THE AGA KHAN UNIVERSITY

Institute for Educational Development, East Africa

EXPLORING STUDENT TEACHERS' KNOWLEDGE AND USE OF PROBLEM-SOLVING TEACHING STRATEGY IN A SCIENCE CLASSROOM: A CASE OF A SELECTED PTC IN LIRA DISTRICT, UGANDA.

BY

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APPROVAL

THE AGAKHAN UNIVERSITY

Institute for Educational Development East Africa

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I hereby give my permission for the research project of the above-named student, for whom I have been acting as a supervisor, to proceed to the examination.

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Date: 22nd April 2023

The members of the research project evaluation committee appointed to examine the research project of the above-named student find it satisfactory and recommended that it be accepted.

Peter Kajoro

(Internal examiner)

Date: 15-03-2023

DEDICATION

I dedicate this dissertation to dearly loved Winifred and our precious daughter Stephanie. May the all-powerful God provide you with His mercy, might, and ability to live and realize all of your dreams.

ABSTRACT

The problem-solving teaching strategy is the key scientific pedagogy that develops a conceptual and contextual understanding of scientific knowledge, skills, and attitude in real life. This study aimed to explore the student teachers' knowledge and use of problem-solving teaching strategies in a science classroom. The study involved a case study at one specifically selected Primary Teachers' College in the Lira district. It purposefully involved 10 student teachers from a selected PTC conducting their final school practice while their learners participated in science lessons. Semi-structured interviews with the student teachers, classroom observations, document reviews, and analysis were used to gather qualitative data. The data was transcribed verbatim, coded, and thematically analyzed to produce the themes. This qualitative study used a cognitive constructivist theoretical framework to understand problem-based learning classrooms.

The findings of this study are reflected through themes: 1) student teachers' understanding of problem-solving teaching strategy, 2) the use of problem-solving teaching strategy in a science classroom, and 3) challenges encountered during problem-based learning. The findings of the study showed that; a) the transferable abilities/skills that the learners are meant to develop during teaching and learning were inadequate, b) limited knowledge and the application of problem-solving teaching strategies, c) tutors' support to student teachers in terms of science pedagogical approaches appeared to be wanting and, d) inability of student teachers to connect their college-acquired knowledge to its application during the planning of science problem-based learning.

The study also found a few difficulties that impacted the student teachers' presentations, especially their inability to manage learners with different learning preferences. Also, time was not helpful for all categories of learners in correspondence. Therefore, based on the findings, the focus needs to be given at the training institutions to help promote the transferability of problem-based learning abilities to student teachers for their learners to realize learning importance, science curricula for primary teachers' colleges and primary schools should be practical and applicable in real life. Similarly, much attention is needed on the tooling and retooling of student teachers and teachers on problem-based learning.

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DECLARATION OF ORIGINALITY

I, Okello Geofrey, hereby declare that this is my work, to the best of my knowledge, that I gave it my all and paid homage to the giants in the process.

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LIST OF ABBREVIATIONS

ERC-Ethical Review Committee

IPA-Interpretive Phenomenological Analysis

MOES-Ministry of Education and Sports

PBL-Problem Based Learning

PSTS-Problem Solving Teaching Strategy

LCE-Learner Centered Education

UNCST-Uganda National Council of Science and Technology

PTC-Primary Teachers' College

SDL-Self Directed Learning

UNITE-Uganda National Institute of Teacher Education

CPD-Continuous Professional Development

NCDC- National Curriculum Development Centre

CHAPTER ONE

INTRODUCTION AND BACKGROUND

1.0 INTRODUCTION

This chapter covers a thorough history of the study, a statement of the problem, the objective of the study, the research questions, and the significance of the study regarding the investigation of student teachers' knowledge and problem-solving approach in the teaching and learning of science.

1.1 Background of the Study

Science is one of the most interesting subjects that arouses students' minds at early levels of learning. However, the pedagogy used in teaching the subject needs to be engaging so that it captures the learner's attention throughout the lesson (Aidoo et al., 2016). Due to the teachers' pedagogical knowledge, the poor performance in science has been attributed to inadequate teaching preparation, few laboratory apparatus, equipment that may not support problem-based learning, and lecture teaching methodology that does not create room for learners' participation due to teachers' rigidity in their approaches to meet the contemporary learning demands of the students. Since the country's independence, facilitating science classes in Uganda in terms of tools, laboratories, textbooks, and the teacher-student ratio has remained a significant concern (MOES, 2010). This has affected the performance of learners in science subjects since the examinations do not compromise the level of attainment but assess the standards of achievement of the learners (Paul & Jefferson, 2019). However, the use of a problem-solving teaching strategy positively enhances students' academic performance in science than the conventional strategy because it creates a friendly environment that caters to diverse forms of learners where they develop problem-solving skills, critical thinking, creative thinking, appreciation of their friends' ideas, making learning participatory (Jaiswal, 2020). Therefore, the teacher's role is to design appropriate tasks that do not confuse the learners' conceptual skills, and she or he moves to support the learners in case of any challenge. The problem-solving teaching strategy of teaching science is not location biased if the teacher plans it well and the correct procedure is followed since the nature of science learning using a problem-solving strategy creates a link to other disciplines due to its importance within and around the world, particularly in the growth of science and technology through innovations (ANSAH)**.** However, traditional science instruction at colleges and universities is typically didactic (teaching by telling) in nature (Ssempala, 2017) which does not make students comprehend the concepts well, and therefore, they tend to teach science in the way they were taught in their training institutions, for instance, teacher centeredness rather than learner centeredness (Ödalen et al., 2019). These teachers frequently lack the transferable knowledge and abilities needed to assist their students to conceptualize the material being taught in the classroom (Fahrman et al., 2020). This is because many science teachers have a rudimentary understanding of science as a problem-solving method due to the demand in terms of the design of the tasks and management of students' discipline during the activities and hence are unable to apply it in their teaching and learning of science (ÇAVAŞ et al., 2013).

According to Dr. John C.M., Uganda's Higher Education Minister, some teachers are still employing obsolete ways of teaching science, which he claims is the cause of the high rate of failure in secondary and tertiary institutions of learning where science is offered as the core subject (Ashraf et al., 2021). In addition, few girls offer science at Advanced level and tertiary institutions due to poor teaching strategies that demoralize them from taking subjects (Simelane, 2019) and this led to a rise in the poor performance of science by students who have gone through the hands of these teachers. Similarly, the failure of these subjects may result in a significant loss for individual students whose career is to continue with further education and pursue a profession in a science-related field (Sithole et al., 2017). However, few studies have probably been done on the student teachers' knowledge and use of problem-solving teaching strategy in the learning of science yet it is one of the best strategies for teaching science in primary teachers' colleges in Ugandan as mandated by the Primary Teacher Education (PTE) syllabus that is used to train student teachers. According to the syllabus, this is the strategy that would help teachers acquire skills such as active listening, analysis, research, creativity, communication, decision-making, and team building among others that they can transfer to their science classrooms during problem-based learning (Moust et al., 2021).

1.2 Statement of a Problem

Science is one of the most important subjects that helps to improve the level of technology (Becker & Park, 2011) in the world. On the same note, it is one of the most essential subjects that is required of every Ugandan learner to go through its curriculum for him or her to have a successful completion at primary and Ordinary secondary levels. However, it was realized that the student teachers' knowledge and application of problem-solving teaching strategies in the science fields, teaching, and learning need to involve problem-based learning where the learners have significant interaction rather than just a lecture method if the students are to conceptualize and apply the concepts learned in their daily lives (Sungur & Tekkaya, 2006). Problem-based learning facilitates a deep understanding of the concepts so that learners can apply them in their daily lives. However, most science teachers this day use a didactic teaching approach (Smerdon et al., 1999) that denies students' exploration out of their curiosity. This is attributed to inadequate attention given to student teachers at the teacher training colleges which makes them apply half-baked skills in the teaching of science. This student teacher's incompetency in the use of problem-solving teaching strategy of learning science seems to be a result of science tutors' lecture method of teaching, low level of attention given to students, inadequate knowledge and skills acquired in engaging learners during problem-based learning, and time management among others (Ayyildiz & Tarhan, 2018). Therefore, it is highly likely that if this challenge is not addressed, there is a likelihood of a continued drastic decline in the performance of science leading to drop out of school by learners at primary and secondary levels or low career development by student teachers in offering science in their future studies.

Additionally, inefficient material delivery by student teachers during problem-based learning may prevent them from meeting the needs of 21st-century learners in their science classrooms, which may make learning less meaningful to them (Lapek, 2018). It is against this background that this study intends to explore the student teachers' knowledge and use of a problem-solving teaching strategy in a science classroom.

1.3 Purpose of the Study

The purpose of this study is to explore the student teachers' knowledge and use of problem-solving teaching strategies in a science classroom in a selected PTC in the Lira district.

1.4 Research Questions

This study is directed by a main research question and a set of supporting questions, with the supporting questions aiming to provide a more comprehensive response to the main research question.

1.4.1 Main Question

What are the status of student teachers' knowledge and use of a problem-solving strategy in science teaching and learning in the selected core PTC in Uganda?

1.4.2 Subsidiary Questions

1. How do science student teachers understand the problem-solving teaching strategy?
2. How do science student teachers use a problem-solving strategy to engage learners during the teaching and learning process?
3. What challenges do student teachers encounter in implementing a problem-solving strategy in a science classroom?

1.5 Significance of the Study

The findings of this study may inform primary teachers and teacher educators about the need to modify their teaching methodologies in science classrooms to cater to the needs of the learners. Similarly, this study may provide insights for science teacher educators that may want to develop continuous professional development training on science teaching and learning in Uganda. Additionally, the findings of this study can also enrich the teacher trainees to be teachers that would encourage conceptual and contextual understanding in their science teaching.

The findings of this study may inform the administration of Uganda National Institute of Teacher Education (UNITE) on how to design assessment tools that can be used by teacher educators to assess science teacher trainees with a focus on problem-solving strategy and a similar way, the findings may enable the curriculum designers to come up with a curriculum that empowers students to be problem solvers. In line with that, other researchers that may take an interest in educational research may use the literature to inform their studies.

1.6 Definition of Key Terms

Problem-solving is the process of defining a problem, locating its root cause, and locating, ranking, and choosing potential solutions (Mintrop & Zumpe, 2019). It is a process of working toward a goal while overcoming challenges.

A teacher's method or technique for assisting his or her students or pupils in the learning process is known as a teaching strategy (Reddy, 2019). As a result, problem-based learning (PBL) is a method that puts the needs of the students first and in which they learn about a subject by working in groups to find a solution to a challenging problem (Jabarullah & Hussain, 2019).

CHAPTER TWO

LITERATURE REVIEW

2.0 INTRODUCTION

In this chapter, student teachers' knowledge and use of problem-solving teaching strategies will be thoroughly reviewed and then a knowledge gap that the researcher aims to address will be identified. The researcher will critically analyze the following key issues; understanding of problem-solving teaching strategy, student teachers' use of problem-solving teaching strategy in a science classroom, and the benefits of encouraging reflective activities in PBL and related challenges of using this teaching strategy.

2.1 Understanding of Problem-Solving Teaching Strategy

In the Challenge Solving Teaching Strategy (PSTS), students study what they already know and what they need to know in-depth within the context of a real-world problem (Mayer, 1998). Foster & Yaoyuneyong (2016), argue that the problem-solving teaching strategy enables students to work in groups to find solutions to real-world problems and to develop their independent learning skills. They compare this to didactic instruction (Akcay, 2009). In this case, the teacher assumes a variety of roles, including coach, facilitator, and lecturer, and classes become more student-centered. Learning also becomes active rather than passive (Roth & Roychoudhury, 1994). By using this strategy, students can also develop their critical thinking abilities, analyze and handle difficult real-world situations, work in groups, and communicate both verbally and in writing (Erdoan, 2019). To conceptually and practically execute PSTS in science, the teachers' task of producing knowledge must be adequate, and they must successfully apply the generated things (Koschmann et al., 1994). The teacher must design the lessons and exercises for this subject utilizing social constructivist learning techniques such as group collaboration, problem-based learning, and peer teaching (Davidson & Major, 2014).

