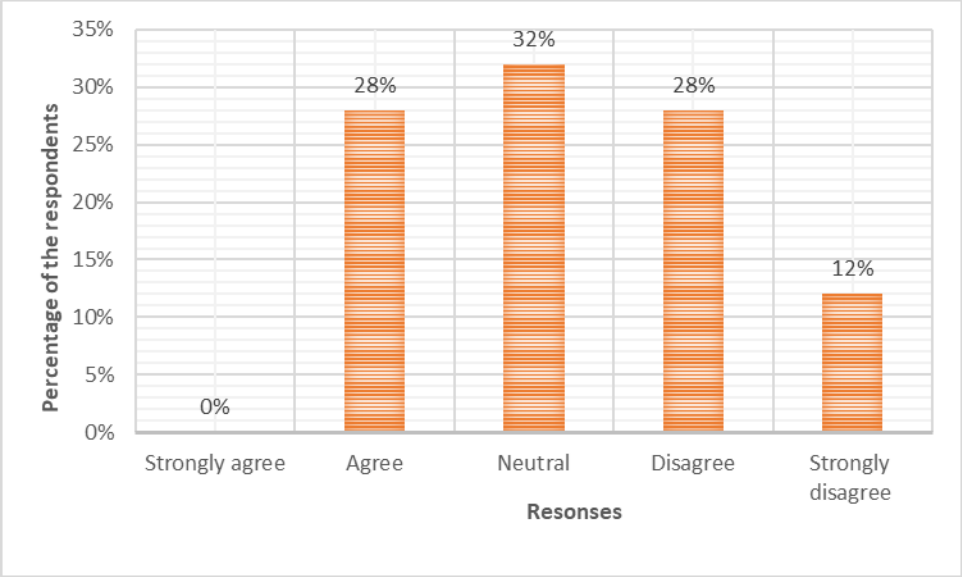

Figure 13: Responses on the challenge that the surrounding environment does not provide enough tools for improvisation.

Additionally, 52% of respondents affirm that some improvised instructional materials for teaching biology are expensive. Nonetheless, 44% of the teacher respondents were against the statement. That means, from their point of view, improvised instructional materials for teaching biology are not expensive.

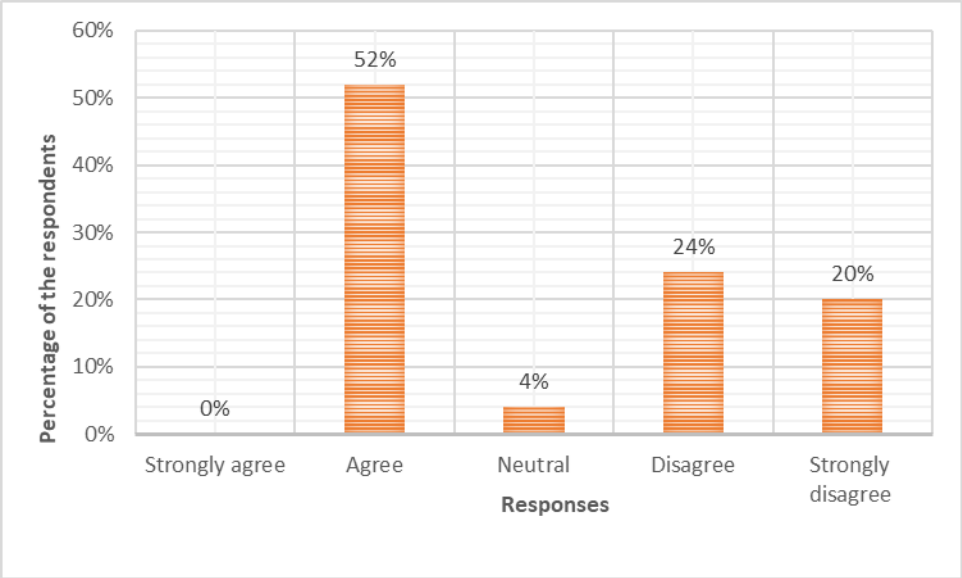

Figure 14: Responses on the challenge that some improvised instructional materials for teaching biology are expensive.

Respondents also rejected the asseveration that students are not interested in helping to develop improvised materials. A total of 68% respondents were against the asseveration

while 12% accepted that students are not interested in helping them to develop improvised materials. 20% were neutral. This finding affirms that students in Rwamagana district are interested in helping to develop improvised materials.

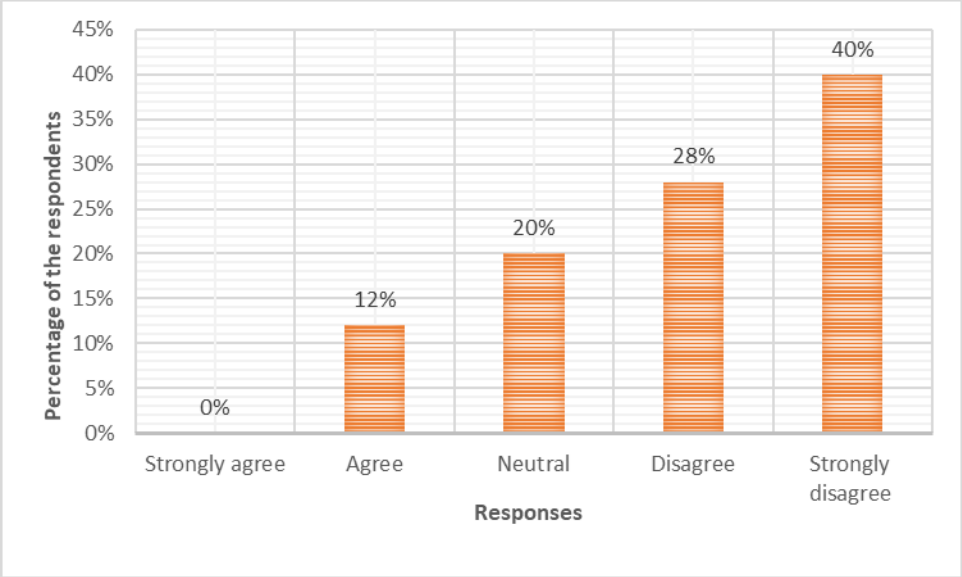

Figure 15: Responses on the challenge that students are not interested in helping to develop improvised materials.