2.1.1 Designing a Problem-Based Learning Environment

Instead of important information being taught, the problem is presented first in problem-based learning, and then students apply their knowledge to resolve problems (Moust et al., 2021). Since PBL is typically group-based and projects might range in length from brief to taking up a whole term, it is advantageous to allot class time to assist pupils in preparing for their PBL project (Tan, 2021). In agreement, Chu et al., (2021), discussed that a well-planned PBL project also gives students the chance to develop their abilities in the following areas: self-awareness, group process evaluation, working independently, teamwork, project management, taking on leadership roles, written and oral communication, analytical and critical thinking, describing ideas, self-motivated education, and applying course material to real-world examples and this is supported by Hursen, (2021), states that information literacy, research, and resolving conflicts between disciplines are a few examples of skills developed in problem-based learning. Therefore, these objectives are achieved by having students collaborate to research a genuine issue they encountered in their classroom practices. However, to establish a productive atmosphere for problem-based learning, the teacher must: provide the students access to the problem; identify the problem statement and he/she has to research the curriculum by gathering information, disclosing it, and developing answers before presenting them to the learners (Aslam et al., 2018). In addition, the solution to the problem can be potentially resolved by the teacher by selecting the best-fit solution, presenting it, and doing a debriefing afterward (Wijnia et al., 2019). This allows the students to make the most of their strengths without the teacher interfering with the results of their discoveries. Wherever it is practical, the teacher should give the students ample time to make discoveries to improve the transferability of knowledge to the real world. The fixed school schedule, which may prevent students from exploring knowledge of their own free will, is said to make problem-based learning difficult for many teachers in terms of time. However, many teachers turn to homework assignments as a solution to the problem, which may prevent one-on-one interactions between the teacher and students on a particular task (Bailey et al., 2018). Although many factors surround problem-based learning, the teachers' understanding of how to design problem-based learning appears to be lacking (Heitzmann et al., 2018). As a result, they are unable to provide adequate support for the students during the lesson. As a direct consequence, the teachers turn to alternative teaching strategies like guided discovery, group discussion, and brainstorming, which may ultimately produce different results depending on the nature of the problem being addressed (Widodo & Budijastuti, 2020). Teachers frequently underestimate the benefits of problem-based learning for students with various learning disabilities since so few of them are equipped to deal with these groups of learners in the classroom, although there are many difficulties associated with it (Gokool-Baurhoo & Asghar, 2019). As a result, teachers usually neglect to include these learners in lesson planning, which makes managing them during the teaching and learning process exceedingly difficult. This is in line with a study done in Uganda in which the results indicate that rather than being influenced by how they interpreted the official curriculum, teachers' use of the problem-solving technique was much more constrained by contextual affordances and restrictions present in schools, the larger educational system, and society (Woo & Henriksen, 2023). In this study, they concluded that the results demonstrate how structural contextual factors influence how instructors in Africa adopt learner-centered pedagogies and regulate the pedagogical practice therefore, based on this study, it was realized that the teachers both regular and student teachers need a lot of support to aid their use of problem-solving teaching strategy in their classrooms. However, the design of this problem-based learning seems to be well taught by the teacher educators but its practicality seems to be lacking due to the large number of learners in the classrooms (Amerstorfer & Freiin von Münster-Kistner, 2021). Despite all these findings, little study has probably been done on problem-solving teaching strategies in science classrooms in Lira District.

2.2 Student Teachers' use of Problem-Solving Teaching Strategy in a Science Classroom

The problem-solving teaching strategy is an essential element of learning science (Docktor et al., 2015). The lecture teaching style, which involves applying concepts and principles analysis, however, lays more focus on the number of learning outcomes than on the effectiveness of learning (Neumann et al., 2002). Contrarily, problem-solving describes the development and evaluation of a conceptual problem-solving instructional approach in which students are urged to defend their use and create solutions (Docktor et al., 2015), which can be completed in groups or alone, to improve performance and lessen anxiety in learning for both boys and girls (Ramirez et al., 2013). However, the study by Gokhale (1995), found that there is no established concept discovered on the learners' anxiety when using the problem-solving teaching strategy. This is contrary to a study by Tobin (1990), who found that, despite being one of the best strategies for teaching and learning science, the problem-solving teaching strategy appears to be favoring boys over their counterparts, though there is no clear justification for this. Additionally, several studies have successfully demonstrated that using a problem-solving teaching strategy in science classrooms promotes the transfer of knowledge and helps students develop their critical thinking and problem-solving abilities because they can put theory into practice (Smetana & Bell, 2012; Belecina & Ocampo Jr., 2016). Additionally, it enhances pupils' analytical abilities and capacity for individualized instruction (Birgili, 2015). However, for any of these to be successful, the teacher must play a significant part in the problem-based learning instructional process and adapt to new ideas and tactics in addition to the conventional approach (Hmelo-Silver, 2004). Students are therefore given a modest amount of time to ask open-ended questions about the issue and discover potential answers by working on the assigned task (Jasanoff, 2005). A study conducted in Singapore revealed that during the teaching and learning of pre-service teachers, the use of a problem-solving teaching strategy should be most emphasized in the teaching and learning of science because it empowers hands-on activities that make learning constructive although challenges such as class control, feelings of inadequacy of science knowledge and insufficient understanding of the pedagogical method of teaching using this strategy need to be addressed (Chai et al., 2010). Therefore, for its success, the teacher must have a good mastery of the content that would support all learners to apply both previous and present knowledge in a given task (Pintrich & Schrauben, 1992). To have a successful application of these skills, pre-service science teacher trainees need to be fully equipped with knowledge and skills of how to apply the problem-solving teaching strategy in their science classroom practices (Hartmann et al., 2015). In support of the findings, Sikoyo (2010), implies that learner-centered pedagogies have a grim future in the region and that education experts in developing nations like Uganda should concentrate on aiding teachers in creating ways for teaching large classrooms when using problem-solving teaching strategies. However, this study focused on the regular teachers, leaving the student teachers where the production of the quality teachers origins. Despite all these findings done on the general challenges, the little study seems to be done on the student teachers' knowledge and use of problem-solving teaching strategies in the science classrooms in the Lira District.

2.2.1 Classroom Organization and Management of a Problem-Based Learning

Although problem-based learning is an approach to learning that has expanded in scope and depth around the world, the majority of literature focuses on problem-based learning's practical applications in specific contexts rather than an analysis of the difficulties and complexities associated with its implementation (Fan et al., 2021)

According to Graesser et al. (2018), the goal of problem-based learning is to provide students enough time to discover the anticipated solutions to the given problems and present them for discussion. In other words, the problem scenarios are contained and constrained by a certain subject or disciplinary area. Nevertheless, some curricula offer students specialized instruction in problem-solving methods, but in many situations, they do not (Shanta & Wells, 2020) and the emphasis in this type of learning is mostly on obtaining the answers the teacher is expecting, and these responses are founded in the knowledge that has been provided to the pupils in some fashion (Chin & Chia, 2004). As a result, the solutions are constantly related to a particular curriculum topic that is seen to be essential for students to learn to become knowledgeable and useful practitioners, and the solutions are constrained by the topic, and learners are expected to look into additional resources in addition to those already offered to find the solutions (Ertmer & Newby, 2013). Instead of using subjects or disciplines, the curriculum is organized on problem scenarios where the learners tackle these problems in groups or teams; however, they are not required to come up with a predetermined list of "correct answers." Instead, students are expected to actively interact with the complex issue that is being given to them and decide what knowledge and abilities they will need to acquire to manage it successfully (Giabbanelli et al., 2019). Although problem-based learning can be implemented in a variety of ways, its fundamental principles are generally more student-centered than teacher-centered learning (Awacorach et al., 2021). This is due to the opportunity that problem-based learning affords students to investigate a wide range of knowledge, connect the learning to their own needs as learners, and cultivate independence in their research (Hung, 2019). Since it may be applied in a variety of ways in and across various fields and situations, problem-based learning is thus a method of learning that is distinguished by flexibility and diversity due to its differences to certain individuals at various times, depending on the faculty and students involved in the programs using the strategy.

Therefore, adequate organization and preparation are called for, so that the learners acquire the best knowledge and skills required of them (Berns & Erickson, 2001).

2.2.2 Teacher Preparations

According to Stronge (2018), teacher preparation is a continuing procedure that changes as we gain new knowledge regarding the learners, their requirements, their interests, and their capacities. Additionally, even before pupils arrive at the start of the school year, the teacher is already playing the role of the problem maker if PBL has to be used as the primary instructional technique for the entire course unit or only at certain points (Major, 2018). Alternatively, a teacher may feel that using PBL exercises at a particular stage of the course would be more beneficial. Furthermore, to choose the optimal locations for PBL activities in this situation, the teacher would evaluate the curriculum. However, the teacher needs to be knowledgeable about the subject matter, abilities, and attitude (Pourshafie & Murray-Harvey, 2013). Additionally, the teacher creates a supportive environment in the classroom, assists students in making connections to the problem, establishes a work schedule, revisits the problem with the class, facilitates the creation of a product or performance, and promotes self-evaluation. The adoption of problem-based learning in the teaching of science is probably influenced by class characteristics and teacher factors (Martyn et al., 2014).

2.2.3 Learner Performance

Based on the learners' progress in problem-based learning, the teacher should seek students who are struggling with the task and provide them with extra assistance and recommendations (Boss & Larmer, 2018), and then these students should be evaluated for more than simply a grade so that the teacher can decide if necessary to change the assignment tasks or classroom procedures to cater for individual differences in the classroom (Balchin & Bouzaki, 2022).

According to the study by Evmenova (2018), Assignments for students must, however, encourage the acquisition of new information and viewpoints through participation in real-world situations. Therefore, it is important to provide students the chance to create their learning activities and present them to the rest of the class, even if encouraging students to share their ideas requires a lot of motivation for them to perform well on formative tests. In a collaborative setting, the students grow in their comprehension of the issue that has to be resolved.

2.2.4 Teacher Performance

To determine if they are offering students the appropriate amount of help and direction, teachers must keep track of their progress (English & Kitsantas, 2013). The teacher should avoid giving learners information or instructions because part of the lesson's goal is to increase their sense of freedom. Similarly, some teachers might want to compile a list of ideas for improving their PBL work in the future at the end of the unit (Delisle, 1997). In a problem-based learning environment, the teacher should also promote ongoing evaluation of students' work rather than appreciating the sum of their grades. As a result, the learners must devote all of their attention the situational analysis to avoid presenting information that may not be relevant to the way they intend to address the problem (Reiser, 2018).

2.2.5 Classroom Interactions (Peer or Learner-Teacher)

During the teaching and learning process, interactions between students and teachers take place in the classroom. These methods of engagement could enhance teaching techniques, student performance, and learning (Cohen et al., 2020). As a result, teachers employ a range of instructional strategies to foster learning in the classroom for instance questioning is one of the most popular methods used to encourage class involvement, especially in testing conceptual knowledge, identifying learning disabilities, and promoting involvement (Chin & Chia, 2006). Additionally, Le et al., (2018), imply that group projects and assignments might help promote interaction in the classroom during the problem-based learning science classroom. Therefore, the type of developed learning activities that allow students to learn through classroom interaction is determined by the teacher's interpersonal and pedagogical skills (Newton et al., 1999). For teachers to understand the topics and design teaching and learning activities that effectively engage learners during the session, science lesson preparation in problem-based learning needs to be made before the teaching time (Saputra et al., 2019). Teachers engage with pupils physically as well as verbally in a variety of interactions. Similar to what Varga (2017), explained that teachers engage with students by delivering directions, asking questions orally, and providing feedback, revealing that teacher-student interactions in the classroom foster classroom management and increase student participation, particularly when the teacher supports the impaired students, which fosters a favorable learning environment. In a similar vein, Ibrahim and El Zaatari (2020), stress the importance of teacher-student contact in promoting positive student behavior and attitude toward the science lesson, helping students to improve their communication skills, improving the learning environment, and enhancing students' performance during problem-based learning. To ensure that, all students can participate in problem-solving learning activities and teachers must understand the kind of pupils they are working with (Winter, 2022). In contrast, problem-solving learning activities that include learners working in pairs or groups produce learner-learner interactions. This enables them to get the chance to connect through debates, questions, and demonstrations as they strive to complete group projects and other problem-based learning activities (Tan, 2021) and as a result, children learn better in such an environment and achieve academic success since classroom engagement would have increased. Additionally, interactions between students can foster peer learning that results in better comprehension and focused learning. It has been demonstrated that learner-learner interactions during problem-based learning help learners to strengthen their critical thinking skills and develop their conceptual grasp of matter (Osman & Kriek, 2021). In agreement with that, Cajander et al. (2012), indicate that when students communicate with one another in student-view language, information retention, and conceptual understanding improve, and Kahu and Nelson (2018), draw the conclusion that classroom interactions stimulate learners' learning, which positively influences academic accomplishment.