For the challenge of irreplaceability of same instructional materials and chemicals, 84% respondents accepted facing the challenge while 16% disagreed. This implies that thought teachers may be good at improvising materials, some practical activities may not be conducted as replacement of required materials by improvisation seems to be impossible.

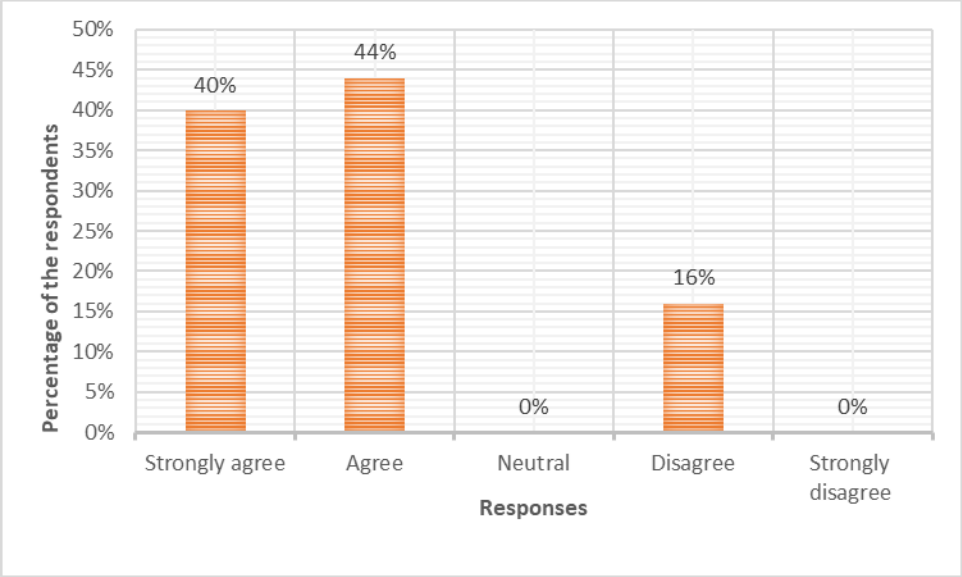

Figure 16: Responses on the challenge of irreplaceability by improvisation of some teaching materials.

Development of improvised materials has been proved time consuming by 88% of respondents who responded by agreeing our statement that developing improvised materials is time consuming. Only 16% of respondents denied the statement. This may be a reason for some teachers to do not improvise instructional materials not because they lack skills but because they do not have enough time to develop them.

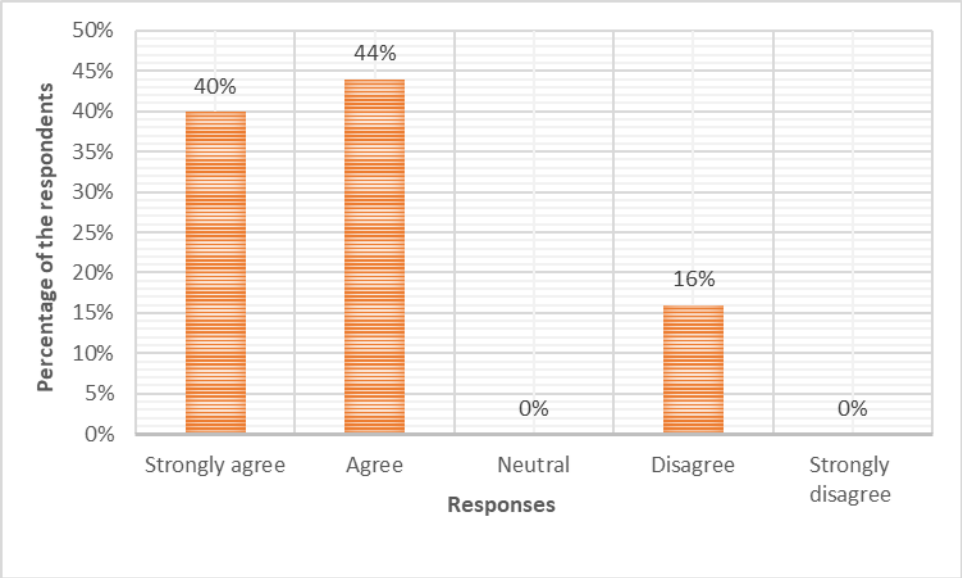

Figure 17: Responses on the challenge that developing improvised materials is time consuming.

Respondents also contradicted the statement that students are less motivated when conducting practical classes using improvised materials. Responses revealed that 68% have

disagreed with the statement implying that students are still motivated even when practical classes are being conducted using improvised materials.

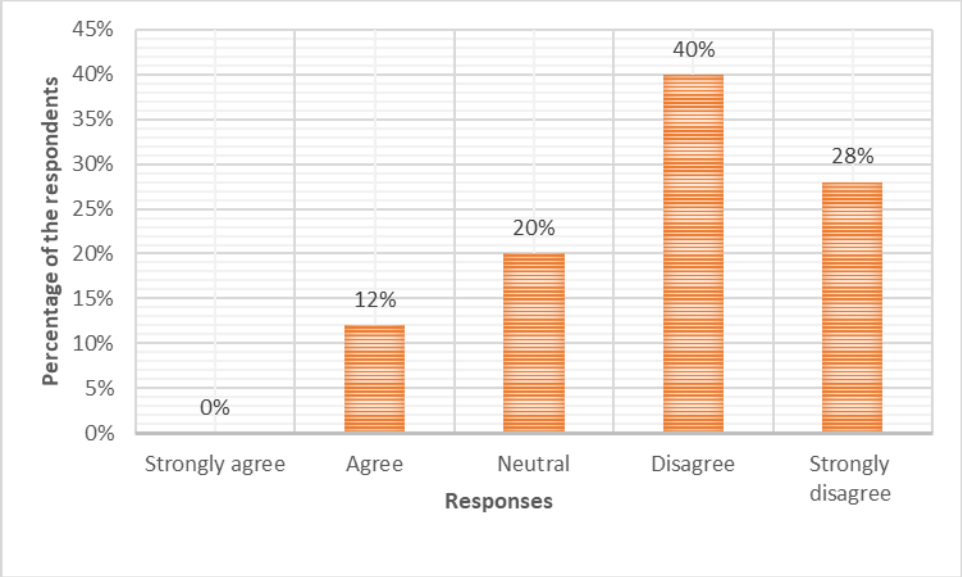

Figure 18: Responses on the challenge that students are less motivated when conducting practical classes using improvised materials.

Lastly, respondents renounced the affirmation that schools do not provide funds for buying relevant components for improvisation of materials. Responses on this matter showed that 48% responded against the given assertion, 32% decided impartiality whereas only 20% affirmed that their schools provide funds to be used for improvisation of instructional materials. This brings in view that most schools provide funds to be used for improvisation of instructional materials.

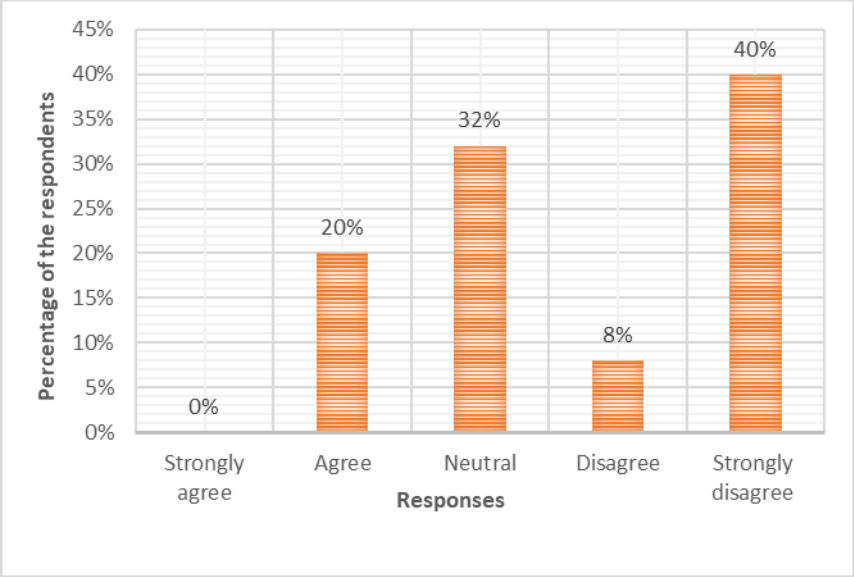

Figure 19: Responses on the challenge that the schools do not provide funds for buying relevant components for improvisation of materials.

Though improvisation is daily used in teaching biology in Rwamagana district, the table 7 provides insight that challenges are faced: lack of enough time due to teaching timetables being overloaded, rarity of trainings on improvisation, expensiveness of some improvised materials, existence of some materials which cannot be easily replaced by improvisation and the fact that improvisation is time consuming are the challenges faced by the teachers of secondary schools in Rwamagana district about development and use of improvisation when teaching biology.

4.4.2 Other challenges faced by biology teachers in the development and use of improvised materials

The contacted teachers during this study mentioned other challenges to the implementation of improvisation techinque in teaching and learning biology within secondary schools of Rwamagana disrict. These are:

- Big class size (big number of students) making it hard to produce enough improvised materials for students to use.
- The timetable does not provide time to prepare biology practical activity, including the development of the improvised materials.

4.4.3 DOSs' view about challenges faced by biology teachers in development and use of improvised materials and how they overcome.

During the research, the DOSs were asked the challenges biology teachers of their respective schools face along the journey of development and use of improvised materials and how they overcome these challenges. Hereunder are the provided responses.

"Sometimes it happens to us to fail to buy some materials due to insufficiency of budget. We try to provide some materials but as you know in biology some needed materials deteriorate easily to be stored for longtime." The DOS 1 said. Talking on how they overcome these challenges the DOS added: *"Teachers use drawings or make the use of ICT where they download videos for students to watch."*

The DOS 2 asked the same question answered: *"Challenges are there. The most occurring is low budget. It would be very costly to buy all materials teachers need to fabricate their teaching aids. Other challenges are time and skills teachers need to be able to create instructional materials."* The DOS added: "*To overcome those challenges, we try to buy what we can afford because we cannot go beyond our financial capacity. If for example the teacher wants five materials and the budget allows only three, we buy these three. Concerning the issue of time, we request teachers to have such spirit of volunteering extra time to make those materials. Concerning skills, sometimes we organize trainings here at the school especially during the holydays, we invite experienced teachers from other schools to come and train our teachers."*

The DOS 3 said: "*There are various challenges: our teachers normally don't have enough time to prepare improvised material. In addition, a few teachers think that improvised materials are substandard and cannot help students understand better like standard materials. Another challenge is insufficient budget that limit affording some materials the teachers need to design the improvised ones."* On how they overcome these challenges, the DOS 3 replied: "*Thought the school has not enough money to invest in improvised material, little by little we buy raw improvisational materials and encourage teachers and students to work together to create possible improvisable materials".*

Lastly the DOS 4 said: *"The most important challenge is lack of budget for improvisation. However, the school avails little money to be used in buying materials that can be used in improvisation. Luckily, few materials are available within the school compound.*
Responses from the DOSs also reveal time constraint. They as well reported insufficient budget to buy materials which would be used to improvise and poor improvisational skills for some teachers. They also put in the ways they overcome those challenges: setting priorities to buy really most needy materials, organizing CPD and using school garden to provide some materials.

4.5 Suggested potential solutions to the challenges faced by teachers about development and use of the improvised materials.

The respondents proposed solutions to the challenges they mentioned to interfere with the development and use of improvisation in teaching and learning biology.

1. **Solution to lack of time to prepare the improvised materials**

93% of respondents mentioned the overloaded timetable. In a week of 55 teaching periods each of 40 minutes, many biology teachers teach between 40 and 50 periods. Few remaining periods are reserved for continuous professional development (CPD) program, lessons preparations, working on pedagogical documents and marking tests and assignments.
For the potential solution, all the respondents suggested reduction of the number of periods that a teacher teaches a week so to have time for developing the effective improvised materials. However, they did not mention the maximum periods a teacher should not go beyond.