2.2.6 Class Feedback

The term "feedback" describes remarks made about a student's performance by either a teacher or a student (Huisman et al., 2019). They go on to say that a student may receive corrected information from a teacher, may hear about a peer's alternative learning strategy, may learn about solutions to difficulties via learning materials, or may receive information from parents.

As a result, the data from each of these sources significantly contribute to the learning of students. Similarly, to this, Elbaz (2018), explains how important it is for teachers and students to have relevant knowledge since it helps them make better decisions regarding teaching and learning. For instance, the knowledge helps students bridge the gap between their conceptual knowledge and the knowledge they are aiming for (Song, 2018) Similar to this, Nasri et al. (2020), assert that students become self-directed learners as a result of descriptive feedback ability to help them understand their mistakes and chart a course ahead. In addition, Toro et al. (2019), highlight that while most teachers exhibit insufficient knowledge and skills when putting feedback into practice, it is a crucial method for enhancing learning in a problem-solving teaching strategy.

2.2.7 Reflection and Problem-Based Learning

Hubble (2018), makes a distinction between "technical reason" and "reflection in action," emphasizing the "technical," in which knowledge and abilities are applied to customary and pre-established ways and approaches. Reflection is seen as an instrumental tool that instills a sense of direction in teachers so they can carry out effective teaching and learning using problem-based learning because it gives them the ability to formulate, frame, construct, and resolve issues that are important to their learners' progress in problem-based learning activities (Tan, 2021). Furthermore, this is essential for developing remedies for the issues related to problem-based learning in science classrooms (Nadeak & Naibaho, 2020). Teachers must consider their practice to go beyond just having academic and technical skills to fulfill their moral commitment to provide their students with the tools they need to actively participate in problem-solving activities that motivate actual life in contemporary society (Shepard et al., 2018). The purpose of pre-service teacher education, in addition to imparting knowledge of material and pedagogy, is to produce reflective teachers. Future instructors who use PBL as a learning technique are encouraged to reflect. PBL has been widely embraced in higher education across a variety of academic and professional sectors. When this approach—which was created by the Greek philosophers Protagoras and Aristotle—was adopted in 1969 at the McMaster University School of Medicine as an alternative educational strategy for instructing doctors, it quickly gained acceptance (Barrows & Tamblyn, 1980). Many other professional fields, including law, nursing, pharmacy, social work, engineering, and business and management, embraced it after it was first introduced. Because using medical knowledge and skills to diagnose patients' problems should be a part of a doctor's professional competence, the PBL curriculum was created to actively engage science students in the material and to foster the development of their critical thinking, communication, and social skills (Ali, 2019). By allowing students to concentrate on difficult, real-world problems and find solutions through self-awareness, critical thinking, complex problem-solving, communication, teamwork, and self-directed learning, PBL encourages "reflection in action" in the students. As the main form of instruction, students frequently first tackle contextualized, poorly structured problems in groups before doing so individually (Chin & Chia, 2006). The issues must also be current and represent a typical situation that subject-matter specialists deal with. For instance, in light of the current drive toward assessment for learning, a teacher must be able to balance formative and summative evaluations. PBL gives students the chance to study and comprehend the significance of underlying information and ideas in their future professional activities by presenting difficulties utilizing real-world scenarios. To embrace PBL, educators are required to "reflect in action" by managing issues based on their professional judgments. PBL focuses a lot of emphasis on collaborative learning, where students not only learn from one another's expertise but also develop crucial character traits including respect for others, cooperation, problem-solving, and knowledge sharing (Temel, 2014). PBL is a learner-centered form of learning that places students in small groups with subject facilitators as opposed to a faculty-centered mode of teaching with didactic lectures. The teacher or professor must act as a guide rather than an authority on the material (Miner-Romanoff et al., 2019). The facilitator must perform three main roles. The facilitator first assists students in developing research-related questions. Thirdly, the facilitator facilitates the formulation of the finished product or the suggested solution. The facilitator also helps students locate and understand essential references and sources (Ruder & Stanford, 2018). To be able to impart the proper skills to the prospective teachers who are intended to interact with the curriculum that produces graduates in the primary sections, teacher educators must possess all the knowledge and abilities of problem-based learning from their institutions of higher learning. However, the emphasis on problem-solving in the primary science curriculum must be sufficient for the learners to acquire all the necessary abilities for daily use.

2.3 Benefits of Encouraging Reflective Activities in PBL and Related Challenges

As much as various studies have shown that problem-solving is an effective teaching and learning approach for science (Gagne, 1980), it has been discovered that if the teacher does not plan adequately, time may be restricted and resources may not be sufficient for the students in the class (Crosby, 2000). Accordingly, the planning of the lesson is guided by the teacher's understanding of the use of problem-solving (Hudson, 2013). Even though some studies have been conducted on the problem-solving teaching strategy, the student teachers' knowledge and use of the approach in the teaching and learning of science is yet to be examined have examined. However, in problem-based learning, the implementation of the aforementioned course demonstrates encouraging reflection in pre-service teachers on both advantages and disadvantages of problem-based learning in their science classroom practices (Baysal, 2017). The PBL approach promotes active learning and higher-order thinking among pre-service teachers, who are required to take ownership of their education (Hung & Amida, 2020). Such pedagogical strategies are in contrast to teacher-centered strategies like didactic whole-class lectures, which are frequently used with big undergraduate courses at higher education institutions. Such a didactic approach limits students' capacity to acquire critical competencies and higher-order thinking skills and places them in a passive role in the learning process (Shah & Campus, 2021). The body of research on assessment demonstrates unequivocally that traditional assessment techniques like summative exams and standardized testing are ineffective in helping students develop higher-order competencies (Wren, 2019). Heavy dependence on these conventional methods of instruction and evaluation is not only harmful to student learning but is also inappropriate for the training of creative science professionals, who must constantly learn new things and advance their expertise. Second, the PBL approach's flaw was contextualized in actual circumstances, exposing future teachers to current assessment problems in the field of sciences. The study conducted by Härtig et al.(2020), shows how a science problem was contextualized in a real-world setting, namely in a school setting. The issue gave the pre-service teachers a chance to "reflect in action" on the caliber of the rubrics (Duncan et al., 2017). The materials and tools aided the pre-service students in their study and problem-solving (Ateşkan & Hart, 2021). In general, pre-service students were able to make meaningful connections between their thoughts and the real teaching of science (Barth-Cohen et al., 2018). The pre-service students claimed that getting the chance to work in groups to address challenging real-world situations helped them hone their reflective abilities as well as other higher-order talents including critical thinking, problem-solving, communication, and teamwork

(Kivunja, 2014). The assertion made by educators that the development of a desire for lifelong learning as well as skill in critical thinking and effective problem solving is a key objective of higher education, including pre-service teacher preparation, is supported by a PBL methodology (Alrajeh, 2021). Finally, the PBL strategy is very beneficial for developing reflective teachers who are knowledgeable about authentic evaluation. The following four characteristics of authentic assessment point to a close resemblance between it and PBL. First, real-world performance in the field is intended to be accurately represented by realistic assessment tasks (Elder & Paul, 2020). As a result, they give students plenty of opportunities to use their learning preferences, skills, and interests as a springboard for mastering higher-order abilities. Second, students and other members of the learning community are freely given access to specific performance criteria and standards in the form of well-developed rubrics. Third, self-assessment is crucial for fostering students' ability to analyze their work against standards, revise, alter, and refocus their efforts, as well as take initiative in keeping track of their development (Da Silva et al., 2018). Because they are in charge of their education, students who engage in such formative assessment practices are more likely to learn independently. Fourth, students are typically required to defend their work in front of a live audience (Virtue & Hinnant-Crawford, 2019). They will be able to communicate more effectively as a result. Given the four characteristics of authentic assessment listed above, it is essential to give pre-service teachers not only the technical know-how of authentic assessment but also the competence to conduct an authentic assessment reflectively (Alrajeh, 2021). Therefore, the PBL method is the best way to encourage authentic assessment literacy because it places the work in the real world and gives pre-service teachers the freedom to explore and learn from their mistakes. To improve students' learning experiences, formative assessment, according to PBL teachers, must be incorporated into the PBL process. For instance, emphasizes the value of opportunities for peer and self-assessment as well as high-quality feedback from PBL facilitators (Mergendoller et al., 2013). Because pre-service teachers typically lack assessment literacy and because of insufficient pre-service training in educational assessment, this benefit of the PBL approach for developing reflective pre-service teachers who are literate in assessment is significant for teacher education (Koh & Tan, 2016). As a result, many of them are unprepared when they begin their teaching careers to comprehend and accept new assessment policies and methods. In the study conducted by Kruse et al. (2020), the majority of student teachers had low levels of assessment literacy and so, they have high levels of confidence in summative assessments of student learning and low levels of confidence in formative assessments. The application of realistic performance assessments and rubrics is anticipated for Alberta pre-service and in-service teachers in light of the state's current activities in curriculum redesign and student learning evaluations. The PBL approach's development of assessment literacy not only makes it possible to fairly evaluate students' mastery of contemporary competencies but also opens up chances for assessment for learning that will improve students' learning experiences (Koh & Tan, 2016). The facilitators' insufficient knowledge of and expertise with PBL, however, posed a significant obstacle to successfully facilitating the reflective process (Bertel et al., 2021). The pre-service teachers had another difficulty since they had to complete three courses at once and were unable to manage their needs for instructor supervision, group collaboration, and independent study. Lack of understanding of the terms and connections between student- and teacher-centeredness is a typical problem experienced by facilitators and pre-service teachers (Al-Amoush et al., 2013). Some facilitators may have been unsure about how much they should direct, interfere with, and help their students during the PBL process. They believed that any direct instruction or direction might be at odds with the PBL's core value of learner-centeredness. Pre-service teachers may share the same mindset as their facilitators in that they believe that since they were designed to be independent learners, they shouldn't rely on or go to their facilitators for assistance (Biggs et al., 2016). These beliefs and presumptions regarding learner-centered approaches generally and the PBL approach were shared by both facilitators and pre-service teachers. According to research, the two biggest obstacles to implementing learner-centered approaches, such as PBL, are a lack of or insufficient structure, guidance, and support, as well as a failure to give students access to the kind of solid background knowledge and critical thinking that they need to succeed (Savery, 2015). According to a report on the subject of structure, direction, and support, while appreciative of the freedom to lead their education, students prefer "bi-directional feedback and guidance as fundamental parts of what student-centered learning should be" (Ngo & Phan, 2019). The requirement for educators to give students a solid foundation in knowledge and deep thinking is related to the learner's desire for ongoing teacher aid. Researchers like Ellis (2016), warn that learner-centered models do not necessarily give students enough opportunities for critical thinking or deeper learning. It follows that the teacher will still need to teach content in some way. When we acknowledge that learner-centered strategies, like the PBL strategy, do not always prevent teacher engagement or direction, the aforementioned difficulties can be overcome. It's important to strike a balance between giving students the freedom to learn on their own and providing them with the support they need from their lecturers and facilitators. Through ongoing appraisal and reorientation of these roles and tasks (Belda-Medina, 2021) contends that there should be a continual exchange between the facilitators (teachers) and pre-service teachers (learners). According to Del Valle (2019), "classroom interactions may appear to an outsider to be teacher-centered, but are versions of Learner-Centered Education (LCE) suited to local cultural traditions and resource realities". Regarding the difficulty of implementing the PBL approach due to time constraints and a lack of clarity regarding how to strike a balance between group collaboration and self-directed study, one suggestion is to assist the teachers and pre-service teachers in realizing that encouraging reflection through PBL does not imply a suspension of teacher involvement or direction (Lee & youn Ahn, 2021). Instead, a balance between teacher direction and learner autonomy is required to gradually empower the student to move beyond technical rationality to reflection in action (Shen et al., 2020). Achieving this balance also makes sure that pre-service teachers can ask their facilitators for help and guidance if they need it when it comes to time management. Additionally, pre-service teachers may communicate with their colleagues while doing self-directed learning and introspective reflection (Makina, 2019). Regarding the first issue, which relates to the facilitators' lack of knowledge and expertise in PBL, it is suggested that in PBL, teachers offer some formal professional development workshops that concentrate on helping them gain knowledge and confidence in utilizing PBL to encourage reflection. PBL is beneficial, according to Al-Busaidi and Al-Seyabi (2021), teachers participate in professional development workshops work on design problems, or create an actual PBL unit. For instance, the assessment course coordinator could involve all the facilitators in the PBL process by asking them to co-develop a PBL unit or PBL assessment curriculum rather than producing the course on their own. Such participation before the start of the course would have aided them in implementing it (Tan, 2021). In a similar vein, a study carried out in Uganda concluded that it is important to establish the teachers' degree of proficiency in using problem-solving teaching strategies and how they should be supported despite the enormous number of students they are responsible for. However, it is regarded as one of the crucial child-centered approaches with a tremendous impact on teaching and learning (Abenawe, 2022)

2.4 Theoretical Frame Work

Cognitive constructivism is a theory that explains how people think (Jones & Brader-Araje, 2002). Therefore, constructivism is a method of learning that proposes that human beings are born with knowledge that is directly influenced by their experiences. Learning, according to this view, occurs as a result of the interplay between what the learner already knows and the physical world (Kahu & Nelson, 2018).