2. **Solution to lack of enough knowledge and skills to plan, develop and use of the improvised materials and reagents.**

Respondents reported that teacher training universities do not teach how to design the improvised materials. They mentioned that while conducting biology practical classes, biology teachers of these universities only use modern laboratory materials, indirectly culturing in the mind of these future teachers that the modern laboratory materials are the

only one to be effective in teaching and learning biology. The respondents also suggested that higher learning institutions that train teachers should incorporate improvisational practical skills in their curriculum. In addition, few teachers suggested regular CPDs among neighboring schools where teachers can meet and share skills of improvisation in teaching biology.

3. **Solution to lack of teachers' initiative/commitment to use improvisation in teaching biology concepts.**

According to respondents, the lack of initiative and commitment appears as results of lack of enough free time that would be used to develop improvised materials. All respondents encourage their school administrators to keep encouraging teachers to make improvised materials during their free times and plan for trainings to help teachers master important improvisational skills.

Some respondents suggest rewarding teachers who use improvisation in their lessons as a way of motivating other teachers who rely on teaching theories when conventional materials are absent.

4. **Solution to lack of teachers' creativity and patience to develop improvised materials.**

Many biology teachers often lack creativity and patience to develop effective improvised materials. The respondents suggested increased opportunities for training by highly competent teachers or other education professionals in developing and using the using the biology laboratory improvised materials.

5. **Solution to complexity of some biology concepts and principles that do not allow the use of improvisation to teach them.**

Some biology concepts are highly complex to give an impression that their teaching could not use improvisation. These are for example the processes such as respiration, photosynthesis, Deoxyribonucleic acid replication, polymerase chain reactions (PCR) among. For such concepts, respondents suggested use simulations that can be shown to students and organizing field trips to visit specific places where they can be shown processes by experts.

6. **Solution to difficulties to improvise chemicals/reagents**

Almost all respondents reported that they do not improvise chemicals because chemicals are almost impossible to improvise apart from a few chemical substances that can be extracted from plants. As the solution to this specific matter, budget should be availed to buy chemicals that cannot be extracted from plants or obtained from reacting chemicals available in the school.

4.6 Role of educational authorities and stakeholders to promote improvisation as proposed by the DOSs

The researcher asked the DOSs what they think educational authorities and stakeholders would do to contribute to the promotion of improvisation so to remediate scarcity of lab materials in teaching and learning biology in secondary schools. Their responses have been the following:

"*All teachers are not trained. We could ask for training to equip them with improvisational skills*", said one DOS. "*Many schools have problems of science teaching materials. So improvisation is one of the remedy. The government of Rwanda through the ministry of Education should organise workshops for teachers especially science teachers, biology included to equip them with enough improvisational skills such that every science teacher could use local materials to make instructional materials".*

"It is true that we cannot improvise everything but at least we can reach the level of improvising enough materials. I think what we need are skills, our environment is rich to provide items we can use to create improvised materials". The DOS 2 added. In the same line, the DOS 3 made his wish: "*Since REB and Ministry of Education don't provide everything we need, we request for teachers training on improvisation*". Lastly, the DOS 4 said: "*In reality, what is needed mostly are continuous trainings where teachers can be trained on improvisational skills. In addition, we would request for the specific science room-laboratory*".

It is clear that all interviewed DOSs claim trainings on improvisation among priorities, this implies that they are aware that most teachers lack adequate trainings on the important practice of improvisation. They also know that schools cannot easily manage to afford standards materials and see improvisation as a better way of easing problems related to lack

of standard materials. Some DOSs insisted that their schools lack laboratories and request for possible provision of lab rooms. Most the visited Nine- and Twelve-Years basic education schools lack laboratory rooms, they use classes during laboratory activities and store few materials and chemicals in classroom. The poor storage may result in damage of apparatuses and faster deterioration of chemicals. Last, a request of continuous provision of laboratory materials has been made.

CHAPTER 5: DISCUSSION AND CONCLUSION

5.1 Introduction

This chapter discusses the findings of the current research. The provided ideas under this discussions are organized as per the specific objectives of this study, which are: (1) exploring the status of the use of improvised materials in teaching Biology in secondary schools of Rwamagana district, (2) identifying challenges faced by teachers while developing and using improvised materials for biology practical classes in Rwamagana district and (3) finding potential solutions to challenges faced by biology teachers while developing and using improvised materials for biology practical classes in Rwamagana district. This chapter also provides conclusion as well as recommendations.

The key findings of this research can be summarized as follows: Many biology teachers of Rwamagana schools are still frequently using lecturing while teaching under pretext that conventional laboratory materials are lacking. This is done regardless that the schools' authorities encourage all the science and mathematics teachers to use improvisation in daily teaching and they provide the required funds under teachers' request. Furthermore, schools' surroundings provide most of the raw materials to design the improvised materials. Challenges faced by biology teachers of Rwamagana district schools while developing and using the improvised materials include lack of time reserved for improvisational activities; large contents to teach that interfere with improvisation; large class size that would require improvising many materials of the same kind; less knowledge and skills about development and use of improvised materials and rarity of trainings on improvisation and complexity of some materials that make them non improvisable. Making a flexible timetable that allows teachers the time for improvisation, training teachers on improvisation techniques, and rewarding teachers who daily use improvisation were suggested among others as solutions to the effective use of improvisation in teaching and learning biology as remedy to scarcity of conventional laboratory materials/chemicals in the schools of Rwamagana district.

5.2. The status of the use of improvised materials in teaching and learning biology in secondary schools of Rwamagana district

The findings of this research show that schools encourage teachers to use improvisation in daily teaching and learning of biology where possible. Here, the schools' authorities are in line with recommendations of Abdu-Raheem (2016) who advised schools to encourage students and teachers to improvise instructional materials to improve teaching and learning in schools as this promotes students' academic achievement. One of the reasons why improvisation is highly encouraged in teaching and learning biology is that it improves one's creativity and thinking skills. According to Euba (2017), interaction between the teacher, students, and environmental resources is crucial for an effective biology education. Improvisation should not only be for schools with ill-equipped laboratories; it should also be encouraged in schools having well equipped laboratories because it reduces cost on conventional materials that could be otherwise improvised. Study conducted by Abigail et al. (2020) showed that students taught with the use of improvised materials perform better than students taught without improvised material. In the same line, Hussaini et al. (2022) concluded that improvised materials are as effective as conventional ones to equipping students with the necessary skills and improving their academic performance. "Tell me and I forget, show me and I remember, let me do it and I understand", this proverb was quoted by Wasagu (2009) while emphasizing on the role of learning by doing. That means students understand better when they are actively involved in practicals, they acquire skills such as teamwork, collaboration, listening, communication, and ability to adapt and solve problems as they work together with teachers during improvisation of materials, and that contribute a lot in improving their academic performance.

The findings also indicate that some biology teachers spend most of their time lecturing and then subjecting students to memorization of what is taught. According to the biology teachers who participated in this study, this is because their respective schools do not have laboratory materials while trainings on improvisation are rare. Such a situation hinders the students' understanding and is not a concern to only schools of Rwamagana district. Imanda (2020) mentioned lack of laboratories, scarcity of resources and failure to improvise as some of the factors that prevent teachers to teach practical classes. He added that lack of practical sessions has a negative impact on learners' achievement, interest and attitude toward biology. In his study as well, Fatima (2012) observed that many secondary school biology teachers

use lecture method to teach, a method that makes learning of biology difficult and leading to poor achievement of learning objectives. In absence of laboratory materials and failure of improvisation, many biology teachers adopt the use of lecturing and presentation in teaching. However, Saka (2016) and Durmaz (2017) agree that effective biology teaching should include laboratory practical activities because biology include abstract concepts and facts that students have to learn in practical sessions. In contrast, teaching biology by lecturing or presenting facts makes students passive rather than active therefore leaving study with no opportunity to produce their own inputs.

Biology teachers in Rwamagana secondary schools and the DOSs appreciate the role of improvisation for a more effective teaching and learning biology. That is the reason why many schools motivate their biology teachers to improvise and to help each other to improve their improvisational skills during weekly organized CPD (Continuous Professional Development) sessions. Bizimana et al. (2022) associated poor performance in biology national examination with scarcity of instructional materials and lack of science laboratory equipment in many Rwandan secondary schools. They explained that poor performance of students in biology in most secondary schools may be caused by inappropriate teaching methods that subject learners to memorization of the contents without exposing them to hands-on activities. The expected outcomes of practicing improvisation include reducing the students' failure caused by scarcity of conventional lab materials and ignoring improvisation where it would be possible.

Biology teachers who are already using the improvisation technique reported that most materials that are transformed into improvised materials are available in the school surroundings and even these ones that need to be bought are reported to be affordable. These include but not limited to plastics, tin, wood, and plants.

5.3. Challenges faced by teachers while developing and using improvised material for biology practical classes

Limited time to prepare the improvised materials, large content to teach leading to lack of time to design and develop improvised materials, and big class size were reported to be the main barriers against production and use of enough improvised materials for teaching and learning biology in secondary schools of Rwamagana district.

A concern of limited time to prepare the improvised materials has been reported by Ndihokubwayo and Habiyaremye (2018) in relation to run of conventional laboratory practicals interfered by vast contents to cover compared to the available limited time. Thus, biology teachers of Rwamagana district do not find time to design and use the improvised materials of some instructional materials for practical activities. These teachers rather tend to spend almost their entire teaching time lecturing, just trying to cover theoretical content. That is in the same view with Kjellfrid and Magne (2017) who put time pressure among factors limiting improvisation of instructional materials. In addition, biology teachers of secondary schools in Rwamagana district claim that the development of improvised instructional materials is itself time consuming.

The biology teachers of Rwamagana district schools also reported class size as a serious barrier to the design and use of improvised materials. This is because when the number of students in class is too large, the teacher will need too much time to make enough instructional materials and this is a burden for teacher as he/she also has other activities to carry out such as marking. The same challenge of big class size was also reported by Isaac et al. (2018) who said that the production of improvised instructional materials is enormously challenged by big sized classes. In such situation some teachers ignore improvisation and see it as an extra work to them and prefer only lecturing. Ugwu & Eze (2005) also regard large class size as a barrier to improvisation of instructional materials because in such a case the more the number of students, the more improvised materials teachers must create. In addition to the class size, biology teachers of secondary schools in Rwamagana district claim that the development of improvised instructional materials is time consuming.

The Competence Based Curriculum currently being implemented in Rwandan schools is too much loaded with content (Ndihokubwayo, 2018). That is a barrier to improvisation because teachers would prefer lecturing and presentation of information to cover the large content in the syllabus instead of taking time to prepare and use improvised materials. Such teaching method would affect learning efficiency as Shana (2020) described it as ineffective method of learning.

Less teachers' training, complex nature of some instructional materials to be improvised, and difficulties to produce improvised chemicals were also listed as challenges faced by teachers to develop and use improvised biology lab materials and reagents. Teachers mentioned that some materials and chemicals are even unable to improvise as similarly reported by

Ndihokubwayo (2017). According to the respondents to this research, preparation of improvised weak acid solutions such orange juice, lemon juice, tomato juice, soapy water, milk, shampoo, vinegar, and baking soda solution could be seen as simple, but it looks almost impossible to improvise strong acids such as sulfuric acid and hydrochloric acid. In a similar view, Abigail & MfonEdet (2020) had mentioned lack of regular teacher training among challenges against development and utilization of improvised materials. Riviere (2006) said that while teaching, teachers imitate the techniques used in their own education. Therefore, lack of training on improvisation may discourage teachers who have been taught without the use of improvised materials. In this way, non-trained teachers are fearful and lack confidence to improvise their own instructional materials or simply do not value the use of improvised materials (Riviere, 2006). There is therefore a need for teachers' training colleges or universities to include the use of improvisation in their curriculum. Additionally, the concept of improvisation skills should be included in the program of different CPDs currently taking place within Rwanda schools.