According to Ajaja (2013), Peer or small group interactions give a rich and required atmosphere for students to modify their cognitive system, which may lead to inventions in problem-based learning. Students learning progress is aided by social interaction with more sophisticated persons who assist in the learning process.

Similarly, Vygotsky's (1978), activity theory of learning on the zone of proximal development theory states that children learn best when they are placed in an environment that demands them to think slightly above their cognitive level as they discover new knowledge and skills through collaboration. Therefore, the benefit of students working in small groups to perform science investigations stands from the conversation that takes place (Gentry, 2021) in developing their curiosity to have an insight into the tasks given to them. In addition, the theories support the contextual learning theory which states, learning takes place when learners find meaning in context (Budiman et al., 2021). So, meaningful learning takes place when learners find it useful and it makes sense to their frames of reference through problem-based learning (Massam, 2019) and so, the classroom knowledge must have relevance to the real-world context (Renzulli et al., 2021). These underpin the ideas that PBL lessons are built on unstructured problems that must permit unrestricted investigation and so, gives learners room for exploration until they come up with meaningful ideas.

Furthermore, Problem-solving is the fundamental component of the PBL process which involves more than just asking questions but the dissemination of knowledge and the creation of workable answers (Haatainen & Aksela, 2021). Additionally, one crucial aspect of PBL is that students create the driving questions and explanations, not teachers who would otherwise manage the process and explain topics. This allows students to test their hypotheses about problems and students, therefore, require prerequisite expertise and knowledge for PBL. In other words, the ability to identify problems and observational abilities are identified as having a high priority, particularly in the early phases (Hawari & Noor, 2020).

The capacity to use suitable metacognitive and reasoning techniques is part of the development of problem-solving abilities. As a result, PBL projects require a high degree of knowledge and ability to complete the given task. Scientific literacy skills, in-depth inquiry, idea testing, scientific method drawing on skills, group functioning, and information from variables are all crucial to problem-solving.

From this vantage point, PBL expands the roles of the teacher, facilitator, or coach rather than the lecturer because the majority of the work is done by students where the duties include establishing whether there is an issue, formulating a precise problem statement and a workable plan, finding information, data, and learning objectives, and producing a practical solution (Renzulli et al., 2021). In light of all these, PBL appears to be rather common for scientists because it is the initial application area and depends on students' prior knowledge and skills, and It is also fed from diverse instances and subjects in high-level classes.

The PBL entails a comprehensive and flexible knowledge base, effective problem-solving skills, self-directed, lifelong learning skills, effective collaboration skills, and intrinsic motivation to learn. These are the five objectives of the McMaster Model, which were created to support students in achieving their learning targets (Savery, 2019). The general procedure for instruction in PBL is as follows: a small group of students is given a problem (in the subject area and in line with the more general curricular goals); in which this complex problem, which lacks a single correct solution, drives student learning and students collaborate in groups to determine what they need to learn to solve the problem. It, therefore, calls for the students to conduct self-directed learning (SDL) activities to find solutions to their learning problems and after that, they then report back to the group on their findings and apply their newly acquired knowledge to the issue.

The student team then develops and presents a solution to the issue; and the activity is concluded by students reflecting on what they have learned and the efficacy of the strategies they have used (Mahasneh & Alwan, 2018). This cycle is repeated with fresh issues and assistance from the teacher to direct the growth of metacognitive thinking abilities so that the students become more knowledgeable in the subject (Marshall, 2019).

The theories employed in this study are interwoven and interdependent in their operations based on the knowledge and abilities that problem-solving teaching strategies require, as they support the core of problem-based learning on conceptualization and contextualization of learning.

2.5 Unfilled Knowledge

Few studies have investigated student teacher's knowledge and use of a problem-solving teaching strategy in a science classroom and how it boosts learner's curiosity to learning of science by assessing the use and challenges of problem-based learning and their impact on learning and performance, especially in primary schools and primary teachers' colleges where, among other things, the teaching and learning environment has been cited as a concern, the current study seeks to add to the body of knowledge (Alrajeh, 2021).

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 INTRODUCTION

The term "research methodology" refers to a road map that shows how a study is carried out (Pandey & Pandey, 2021). It pertains to the study's conceptual underpinnings. To make the conclusions of this study reliable, a detailed description of the research methods employed for it was provided in this chapter. As a result, this chapter covers the research approach and design, location and setting, sampling and sampling procedures, data collection methods and instruments, data analysis methods and reliable data, study limitations, and ethical considerations during the research.

3.1 Research Approach

The study adopted the qualitative research approach (Mohajan, 2018) where Observation, an insight semi-structured interview discussion, and document analysis were used to grasp the participant experiences on the problem-solving strategy (Bolderston, 2012) that enable the participants to interact in a natural setting (Moser & Korstjens, 2018). To help the researcher better grasp, the various attitudes and opinions of the student teachers on the knowledge and use of a problem-solving teaching strategy in their science classrooms, a qualitative technique was chosen in this case. Additionally, Merriam and Grenier (2019), explain that the qualitative approach is concerned with the attitudes, beliefs, and actions of study participants. They continued to explain that the main goal of qualitative research is to gain a deeper comprehension of a phenomenon.

3.2 Research Design

The researcher's fundamental premise is that interactions and experience are the building blocks of knowledge (Chatterjee et al., 2018). Based on that, the researcher might interact with the participants to gain a better knowledge of the phenomenon being examined. The present study's qualitative case study design became more appropriate given the nature of the research topics it seeks to address (Baskarada, 2014). Therefore, to collect concrete, contextualized in-depth data, and multifaceted explorations of complex issues in the real world of student teachers' knowledge and use of problem-solving teaching strategy in a science classroom (Hancock et al., 2021), with the reduction of biases but an open expression of opinions (Jones & Alony, 2008). As a result, only Primary Teachers' college was chosen for the investigation.

3.3 Setting and Research Location

The study was conducted in Northern Uganda specifically in the Lira district. The region was chosen for convenience since the researcher works there, and given the economic circumstances of the research. In addition, the study involved Primary Teachers' College in the Lira district because that is the level the researcher teaches currently and has a better understanding of the teaching pedagogy in science education and the transferable skills expected to be used by the teacher trainees in primary school science classrooms. For instance, when he/she is engaging the learners in problem-based learning. Further, the study was conducted in one Primary Teachers' College (PTC) due to limited time and funding to accomplish the study. However, it also enabled the researcher to develop a clear and deeper understanding of participants' behavior and opinions towards the knowledge and use of problem-solving teaching strategy in a science classroom and how it enhances the learners' conceptual and contextual understanding of science (Kelley & Knowles, 2016).

The PTC used in the study was also advantageously chosen since it was close to the researcher's home, enabling the researcher to easily contact the primary schools where students were engaged in their last school practice. This made it simple to obtain the necessary study participants' data.

3.4 Sampling and Sampling Procedure

Sampling design. It is the process of selecting a group of participants from the population based on an established way that you will collect data in your research (Palinkas et al., 2015). In this study, the researcher focused on year two student teachers who completed their first school practice and pursued their final school practice to grasp the experiences of problem-based learning in the previous school practice. Furthermore, the study adopted stratified purposive sampling because it describes the samples within a sample and suggests that purposive sampling can be stratified or nested by selecting particular units that vary according to a key dimension (JULIANTO et al., 2019). Therefore, for credibility, the researcher picked 6 participants who are students, minding 3 ladies and 3 gentlemen respectively based on their performance in science education assessment records. The selection protocol was as indicated; (2 highest, 2 average, and 2 lowest) to participate in the interviews meanwhile four students that is to say 2 ladies and 2 gentlemen respectively were purposively selected to participate in the class observations and document analysis. This was to give an equal representation of the participants' views in the findings.

3.5 Data Collection Procedures and Instruments

The researcher interacted with 6 student teachers during one on one semi-structured interviews to grasp their understanding, knowledge, use, and challenges in the problem-based learning environment. The classroom observation and document analysis protocols were as well used. Therefore, the data collected from the field went through multiple procedures for it to be triangulated so that there is an increase in rigor and trustworthiness (Johnson et al., 2020).

3.5.1 Non-Participant Observations

The researcher conducted non-participant observations of the four student teachers conducting science lessons in four different classes to see their present knowledge and the use of a problem-solving teaching strategy in the classrooms. On that basis, the observations were carried out, with each student-teacher participant being observed once while instructing in the classroom at their desire. Additionally, Kaplan & Maxwell (2005), contend that observation is a technique for evaluating the veracity of participant information. They went on to say that through making observations, the researcher can learn firsthand details about a phenomenon from participants who are in their natural environment. The four participants were purposefully chosen based on their qualifications and the applicability of the data anticipated of them, taking into account the student teachers' schedules. This helped a researcher who was seeking to eliminate participant biases in selecting their preferred class and boost the trustworthiness of the data (Shenton, 2004).

3.5.2 Semi-Structured Interviews

Semi-structured interviews, according to Iyamu (2018), enable the researcher to gather thorough data regarding how the participants perceive their realities. Two student teachers underwent one post-class interview. The researcher used these interviews to learn more about the observed behaviors and to better understand the attitudes and perspectives of student teachers toward problem-based learning. Each participant's interview lasted approximately 20 minutes, and with their permission, it was taped so the researcher could record and analyze the participants' perspectives. Zina (2021), explains that the researcher can gather useful information from conversations or change the questions' objectives to pique participants' interests.

3.5.3 Document Review and Analysis

The students' exercise books were gone through and looked at to understand more about the different kinds of assessment activities and feedback procedures. The researcher made an effort to relate and connect data from observations and interviews to the relevant documentary evidence. The practice involved four randomly selected students from primary four (P.4), primary five (P.5), and primary five (P.6), respectively. The researcher gathered and arranged practice books and reviews according to the particular day's un repeatedly while considering the learners' gender. This was done to reduce gender biases and boost the reliability of the data.

3.6 Data Collection Tools

The researcher used an unstructured interview guide, document analysis checklist, and observation checklist to compile extensive data. These resources helped the researcher to get pertinent information that addressed the research questions. Additionally, the use of a variety of tools made it easier to validate the data so that others can assess it (Busetto et al., 2020) and so data triangulation improves the research rigor.

3.6.1 Semi-Structured Interview Protocol

The interview protocol entails preparing a list of questions in advance of the interview (Newcomer et al., 2015). It is the process that helps the researcher to maintain concentration on crucial aspects of the investigation. In this study, six student teachers were interviewed using the semi-structured interview procedure. The approach let the researcher maintain focus while learning more about problem-based learning.

3.6.2 Observation Checklist

The observation checklists were created and each of the four student teacher’s science lessons was observed once based on the timetable. The checklists enable the researcher to carefully examine the phenomena and manage to get data from the participants in their natural settings. In addition, the researcher was able to get a deeper understanding of student teachers on the use of a problem-solving teaching strategy in science classroom practices.

3.6.3 Document Review and Analysis Checklist

The checklists were created to gather information about the types of teaching resources, assessments, and nature of feedback administered to the learners during problem-based learning. The researcher examined the syllabus, schemes of work and lesson plans, and learners' exercise books to get in-depth data on the use of a problem-solving teaching strategy in a science classroom.

3.7 Data Analysis Procedures

The study used Interpretative Phenomenological Analysis (IPA), in which the researcher analyzed the data and used them to support a narrative account of experiences. Using this as a foundation, Smith, and Fieldsend (2021), explain that interpretive phenomenological analysis entails giving meaning to participants' experiences and views about a phenomenon under study and connecting their meaning to the researcher's own experience to interpret participants' realities.

The manual transcription of the interview recordings using Microsoft Word was the first step in the analysis of the study's data. The transcripts were then read aloud repeatedly to help the researcher absorb the material. The researcher then conducted his verbatim transcription because he had interacted with the interviewees during the interviews. Because of this, he was able to remember, comprehend, and recall both the participants' verbal and non-verbal cues. The information from the interviews was then manually coded, organized, and themes were created.