Even though the improvisation is not too costly, financial constraints were as well mentioned by some respondents as one of the challenges to get the improvised materials. This respondents' concern agrees with Riveire (2006) and Utibe-Abasi (2015) who concluded that improvisation of instructional materials may be compromised by shortage of money. This is because the improvisation does not mean costless even though it is a less expensive method as it uses locally available materials. In addition, some materials in biology such as electron balances, thermometers, centrifuges, and reagents such as strong acids and bases cannot be easily replaced by improvisation. This reality brings a question of how teachers behave when they cannot improvise some materials and provides an insight that whenever the material is absent cannot be replaced by improvisation while the schools cannot afford it, teachers may rely on lecturing and presentation to teach related topics.

5.4 Solutions to challenges faced by biology teachers while developing and using improvised materials for biology practical classes in Rwamagana district

The respondents of this research suggested potential solutions to challenges faced by biology teachers while developing and using improvised materials for biology practical classes in Rwamagana district. These include reserving on the timetable time for developing

improvised materials; training biology teachers to develop and use improvised materials; rewarding teachers who use improvisation in their lessons; encouraging teachers to volunteer extra time, among others.

According to the respondents of this research, some biology teachers do not improvise, not because they don't have improvisational skills but because their daily workload is heavy and could not find time to prepare improvised materials. Therefore, these respondents suggest reserving few working periods on the timetable to be used for development of improvisable materials. This will much more engage the teachers in developing the improvised materials. In addition, where reserving time seems difficult, running for extra time is another proposed option. However, the schools should be responsible for recognizing and possibly rewarding biology teachers who use extra time for improvisation. That is in line with Ndirangu et al. (2003) who opinioned compensation of teachers for extra time as motivation of teachers to create their own instructional materials.

On another hand, educational authorities should avail budget for improvisation. This suggestion was based on the reported challenge that schools do not have budget specifically reserved for improvisation of instructional teaching materials. Though improvisation uses locally available materials, the cost can be applied to some of the materials. The researcher sees it as the responsibility of educational authorities to buy materials used in improvisation rather than being teachers' responsibility. This view agrees with Ugwu & Eze (2005) recited by Nnenna (2018) who shout that it may be difficult for teachers to spend money from their salaries to improvise instructional materials.

Though trainings provide trainees with skills to do things and updates, respondents reported absence regular training on improvisation. This may result in some teachers fear to improvise materials just because they are unsure of being successful. Therefore, the respondents suggested regular trainings to be organized so to help teachers regularly acquire improvisational skills. Esu (2004) recited by Sallau et al. (2019) underlined that improvisation involves adventure, creativity, curiosity, and perseverance as qualities of an improvising teacher which are achievable through a well-planned improvisation training program. Much effort should therefore be put in organizing time to time improvisational trainings for biology teachers, added Sallau et al. (2019). In the same view considering importance of improvisation, Dorothy (2015) suggested that education authorities should establish workshops in schools to train teachers on the development and use of improvised instructional materials and recommended incorporation of the use of improvisation in the

curriculum. As biology subject contains complex and abstract concepts such as molecular biology, protein synthesis, and evolution among others, biology teachers should adopt simulation-based teaching. This idea is also supported by Niyigena and Nzabalirwa (2022), who reported inadequacy of laboratories in Rwanda's schools and suggested the use of computer aided-simulations to improve biology learning in absence of laboratories and failure to improvise teaching materials.

5.5 Conclusions

Findings from this research provide insight that majority of biology teachers in secondary schools of Rwamagana district are equipped with improvisational skills and master improvisation. However, they still face challenges such as lack of time to prepare improvised materials, large class size that would necessitate manufacturing a big number of materials, lack of improvisational skills limiting some teachers to improvise, and lack of regular trainings on improvisation of biology instructional materials. Lack of fund to support improvisation was also reported in some schools. To deal with these challenges, respondents of the current research suggested availing time on the timetable for making improvised materials, enhancing improvisational skills through regular trainings and CPDs, encouraging biology teachers to use extra time such that they obtain time to improvise and use improvised materials, and award the teachers who develop and use improvised materials.

5.6 Recommendation

5.6.1. Recommendation to the institution in charge of education in Rwanda

In the light of the findings of the present research, the researcher recommends the followings:

- MINEDUC through Rwanda basic Education Board (REB) should organize time to time improvisational trainings to in-service biology teachers in all districts, this will serve to equip biology teachers across the country with adequate improvisational skills.
- Educational authorities should ensure availability of fund for improvisation.

- REB is recommended to reserve time on science teachers' timetable for improvisation of materials.

- HEC (Higher Educational Council) is recommended to incorporate improvisation into curriculum of colleges and universities that train science teachers.

- Neighboring schools are recommended to collaborate and share skills during CPD program.

- Educational authorities are recommended to reward and motivate teachers who practice improvisation in teaching biology and other science.

5.6.2. Recommendations to mathematics and science teachers

To improve the quality of mathematics and science education and therefore enhance students' achievement, mathematics and science teachers are recommended to:

1. Design, develop and effectively use improvised materials for effective teaching and learning to take place.
2. Utilize improvised instructional materials that meet learning objectives.
3. Involve students in design and development of improvised instructional materials. This will enhance students' understanding of mathematics and science as well as appreciating the role of local resources in the surrounding environment in education.
4. To handle with care the improvised materials to last long.
5. Update their knowledge and improvisational skills through research and collaboration with mathematics and science teachers from other schools.
6. Share knowledge and improvisational skills during CPDs.

2.6.3. Recommendation for further research

To complete our study, we are recommending the following for further research:

1. Impact of AIMS trainings on biology academic performance in Rwamagana district.
2. A comparative study on improvisation in private and public secondary schools of Rwamagana district.
3. Influence of biology teachers' gender in developing and using improvised teaching and learning materials.

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APPENDICES

Appendix 1: Informed consent

Researcher

My name is NDAYISHIMYE Marie Prosper, I am a Masters student at University of Rwanda College of Education. I am inviting you to participate in my research study entitled "**Investigation on the use of improvised materials to remediate scarcity of lab materials in teaching-learning biology in secondary schools of Rwamagana district**". Before we start I will explain the study to you and you have right to ask anything you want. This research is purely academic. All the answers you provide will be kept confidentially and will only be used for the research purpose. Writing your name is not mandatory, you may skip it in case you don't feel comfortable with writing it. As you respond honestly you will be impacting improvisation in education.
Kindest regard!