Additionally, the themes were examined to construct a single narrative scenario using portions of the transcripts, to support the data (Lemon & Hayes, 2020). Remarkably, information from observations and document analysis was used to confirm what was said in the interviews. As a result, the analysis showed how student teachers use a problem-solving teaching strategy in their science classrooms.

3.8 Trustworthiness

To gather information from the student teachers and learners about their practices, opinions, and perspectives on problem-solving teaching strategy, the study included observation, interviews, and document analysis to triangulate the data and boost its trustworthiness. Similarly, Abdalla et al. (2018), explain that combining data from several sources of evidence reduces prejudice and inaccuracies. Additionally, to eliminate any ambiguities, the research tools were intensively discussed with the supervisor and went through the ethical review committee to prove their authenticity before the actual data collection (Kvale & Brinkmann, 2009). The data was collected, transcribed, and shared with the supervisor for further guidance.

3.9 Limitations of the Study

Due to the study's small sample size, participant differences, and short research period, few observations were made, which might have disrupted the classroom's natural environment and made it difficult to observe all the procedures as they were being done. Therefore, the researcher used several data collection strategies to address these flaws.

3.10 Ethical Consideration

The practices that secure participant protection determine the value of the study (DePoy & Gitlin, 2019). To gain access to the chosen PTC, the researcher first got permission to conduct research from ERC-Aga Khan University and then from the Uganda National Council of Science and Technology (UNCST). The researcher then took action to gain access to the Principal's office which signed a letter of consent to authorize and introduce the researcher to the school practice centers where the student teachers were placed for their final school practice and enable him to conduct the study.

All study participants received thorough information about the study objectives before being asked to complete forms of consent and assent. This is required so that participants may make informed decisions about their participation in the study (Mitchell et al., 2018).

To protect their independence, participants had the choice to take part in the study or not (DeJonckheere & Vaughn, 2019). Similarly, participants' genuine names were also given pseudonyms to disguise their true identities.

CHAPTER FOUR

FINDINGS, ANALYSIS, AND DISCUSSIONS

4.0 INTRODUCTION

The findings from the investigation into (a) student teachers' understanding of a problem-solving teaching strategy in science classrooms, (b) student teachers' use of a problem-solving teaching strategy to engage students during the teaching and learning process, and (c) challenges student teachers do encounter when practicing a problem-solving teaching strategy in science classrooms are analyzed and discussed in this chapter report. Observation, semi-structured interviews, document analysis, and review were used to acquire the study's findings.

4.1 College Background

The college that took part in the study was a government primary teachers' college. In Uganda, there are forty-five government-aided colleges, including this one. However, this study focused on one of three colleges in the Lira district. In this college, the majority of the students come from the region although some students hail from other parts of Uganda.

4.2 Nature of the Participants

Student teachers and learners from selected primary schools participated in the study. The accomplishment of this study was specifically attributed to ten science student teachers and learners of primary four, five, and six engaged during the science lessons. Six learners from the corresponding classrooms, aged 10 to 13, took part in the document analysis. Nevertheless, throughout this investigation, non-participant observations were conducted with the full class.

4.3 The Study Findings and Analysis

The manual transcription of the interview recordings using Microsoft Word was the first step in the analysis of the study's data. The transcripts were then read aloud repeatedly to help the researcher absorb the ideas. Because of this, he was able to remember, comprehend, and recall both the participants' verbal and non-verbal cues. The information from the interviews was then manually coded, organized, and themes were created.

Additionally, the themes were examined to construct a single narrative scenario using portions of the transcripts, to support the data (Lemon & Hayes, 2020). Remarkably, information from observations and document analysis was used to confirm what was said in the interviews. As a result, the analysis below shows how student teachers understand and use a problem-solving teaching strategy in their science classrooms.

4.3.1 Student Teachers' Understanding of Problem-Solving Teaching Strategy

In this study, both student teachers and learners provided information on the ideas of problem-based learning and its implementation. For a thorough knowledge of problem-solving teaching strategy processes, data were gathered using a variety of data collection techniques, including classroom observations, semi-structured interviews with student teachers, and document analysis and reviews under which student teacher's schemes of work, lesson plans, and learners' exercise books were fully reviewed. Consequently, the analysis produced several sub-themes such as the knowledge of problem-solving teaching strategy, the nature of problem-based learning, and the application of problem-based learning in daily life.

4.3.1.1 The knowledge problem-Solving Teaching Strategy

Based on the study findings, student teachers had a variety of ideas regarding problem-solving teaching strategy, including that; it should be challenge-based, solution-based, and strive to get the best alternative solutions, when asked about problem-solving teaching strategy, participants proceeded to say that problem-solving teaching strategy needed the teacher to define the problem, identify the problem and find the best alternative solutions for that problem. However, according to the reviewed document, problem-solving teaching strategy was not included in the proposed methods, information from students' exercise books, teachers' lesson plans, and schemes of work that could provide insight into its content. Instead, they used other teaching methods in the preparations.

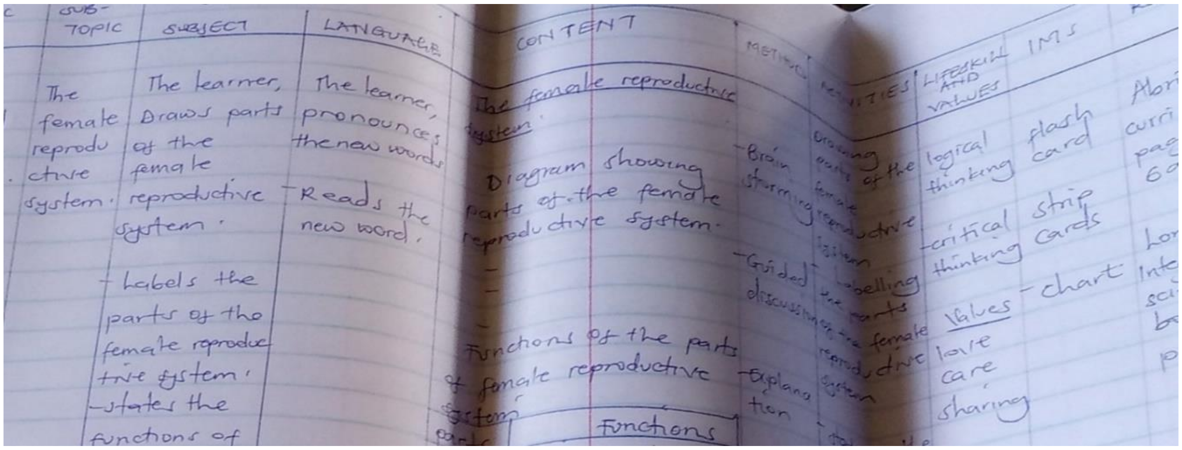
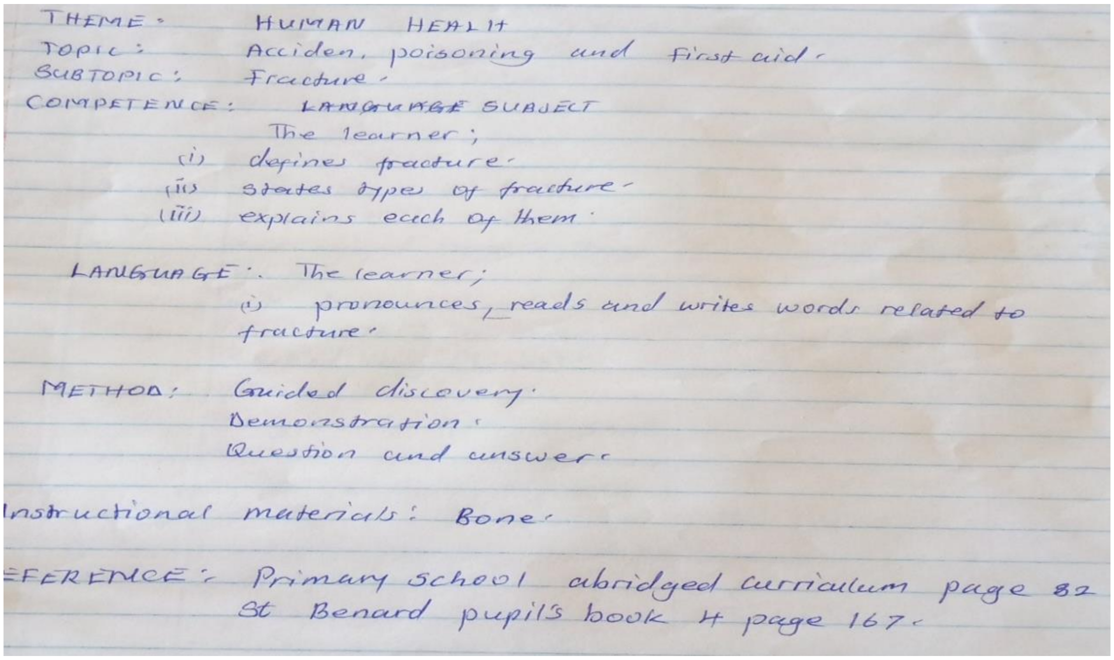


Figure 1: A sample scheme of work for the Primary six science lesson on the female reproductive system

The teachers' preparations showed how the science sessions were structured to fulfill the needs of the students while teaching and learning utilizing a problem-solving teaching method. Here, the analysis of the instructional strategies and comparison with the theoretical ideas raised during the science teacher interview sessions were the main points of emphasis. Based on the instructional design, the student teachers showed that their class-level work schemes were well thought out. However, during interviews, the student teachers proceeded to share their understanding of problem-based learning which was not demonstrated in the schemes of work and lesson plan preparations.

> "My understanding is it means the act of defining problems or identifying those problems and then finding the best alternative solution for that problem". (student teacher's voice; R8 retrieved from interview Thursday, 6th, October 2022).
>
> "Ok with the problem-solving? And the way I understand it since I have ever used it, in case a learner is having any difficulty in an area, and he/ she asks you as a teacher and you should be able to find a solution to the challenge that the learner has come up with". (student teacher's voice; R1 retrieved from interview Wednesday, 5th, October 2022).
>
> Therefore, the student teachers' understanding of problem-solving teaching strategy and their practices remain challenging.



THEME: HUMAN HEALTH
TOPIC: Acciden, poisoning and First aid.
SUBTOPIC: Fracture.
COMPETENCE: LANGUAGE SUBJECT
The learner;
(i) defines fracture.
(ii) states types of fracture.
(iii) explains each of them.

LANGUAGE: The learner;
(i) pronounces, reads and writes words related to fracture.

METHOD: Guided discovery.
Demonstration.
Question and answer.

Instructional materials: Bone.

EFERENCE: Primary school abridged curriculum page 82
St Benard pupil's book 4 page 167.

Figure 2: A sample lesson plan for the Primary four science lesson on fracture

According to a review of science lesson plans, each lesson's preparation paid less attention to the problem-solving teaching strategy. Although student teachers thought they were employing a problem-solving teaching model, other approaches were utilized. According to Figure 2, student teachers did not appear to have a clear understanding of the practicality of problem-solving teaching strategies because the majority of the lesson plans examined had a similar format and the methods employed did not specifically mention problem-solving teaching strategies, even though the majority of participants stated that they always use other methods when teaching and learning the content.

4.3.1.2 Designing A Problem-Based Learning Environment

Based on the study findings obtained through the interviews, the participants were able to explain how they design their science learning environment during problem-based learning. For example,

> "…In this topic of sanitation, I could engage learners in different activities because that was practical. Therefore, I engaged them in some activities within the school community where I could bring them out and take them to a dirty area, mm-hmm, what can you do here? And in that question, there

> is a problem of course, in their minds, they thought of solutions coming out as we need like slash, we need to clean. we need to sweep and among others as practical method…". (student teacher's voice; R9 retrieved from interview Friday, 7th, October 2022).

Even though the participants came up with a significant amount of knowledge, there was little indication of assignments that may inspire students to recognize problems and decide on remedies during class participation because teachers had complete control over what the learners should accomplish. Similarly, to this, the grouping of the learners could not be based on the intended structure, but rather more appropriately on the interests of the teacher, as demonstrated by the student teachers' style of group discussion and question-and-answer approach during the class.