Participant

I have understood well the purpose of this research and all questions and concerns I had about it have been addressed. I voluntarily choose to participate and certify that I am above 18 years of age.

Name of participant _____Signature _____ date __/__/2023

Appendix 2: Questionnaire for biology teachers

Teacher's name: ……

Qualification: ……

School: ……

Subjects taught: …….

Teaching experience in years: 1-5 ☐ 6-10 ☐ 11- 15 ☐ 15-20 ☐ 21 and above ☐

Gender: Male ☐ Female ☐

Class where you teach biology: O' level ☐ A' level ☐ Both O and levels ☐

Place a tick (✓) where appropriate in relation to problems faced by biology practical classes.

1. Status of the use of improvised materials in teaching and learning biology in Rwamagana district.

S/N	Statement	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1	The school encourages teachers to use improvisation in daily teaching and learning of biology.					
2	The school facilitates biology teachers to get updates on the use of improvised materials [for example offering (or allowing the teachers to go to) trainings on improvisation and other modern teaching methodologies].					
3	As the school does not have laboratory and any modern teaching and learning aids (or the school does not have a well-equipped lab and the modern teaching and learning aids are not enough), I spend most of the class					

	time giving lectures or presentation, the students only have to memorize.					
4	Anytime I miss lab materials to concretize content of a given biology unit, I just explain the concept by only using drawings that I directly make in front of the students					
5	Most of time I use available resources in the surrounding and/or real-life examples anytime I am teaching biology					
6	I mostly use plastics, tin and woody materials to improvise instructional materials for teaching Biology.					
7	When it comes about laboratory reagents, I mostly use plant extracts.					
8	When it comes about heating, I use charcoal stove instead of Bunsen burner					

List down any other improvised materials and chemicals you often improvise, the conventional/modern materials or chemicals they replace, what it is used for (i.e. the biology concept in which it is used) (Fill the table below):

Materials		
Improvised material	The replaced conventional/modern lab material	What it is used for (i.e. the biology concept in which it is used)

Reagents		
Improvised chemical	The replaced conventional/modern chemical	What it is used for (i.e. the biology concept in which it is used)

2. Challenges faced by teachers while developing and using improvised material for biology practical classes.

S/N	Statement	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1	I understand well the use of improvisation and its role in teaching and learning biology but I don't find time to prepare the improvised materials because I have a very heavy teaching load/the timetable is full.					
2	I don't master how to use improvisation in teaching biology					
3	I find it difficult using improvisation in teaching biology concepts and principles					
4	Trainings on improvisation are rare.					
5	The surrounding environment does not provide enough tools to be used in improvisation					
6	Some improvised instructional materials for teaching Biology are expensive					
7	Students are not interested in helping to develop improvised materials					
8	Some instructional materials and chemicals cannot be replaced by improvisation					
9	Developing improvised materials is time consuming					
10	Students are less motivated when conducting practical classes using improvised materials					
11	The school does not provide funds for buying relevant components for improvisation materials.					

Kindly write down in the space provided here below any other challenges (not specified above) that interfere with your development and use of improvised materials in biology practical classes.

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3. What do you think can be done in your school to alleviate the following barriers that interfere with the development and use of improvisation in teaching and learning biology?
    1. Lack of time to prepare the improvised materials

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    2. Lack of enough knowledge and skills to plan, develop, and use of the improvised materials and reagents

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    3. Lack of teachers' initiative/commitment to use improvisation in teaching biology concepts and principles

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4. Lack of school support in finding the materials/reagents to be used for improvisation during biology classes

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5. Lack of students' motivation during practical classes using improvised materials/regents

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6. Complexity of some biology concepts and principles that do not allow the use of improvisation to teach them

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7. Difficulties to improvise chemicals/reagents

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Kindly suggest solutions to challenges faced while developing and utilizing improvised materials for biology practical classes in Rwamagana district

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Kindly suggest solutions to any other challenges you may have faced while trying to develop and utilize improvised materials/reagents for biology practical classes in your school.

Challenge

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Solution:……
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Challenge

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Solution:

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Challenge

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Solution:

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Challenge

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Solution:……

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Appendix 3: Interview guiding questions for head teacher or deputy head teacher in charge of studies

1. Briefly describe the usage of improvised materials in your school.
2. How and what ways does the school help the teacher to develop and use improvised materials to remediate scarcity of convenient materials?
3. What are challenges do you face as the school in helping teachers to develop improvised material and how do you overcome those challenges?
4. What do you think educational authorities and stakeholders should contribute to promote improvisation to remediate scarcity of lab materials in teaching and learning biology in secondary schools?

Appendix 4: A letter requesting for data collection authorization

NDAYISHIMYE Marie Prosper
EASTERN PROVINCE
RWAMAGANA DISTRICT
E-mail: prosper201@gmail.com
Tel: 0788591031/0728591031

February 10th, 2023

Director of research and innovation/UR-CE

Through:
Head of Teaching and Learning, ACEITLMS

Supervisor, Dr. HABIYAREMYE Jean de Dieu (PhD)

Dear Director,

RE: Application for data collection authorization

I would like to submit my application letter for data collection authorization.

I am a student pursuing a Master of Education in Biology Education at University of Rwanda-College of Education, Remera campus. I am conducting a research on "**the use of improvised materials to remediate scarcity of lab materials in teaching-learning biology in secondary schools of Rwamagana district"**. In this line, I would like to apply for data collection authorization. I will do my level best to collect data in accordance to the research standards of the University of Rwanda.