Figure 3: Primary six learners engaged in a group discussion during a science lesson

The students participated in a discussion of the teacher's questions, and each group came up with its conclusions. However, some students observed what a couple of their peers were doing in the discussion, and the teacher kept watching as he waited for the results. Despite the teacher's best efforts, some students were unable to understand the concepts because the teacher did not pay close attention to each student in the class. As a result, competencies appear to be less achieved, and therefore, based on these findings, it is highly likely that student teachers use other methods, such as guided discussion, group discussion, as well as guided discovery as a problem-solving teaching strategy which was demonstrated during the class teaching and learning of science content. This is true even though problem-solving teaching strategy is taught in primary teachers' colleges as a key method of teaching science. The student teacher's instructions constrained how the learners participated in the lesson, which caused them to have limited ideas for participation. As a result, some student teachers were able to use the traditional style of instruction rather than the problem-solving teaching strategy since they were unable to fully demonstrate how to teach the learners interestingly. Additionally, several student teachers talked about how using the problem-solving teaching strategy can result in students not grasping the concepts; as a result, the teacher must use alternate methods to make sure that students understand the material they are learning.

> "…Yeah. Uh-Huh. Integration of other methods like questions and answers and explanation among others…". (student teacher's voice; R9 retrieved from interview Thursday, 6th October 2022).

4.3.2 Student Teachers’ Use of a Problem-Solving Teaching Strategy in A Science Classroom.

The student teachers' use of problem-solving teaching strategy was to inculcate the idea of understanding science in a real-world situation rather than learning science from an abstract point of view. Therefore, it has been noticed that learners enjoy learning when it carries meaning to them. In this respect, therefore, the researcher's second study question was, how do science student teachers use a problem-solving teaching strategy to engage learners during the teaching and learning process? The researcher's goal in asking this question was to understand more about how student teachers organize and manage their classrooms during science lessons, prepare the lessons that make the learners and teachers perform in problem-based classrooms, interact with their learners, give feedback to their learners, and reflect on their lessons. Data for this question were collected through semi-structured interviews with student teachers and observations and document analysis and reviews.

4.3.2.1 Classroom Organisation and Management

While participating in this study, some student teachers organized their learners into groups and gave them assignments, even though some of them in some classes used the traditional method of teaching the content that did not motivate the learners to learn any aspect of problem-solving skills, which the teacher had promised to implement in the teaching and learning of the content which was in contrast to the learner-centered problem-solving approach. In several instances, the student teacher's classroom organization was unable to show meaningful movement, preventing certain learners from receiving teacher and peer support.

Figure 4: A student teacher conducting a science lesson in a Primary five class

The teacher was teaching a lesson on the breeds of sheep, and the students were paying close attention as he explained the ideas while they were seated in their columns. In this regard, the teacher explained to the students as they followed the presentations, and these students were not allowed to discuss the content. However, the teacher revealed in an interview that he had prepared a problem-based learning even though no problem was given to the students. The student teachers chose to use the problem-solving teaching strategy in this lesson even though his lesson plan called for discussion and question-and-answer sessions, which were completely at odds with the problem-solving teaching strategy. Although this has been suggested, it is most likely a challenge because teaching learners how to solve problems appeared to be slightly different from what student teachers were taught during their college training and Some of these difficulties prevented students from mastering the lesson's competencies because the teacher tended to adopt a teacher-centered approach rather than a child-centered approach to problem-based learning.

4.3.2.2 Teacher Preparations

The lesson plans and schemes of work that student teachers were given had a methodical and logical flow to the subject. However, the teaching and learning of science material in primary schools do not appear to place a strong emphasis on problem-based learning, according to the methodology employed in all of the lessons that were observed. However, the use of various approaches, such as discussion, demonstrations, brainstorming, and think-pair-share, has been credited with these among other strategies, observation, and guided discovery during the teaching and learning process. This, therefore, was in contrast to the training that student teachers have received, which emphasizes problem-based learning as the major method for teaching and learning science at all primary levels, although it could appear that little emphasis has been placed on the use of problem-solving teaching strategy in the primary science curriculum.

> "Yeah, I know when a learner is not understanding any concept you need to employ other skills that can make the learner understand more. I tried to employ demonstration skills when the learner has failed to understand a given concept through the problem-solving method, I demonstrate to the learner and he/she will be able to pick more about the things that you talked about or explained to him or her". (student teacher's voice; R1 retrieved from interview Wednesday, 5th October 2022).

Since many learners were unable to demonstrate the transferable skills they had learned throughout the lessons in real-world circumstances, the student teachers' lesson preparations did not completely emphasize the learners' centeredness, even though that should have been a major idea and so, the concept of problem-based learning was not demonstrated clearly during the lesson preparations and presentations.

4.3.2.3 Teacher and Learner Performance

The student teachers' knowledge and skills were appropriate for the learners' class level made the tasks to be clearly defined where learners were grouped based on the stages of the teacher's task design, which created a clear atmosphere of sharing among themselves although they were not given enough chances to explore other stages of problem-solving, such as evaluating alternatives, choosing a solution, putting the solution into practice, and evaluating the result. In contrast, some classes had inadequate practicability of content, active participation, and involvement of all learners in the class activities that completely denied peer interaction. The assessment of the students showed that individual effort was preferred above problem-solving by the student teachers in their interactions with the researcher, therefore, it appears that the student teachers seem to be placing a lot of importance on individual activities rather than group work. This was contrary to the problem-solving assessment format that required collaboration between learners and how the student teachers would assist them in moving forward with their work, similarly, it appears that the assessment of the learners' work illustrates the relationship between the student teachers' scientific methodologies and the assessment used. The evaluation turned out to be at odds with the information acquired during the interview session regarding the usage of a problem-solving teaching strategy in science classrooms.

> "…I could give them in terms of, how their products are because, by the time I give them marks, they would have planted and maintained their plants. My role is to keep on checking how the crops were building up from different groups…". (student teacher's voice; R3 retrieved from interview Wednesday, 5th October 2022).

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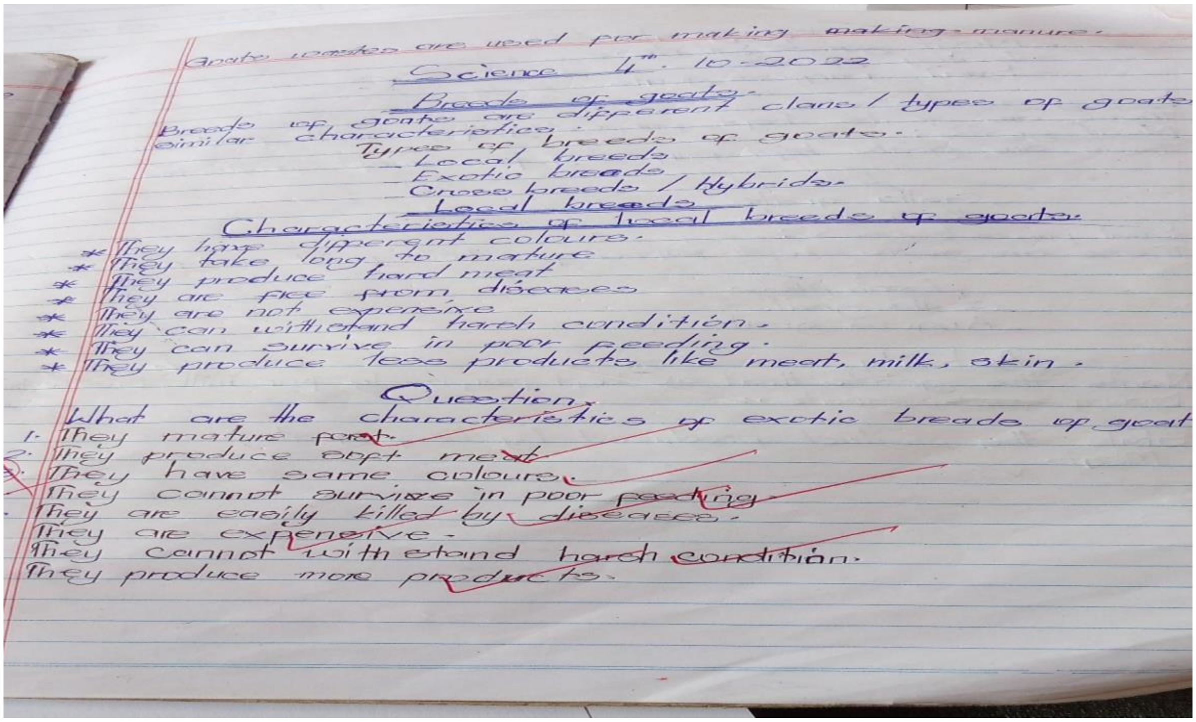
Goats wastes are used for making making manure.

Science 4th. 10-2022

Breeds of goats.

Breeds of goats are different class / types of goats similar characteristics.

Types of breeds of goats.

- Local breeds
- Exotic breeds
- Cross breeds / Hybrids.

Local breeds

Characteristics of local breeds of goats.

* They have different colours.
* They take long to mature
* They produce hard meat
* They are free from diseases
* They are not expensive
* They can withstand harsh condition.
* They can survive in poor feeding.
* They produce less products like meat, milk, skin.

Question.

What are the characteristics of exotic breeds of goat

1. They mature fast.
2. They produce soft meat
3. They have same colours.
They cannot survive in poor feeding.
They are easily killed by diseases.
They are expensive.
They cannot withstand harsh condition.
They produce more products.

Figure 5: A sample of the science assessment task in the Primary five class

The student grades showed the best student performance in the selected sample assessment book. However, even though the purpose of this study was to examine the evaluation techniques these student teachers employ in a problem-based learning setting, some students did not perform as well as the teacher had hoped. This evidence demonstrated that even though student teachers had learned about the evaluation criteria for problem-solving learning activities during the interview interactions, it was observed that individual evaluation rather than group evaluation was used in the learners' exercise books, which appeared to have fewer opportunities for research than would be necessary for a problem-based learning environment.

4.3.2.4 Classroom Interactions (Peer and Teacher-Learner)

The results of the study show that student teachers frequently use oral and written questions interchangeably which might promote classroom interaction but may not support peer engagement which is very important in solving the problems set by the science teacher. These results appear to indicate that teacher-learner interactions are more carefully fostered than student-student interactions. Since the teacher tends to create the atmosphere in the classroom by him/ herself and the learners are given limited time to articulate their findings in case they are given the chance.

> "…Yeah, it always informs me to at least try my level best to involve such learners to participate like others, and it also informs me to make sure that I guide and counsel such learners to get involved in active participation during lesson time…". (student teacher's voice; R2 retrieved from interview Wednesday, 5th October 2022).

> "…I put them in small groups, for instance, groups of like ten- ten, and then I pose the question to them and then I tell them to discuss among themselves…". (student teacher's voice; R2 retrieved from interview Wednesday, 5th October 2022).

Therefore, the learners should have enough opportunity to participate completely in the teaching and learning of science while engaging in problem-based learning, as well as to communicate with their peers, when adopting a problem-solving teaching strategy to teach and understand science, this would eventually inspire the other students who appear shy.

4.3.2.5 Feedback on the Learners' Work

According to study results, science student teachers preferred written feedback that included grades, scores, error flags, and other encouraging remarks. Additionally, the results show that scoring promoted academic competition among students and awareness of one's academic standing. However, according to the study findings, all of these practices limit students to a single perspective on solving scientific problems while ignoring other pertinent areas of problem-based learning assessment in which students collaborate in teams with a spirit of sharing, appreciation, and effective communication, among others.

> "…I Provide them with writing materials and after that, I display their work on the wall to give them room for incidental learning…". (student teacher's voice; R8 retrieved from interview Thursday, 6th October 2022).

> "Yeah. I go by assessing them weekly or mostly I must always do it after every lesson after we share a subtopic, and something little. At least I give them some guiding questions to do or I give them some other activities like when we are sharing about poultry in P.5, I take them outside their classroom and show them how the birds are moving around the compound". (student teacher's voice; R2 retrieved from interview Wednesday, 5th October, 2022).

According to the input from R2 and R8, the student teachers consistently rely on written feedback to inspire their students to work more. Contrary to the assumptions put out by respondent R8, the researcher barely noticed the exhibition of the student's work during the class observation. This demonstrates that additional aspects that need to be looked at could have prevented the display of the students' work as mentioned. Although the assessment records examined in the learner's books showed that the written assessment did not have the design of the problem-solving approach but rather a typically written assessment style, respondent R2 spoke about daily lessons.

4.3.2.8 Teacher's Reflection

In this study, the evidence of self-reflection was discovered through document analysis and reviews. Even though the student teachers had this section on the lesson plans, there was no clear indication of the remedial lesson in the lesson plans. The student teachers had evidence of evaluating their performance, but the self-evaluation could not show the strategy used to mitigate some of the weak areas that might be realized during teaching and learning using a problem-solving teaching strategy.