Yours sincerely,

NDAYISHIMYE Marie Prosper

Appendix 5: Research ethical clearance

UNIVERSITY of RWANDA

COLLEGE OF EDUCATION

RESEARCH AND INNOVATION OFFICE

Rukara, 22nd February, 2023
Ref: 03/DRI-CE/034(a)/ EN/gi/2023

Mr Marie Prosper NDAYISHIMYE
Master Student
Master of Education in Biology Education
ACEITLMS
UR-CE

Dear Mr Ndayishimye,

RE: RESEARCH ETHICAL CLEARANCE FOR YOUR STUDY

Following your application for research clearance for your study entitled: "**Investigation on the Use of Improvised Materials to Remediate Scarcity of Lab Materials in Teaching-Learning Biology in Secondary Schools of Rwamagana district.**"

Having reviewed your application and being satisfied with your protocol (your research topic, interview schedule, and informed consent): your study is ethically acceptable. This ethical clearance shall last for 8 months and is renewable upon your request and presentation of the progress report to the UR-CE Research Screening and Ethics Clearance Committee (RSEC-C) through the Research and Innovation Unit. Please note that you will have to apply for ethical clearance before making changes in the protocol during the implementation phase. The Research and Innovation Unit shall receive a final copy of your study report at the end of your study.

We wish you success in your study.

COLLEGE OF EDUCATION
UNIVERSITY OF RWANDA
RESEARCH AND INNOVATION UNIT

Assoc. Prof. Eugene Ndabaga
Chairperson, UR-CE RSEC-C
Director of Research and Innovation Unit
Tel.: 250788308862
Email: ndabagav@yahoo.ie
UR-College of Education

Cc:

- The Principal, CE
- Director, ACEITLMS-CE
- Dr Jean de Dieu Habiyaremye (Supervisor)

Appendix 6: Data collection authorization

REPUBLIC OF RWANDA

Rwamagana 03/03/ 2023
NO 1195/05-01

EASTERN PROVINCE
RWAMAGANA DISTRICT
P.O. BOX 24 RWAMAGANA

To NDAYISHIMIYE Marie Prosper

Re: Response to your letter to carry out research

Dear **NDAYISHIMIYE ,**
Reference is made to your letter requesting the Permission to carry out research on **''Investigation on the use of improvised materials to remediate scarcity of lab materials in teaching-learning biology in secondary schools of Rwamagana District"** ;

I hereby allow you to carry out your research in Rwamagana District for the above mentioned subject and I request you to share with us your research findings.

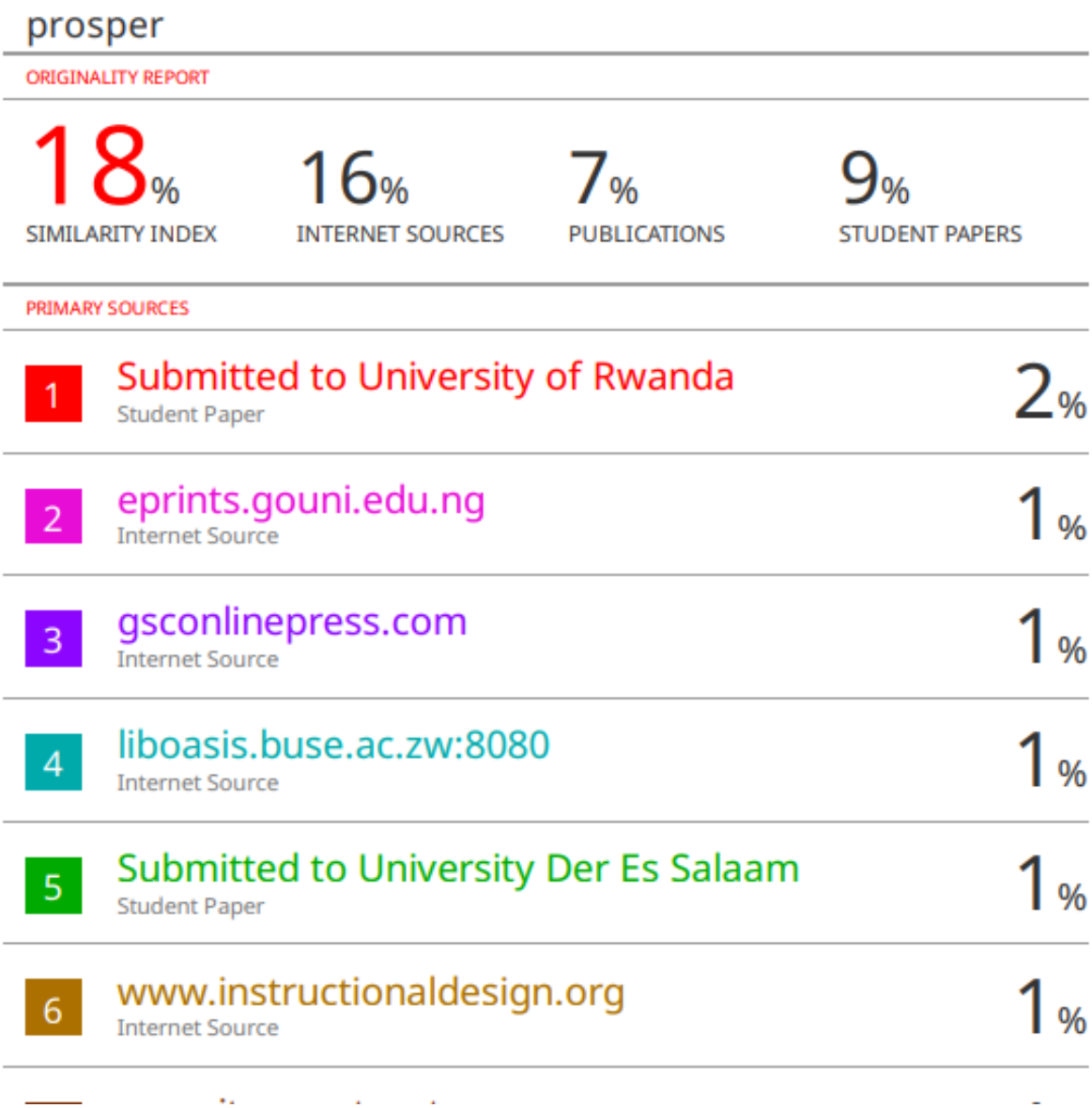
I wish you all the best.

Yours faithfully,

AKARERE KA RWAMAGANA

MBONYUMUVUNYI Radjab
Mayor of Rwamagana District.

Appendix 7: Turnitin report



prosper

ORIGINALITY REPORT

18%	16%	7%	9%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

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5	Submitted to University Der Es Salaam Student Paper	1%
6	www.instructionaldesign.org Internet Source	1%