> "…Ok, identify the strengths, weaknesses, and way forward and early preparation to review on the method, in this case, problem-solving teaching strategy…". (student teacher's voice; R8 retrieved from interview Thursday, 6th October 2022).

> "…There are others like giving learners more remedial work, about that same problem-based method and have a lesson with them…". (student

teacher's voice; R8 retrieved from interview Wednesday, 5th October 2022).

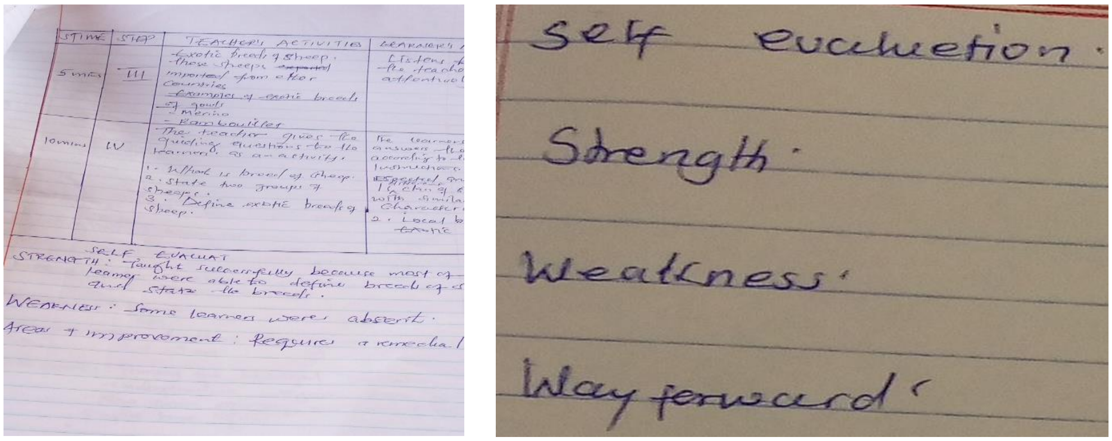

Figure 6: A sample of student teacher's self-evaluation of a Primary five science lesson

According to the results of the study, the teacher's reflection appears to be lacking because almost all student teachers did not write on the efficacy of the problem-solving approach despite explaining how frequently they used it as a teaching tactic. The self-evaluation of problem-based learning by student teachers also appears to be difficult for those who were able to write it. Similarly, they were unable to articulate the strengths, weaknesses, and next steps, even though some problems, like absenteeism, could be resolved with remedial work.

4.3.3 The Challenges Encountered During a Problem-Based Learning

Based on the interviews, classroom observations, and document analysis and reviews, the participants brought out the challenges such as fear, time, large enrollment, absenteeism, and poor delivery of content among others that have contributed to the poor performance of learners as they learn through problem-solving teaching strategy. The student teacher acknowledged in the lesson plan (figure 6) the shortcomings of learner absence and, when questioned about it, connected them to a lack of connectedness in the classroom's knowledge flow.

> "…Ok, the poor way of delivery, failure to use the problem-solving method, the understanding of the concept by the learners among others…". (student teacher's voice; R3 retrieved from interview Wednesday, 5th October 2022).

> "…Yeah, there is no lesson that is, 100 percent perfect. At least there is always the challenge, in this case, there are other learners who are so shy and they fear exposing their issues or what they always go through and what you see at home. They fear to express it to the rest. They are too shy to share their experiences...". (student teacher's voice; R3 retrieved from interview Wednesday, 5th October 2022).

However, the researcher discovered several potential methods to address some of these issues, and they include, among others, peer support from colleagues, enough time, remedial tests, and group activities.

> "…First of all, there are children with low self-esteem and others in our special needs category. There need to give them adequate time, group activities, remedial tests, incorporate other skills like demonstration and extra preparation for the specific group of learners...". (student teacher's voice; R3 retrieved from interview Wednesday, 5th October 2022).

> "…Okay consult my co-teacher as we sit at a table as we learn from one another. Another solution is giving my colleague to teach the content I'm not familiar with...". (student teacher's voice; R3 retrieved from interview Thursday, 6th October 2022).

Even though these were some of the concerns and their solutions, the research found that problems with learners with special needs continued to be difficulty in teaching and learning science utilizing a problem-solving teaching strategy.

4.4 Discussion of the Findings

The purpose of this study was to explore the student teachers' knowledge and use of problem-solving teaching strategies in a science classroom.

In Problem-Solving Teaching Strategy (PSTS), students utilize an actual problem as a setting for a thorough study of what they need to know and what they already know (Mayer, 1998). When given the opportunity the exploration of ideas in their natural classroom settings (Ulger, 2018). However, the results of this study revealed that although student teachers had a theoretical understanding of the knowledge and use of problem-solving teaching strategy, there was a minimal connection between their actual practices and the information from the interviews although there were some indications of problem-based learning seen in a few classes during the teaching and learning of the topic, the student teachers' knowledge of the method likely appears to be imperfect in its application. Much as Foster & Yaoyuneyong (2016), stated that an educational strategy known as a problem-solving teaching strategy pushes students to collaborate in groups to find solutions to real-world problems and to develop the ability to study on their own and therefore, lessons are more centered on the learners where learning becomes active rather than passive (Chrastil & Warren, 2012) and the teacher assumes a variety of responsibilities, including a coach, facilitator, and lecturer (Roth & Roychoudhury, 1994). On the same note, a study conducted in Uganda revealed that the teacher's pedagogical practices in problem-based learning yield a lot of fruit during the teaching and learning of the subject content although the study also found out that there is highly a great challenge in managing the large class enrollment by regular teachers (experienced teachers) (Sikoyo, 2010).

Nevertheless, student teachers appear to be aware that problem-solving includes, among other things, group discussion, demonstration, guided discovery, and questions and answers but the training they have acquired seem to have not given enough skills on how to apply it in their classroom practices. In addition, based on the student teachers' classroom designs, the lesson was contrary to Moust et al. (2021), who stated that for problem-based learning to be successful, the problem is provided first rather than pertinent content being taught and then students use the knowledge to solve difficulties.

Similarly, Tan (2021), added that PBL assignments might be brief or longer, taking up an entire term because it is frequently group-oriented, it is advantageous to set aside class time to help students get ready to work in groups and participate in their PBL project where he continued to say a well-designed PBL project also offers students the chance to improve their skills in the following areas; working as a team, project management, taking on leadership roles, written and oral communication, self-awareness, group process evaluation, working independently, analytical and critical thinking, describing ideas, self-motivated education, and applying course material to real-world examples. However, the classroom observations of the student teachers' understanding of the concept could not bring out these pertinent issues due to limited time and the teacher's lesson preparations in both schemes of work and lesson plans.

The problem-solving teaching strategy is a critical element of learning science (Docktor et al., 2015). Although this study finding realized limited emphasis was put on the preparation of lessons observed that could not bring the key elements of the problem-based learning environment. However, the student teachers tried to engage the learners in the class discussion although some especially those with special needs were completely left out of the interview interactions, the student teachers were able to articulate how they assist all these categories of learners. The student teachers' practices seem to be in line with Neumann et al. (2002), teacher lecture methods emphasize the quantity of the products of learning rather than the quality of learning where analysis of concepts and principles are applied. Despite all the concepts and the use of a problem-solving teaching strategy, the student teachers displayed individual assessment records and traditional group work where the teacher direct the learners to what he/ she wants as opposed to the previous study by Docktor et al. (2015), that brought out that problem solving describes the development and evaluation of an instructional approach called conceptual problem solving in which students are guided to justify their use and after plan for solutions. In correspondence, Ramirez et al. (2013), said problem-based learning activities can be done in groups or as individuals to improve achievement and bring about a reduction of anxiety in learning for both boys and girls. Additionally, several researchers have successfully affirmed that the implementation of a problem-solving teaching strategy in science classrooms encourages the transfer of knowledge (Smetana & Bell, 2012) that facilitates critical thinking and problem-solving skills among learners since students can apply theory into practice (Belecina & Ocampo Jr, 2018). In addition, it also improves the students' analytical skills and ability to personalize learning (Birgili, 2015). Although the previous studies have explained all these success stories, the present study realized that learners were given a limited time that could not enhance the adequate exploration of the activities and in some classes, the tasks could not allow room for effective sharing and discovery of ideas yet according to Hmelo-Silver (2004), the teacher needs to play a key role in the problem based learning instructional process and that the teacher needs to adapt to new ideas and strategies other than the traditional method and students are given humble time to ask open-ended questions, that are related to the problem and find possible solutions through engagement in the given task (Jasanoff, 2005).

Based on the previous study conducted in Singapore, the teaching and learning of pre-service teachers and the use of a problem-solving teaching strategy should be most emphasized in the teaching and learning of science at the college or university level (Chai et al., 2010). This is because it empowers hands-on activities that make learning constructive although challenges such as class control, feelings of the adequacy of science knowledge, and insufficient understanding of the pedagogical method of teaching using this strategy need to be worked on. Nonetheless, the current study shows that the student teachers' training seemed to have put less attention on the transferability of learned problem-solving skills as evidenced by student teachers' classroom practices. This is encountered several challenges as it has been outlined in the previous study by Chai et al. (2010), although the student teachers' good mastery of the content was commendable would support all learners to apply both previous and present knowledge in a given task (Pintrich & Schrauben, 1992). Therefore, a successful application of these skills in training the pre-service science teacher trainees builds their competencies on the knowledge and use of a problem-solving teaching strategy in their science classroom practices (Hartmann et al., 2015). Although the present study shows that student teachers did not have a problem-solving teaching strategy in all their schemes of work and lesson plans much as they claimed to be using during the teaching and learning practices. In addition, the current study indicates that it is highly probable that the student teachers take problem-solving teaching strategy as an integral of different methods such as brainstorming, group discussion, guided discovery, and demonstration among others, and yet these methods do not follow the procedure required.

The previous study by Stronge (2018), defines teacher preparation as a continuing procedure that changes as we gain new knowledge regarding the learners, their requirements, their interests, and their capacities. This argument was even supported by Major (2018), who explained that before pupils arrive at the start of the school year, the teacher is already playing the role of the problem maker if PBL has to be used as the primary instructional technique for the entire course unit or only at certain points. Alternatively, a teacher may feel that using PBL exercises at a particular stage of the course would be more beneficial. Based on the previous findings, it seemingly looks different from the actual classroom practices that the present study has found. This study shows that teachers did not have prior preparations for engaging learners using a problem-solving teaching strategy much as they were articulating the operation of PBL. Furthermore, to choose the optimal locations for PBL activities in this situation, the teacher would evaluate the curriculum. However, the teacher needs to be knowledgeable about the subject matter, abilities, and attitude (Pourshafie & Murray-Harvey, 2013), and this might call for scrutiny of the content to be delivered to the learners, however, it seems to be contrary to the connection in the flow of knowledge in both the primary teachers' science syllabus and the primary school science syllabus because the study findings revealed that less attention is given to problem-solving teaching strategy in primary schools yet this has been the core teaching strategy emphasized in PTC science syllabus. Even though problem-based learning seems to be challenging to student teachers, it enables them to create a supportive environment in the classroom, assists students in making connections to the problem, establishes a work schedule, revisits the problem with the class, facilitates the creation of a product or performance, and promotes self-evaluation. Although the present study shows that student teachers' self-evaluation reports in their lesson plans could not bring out the learning challenges that would empower them to reflect on their previous lessons, the adaptation of problem-based learning in the teaching of science is probably influenced by class characteristics and teacher factors (Martyn et al., 2014).

The previous study shows that for learners' progress to be realized in problem-based learning, the teacher should seek students who are struggling with the task and provide them with extra assistance and recommendations (Boss & Larmer, 2018), and then these students should be evaluated for more than simply a grade so that the teacher can decide if necessary to change the assignment tasks or classroom procedures to cater for individual differences in the classroom (Balchin & Bouzaki, 2022). However, in the present study, there was no evidence of extra support given to the struggling learners much as they were struggling to participate within the time frame whereas the fast learners took advantage of their counterparts and participated actively during the classroom group discussion and presentations that were evidenced in-class observations. The student teachers' teaching strategy could not allow identification and scaffolding since it was put in the lesson plans and the schemes of work. Despite all those challenges student teachers were facing in their classrooms, English & Kitsantas (2013), stated that if they are determined to offer learners the appropriate amount of help and direction, student teachers must keep track of their learners' progress, student teachers need not give learners information or instructions because part of the lesson's goal is to increase their sense of freedom. This is in line with Delisle (1997), who stated that teachers need to compile a list of ideas for improving their PBL work in the future at the end of the unit. Similarly, the design of this problem-based learning seems to be well taught by the teacher educators but its practicality seems to be lacking due to the large number of learners in the classrooms (Amerstorfer & Freiin von Münster-Kistner, 2021) as discussed in the study conducted in Uganda on the general use of problem-solving teaching strategy in a child-centered pedagogical practice during teaching and learning.

The previous study indicates that during the teaching and learning process, interactions between students and teachers take place in the classroom which might result in learners' engagement which could enhance learners' performance and learning (Cohen et al., 2020). Similarly, teachers employ a range of instructional strategies to foster learning in the classroom for instance questioning is one of the most popular methods used to encourage class involvement, especially in testing conceptual knowledge, identifying learning disabilities, and promoting involvement (Chin & Chia, 2006). However, the present study indicates that the learners' engagement was found to be minimal since the tasks were not adequately distributed to make learners comprehend the information and that created a learning gap because some learners were left out of the activities. Nonetheless, Le et al. (2018), imply that group projects and assignments might help promote interaction in the classroom during science problem-based learning. It is, therefore, noted that the type of learning activities given to learners by the teachers give them opportunities to learn through classroom interactions, and this was termed as interpersonal and pedagogical skills (Newton et al., 1999). In contrast, the student teachers had several theoretical skills that were generated during one on one interviews but it was seemingly realized that the content had little connection to their classroom practices which was observed during lesson observations and document analysis and reviews. Although student teachers struggled to teach science problem-based lessons, Saputra et al. (2019), continue to emphasize that, for teachers to understand the topics and design teaching and learning activities that effectively engage learners during the lessons, science lesson preparation in problem-based learning needs to be made before the teaching time. This argument is in line with the present study finding where student teachers revealed that time was the most challenging factor that hindered the application of a problem-solving teaching strategy in their science classrooms.

The previous study conducted by Koh & Tan (2016), showed that pre-service teachers typically lack assessment literacy which is due to insufficient pre-service training in educational assessment, and yet the PBL approach needs effective assessment based on the learners' progress that is needed to be exhibited by pre-service student teachers and tutors who supposed to be literate in the assessment that is significant for teacher education. In contrast, many student teachers graduate when they are unprepared to begin their teaching careers because they are unable to comprehend and accept new assessment policies and methods. This, therefore, is in agreement with the present study that student teacher's assessment literacy seems to be traditional because the nature of the given tasks could not provoke the learners to solve the problem in a real context much as they had articulated the key issues during the one on one interviews. It, therefore, means that little connection between pedagogical knowledge, skills, and transfer is being put in place. In addition, the science tutors seem to pay less attention to the pedagogies of teaching science that these student teachers need to learn before they leave for college practice. The present study findings continue to agree with the previous study that the vast majority of student teachers had low levels of assessment literacy especially formative assessment and high levels of confidence in summative assessments of student learning that is contrary to the assessment of the learners' performance in problem-based learning classrooms.

Overall, the results of this study suggest that student teachers were informed about problem-based learning from the college but the application of the strategy seems not to be given much attention, in addition, student teachers tend to pay little attention to the use of problem-solving teaching strategy at primary level, and similarly, the assessment of problem-based learning seems not to be understood by the student teachers. It was also noted that time and classroom organizations could not support learners with special needs which indicates that their learning needs were not met during teaching and learning. Therefore, it was difficult for student teachers to use efficient formative assessment strategies to handle such kinds of learners. On the other hand, the results demonstrate that the low student teachers' knowledge and use of a problem-solving teaching strategy impede science learning and the performance of shy and fearful learners, especially during classroom engagements.

CHAPTER FIVE

CONCLUSION, IMPLICATION, AND RECOMMENDATIONS

5.0 INTRODUCTION

This chapter presents the study summary, conclusion, and recommendations. A detailed description of the entire study is offered in the first section which is a summary of the Study followed by the study conclusion and lastly recommendations to several educational stakeholders on the status of student teachers' knowledge and use of a problem-solving teaching strategy. In addition, these recommendations came from a rigorous examination of study findings.

5.1 The Summary of the Key Findings

The student teachers demonstrated limited knowledge and the application of problem-solving teaching strategies, much as they had gained during classroom instruction in the college. These are the transferrable skills that the students are expected to build while teaching and learning. Additionally, the science teachers' help from the science tutors in terms of their knowledge of the science pedagogical material appears to be lacking, which makes it difficult for the student teachers to distinguish between the various teaching methods for science. Similarly, to this, the study found that the student teachers were unable to connect their college-acquired knowledge to its application to the planning of primary scientific problem-based learning. However, although the student teachers were giving all instructions for the learning activity which was in opposition to an inclusive problem-based learning environment although they possessed the knowledge and abilities to establish an engaging classroom environment.

The study also presented a few difficulties that had an impact on the student teachers' presentations, including their inability to manage learners with different learning preferences that hampered the lessons since their needs had not been taken into account during lesson preparation. On the other hand, time was not helpful for all categories of learners in correspondence, some learners were completely left out.

5.2 Conclusion of the Study

The student teachers' knowledge and use of the problem-solving teaching strategy affect learners' outcomes if it is not properly applied in the teaching and learning of the science content, despite the research's suggestion that numerous factors influence learners' performance in science. This study offers details on the obstacles these teacher trainees face in their practices in science classrooms, as well as their comprehension and application of a problem-solving teaching strategy.

The findings of this study indicate that problem-solving teaching strategy appears to have a significant effect on learners, particularly when it is given the appropriate attention. This is in line with Tan (2021), which increases learning and performance through collaboration, skills development, and connecting classroom knowledge and abilities to real-world situations, among other things.

5.3 Implication and Recommendations

A problem-solving teaching strategy may enhance students' learning and performance. This indicates that one strategy for improving learners' learning and performance is problem-based learning. Regarding the study findings, the following recommendations are presented.

5.3.1 Recommendation to the Policy Makers

According to the study's findings, tutors place less importance on tutors' pedagogical content expertise and student teachers' lack of understanding and proficiency in problem-solving teaching strategies. The effectiveness of training at college and other levels of teacher training, such as National Teachers' Colleges and other affiliated Universities, which are directly in charge of the curricula used in teacher education, needs to be emphasized by the Ministry of Education and Sports, which is responsible for awarding grade three certificates of registration to teachers. In that vein, the ministry can reevaluate and revamp the existing curricula, which hardly adequately equip and place an emphasis on knowledge and the use of a problem-solving teaching strategy. This is because teachers can develop and implement a problem-solving teaching strategy to enhance scientific learning and performance provided they obtain proper pre-service or in-service teacher training on the science subject.

5.3.2 Recommendation to Uganda National Institute of Teacher Education (UNITE)

According to the study's conclusions, student teachers' knowledge of assessment appears to be focused on tests, exams, and scheduled quizzes that do not allow for time for exploration and discoveries. To involve the students in a problem-based learning environment, the findings of this study are likely relevant to the type of assessment tools that teacher educators may use when evaluating science teacher trainees. UNITE can develop Continuous Professional Development (CPD) training programs that will aid in the retooling and tooling of teacher educators and teachers on the method of assessing students who are engaged in problem-based learning. Additionally, the National Curriculum Development Center (NCDC) in partnership with UNITE could develop a curriculum that promotes problem-based learning activities through coursework and assignments rather than giving tests and assessments after the course units/semesters to boost learners' abilities in problem-solving in their daily life.

5.3.3 Recommendation to Teachers and Teacher Educators

According to study findings, student teachers frequently employ techniques that exclude students with learning disabilities from problem-based learning environments, including group discussions, brainstorming, and questions and answers. This shows that to develop and implement a teaching plan that encourages learners to participate, particularly those that generate a pleasant learning environment in the classroom, their teaching pedagogy needs to be strengthened before they leave college. This is so because peers are likely to participate in the knowledge distribution process, and students can learn more quickly. Additionally, teachers should employ problem-based learning activities that help learners to advance academically over time. In addition, teachers should also let learners participate in learner-based activities and give them adequate time to explore their options as they find answers to problems. In other words, the type of challenge that the teacher or the learners have created determines how the students will explore their thoughts. Accordingly, it is advised for teachers to adopt instructional tactics that assist learners in comprehending concepts, such as the use of motivating feedback in place of a didactic approach to teaching and learning that is exclusive.

5.3.4 Recommendation for Future Studies

These study findings came from a single PTC in the Lira district. Other researchers at Primary Teachers' Colleges or other educational levels, however, may examine the same or different components of the problem-solving teaching strategy, particularly how learners with disabilities are engaged in an inclusive problem-based learning environment, among others, to come up with more significant findings on this approach to teaching science.

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APPENDIX A
ETHICAL CLEARANCE CERTIFICATE

THE AGA KHAN UNIVERSITY

Ref; *AKU/2022/0190/fb/08/47*

Date: 19th August, 2022.

Okello Geofrey
Aga Khan University
P. O Box 125
Dar es Salaam,
Tanzania.

Dear Okello Geofrey,

ETHICAL CLEARANCE CERTIFICATE

This is to acknowledge that your application for ethical clearance for a research study entitled, "*Exploring Student Teachers' Knowledge and Use of Problem-Solving Teaching Strategy in a Science Classroom: A Case of a Selected P.T.C in Lira, Uganda.*" was received and reviewed by the Aga Khan University, Ethical Review Committee, East Africa (AKU-ERC, EA).

We would like to inform you that the committee has approved your proposal and advise you to proceed with your research project in line with the Aga khan University policies, laws and regulations and ethical guidelines.

I wish you all the success in your research.

Yours Sincerely,

Dr. Fortidas Bakuza
Assistant Professor
Chair, Ethical Review Committee

CC: National Institute for Medical Research

Salama House, 344 Urambo Street, P.O. Box 125, Dar es Salaam, Tanzania
Tel: +255 22 215 2293, 22 215 0051, Fax: +255 22 215 0875; Email: ied-tz@aku.edu
www.aku.edu

APPENDIX B
RESEARCH PERMIT FOR MASTER OF EDUCATION STUDENT AT AGA KHAN UNIVERSITY

THE AGA KHAN UNIVERSITY

Office of the Registrar

September 16, 2022

The principal
Canon Lawrence PTC Boroboro
P. O. Box 81,
Lira, Uganda

Dear Sir/Madam,

Re: Research Permit for Master of Education Student at Aga Khan University

We would like to request your office to please process research permit for **Okello Geofrey** Master of Education student who will be conducting his research study in Lira, Uganda. The research topic is written here below.

"Exploring Student Teachers' Knowledge and Use of Problem-Solving Teaching Strategy in a Science Classroom: A Case of a Selected P.T.C in Lira, Uganda"

We thank you in advance for your continued cooperation.

Yours sincerely,

Agatha Damas
Assistant Registrar, Tanzania

Aga Khan University
Dar-es-Salaam,
Tanzania
Office of the Registrar

Salama House, 16 Urambo Street – Upanga, P.O. Box 125 11102 Dar es Salaam, Tanzania
Tel: +255 22 2152293 / 222150051
Email: regoff.tz@aku.edu, Website: www.aku.edu

APPENDIX C
UGANDA NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY

Uganda National Council for Science and Technology

(Established by Act of Parliament of the Republic of Uganda)

UNCST

Your Ref: SS1440ES **Date: 17th November 2022**

Our Ref: UNCST/INV/1028

ATTENTION:- Mr. . GEOFREY OKELLO
LORO CORE PRIMARY TEACHERS' COLLEGE

Protocol Title: EXPLORING THE STUDENT TEACHERS' KNOWLEDGE AND USE OF PROBLEM-SOLVING TEACHING STRATEGY IN A SCIENCE CLASSROOM.

INVOICE

	Details	Amount (USD)
01	Payment for protocol SS1440ES	50 USD

UNCST Bank Account Details

Account Name: Uganda National Council for Science and Technology
Bank Name: Standard Chattered Bank
US Dollar Account Number: 8705611811400
UG Account Number: 0105610632101
Swift code: SCBLUGKA

FOR AND ON BEHALF OF UGANDA NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY

UGANDA NATIONAL COUNCIL FOR SCIENCE & TECHNOLOGY P. O. BOX 6884, KAMPALA ACCOUNTS UNIT

ACCOUNTANT

LOCATION/CORRESPONDENCE

Plot 6 Kimera Road, Ntinda
P.O. Box 6884
KAMPALA, UGANDA

COMMUNICATION

TEL: (256) 414 705500
FAX: (256) 414 234579
EMAIL: info@uncst.go.ug
WEBSITE: http://www.uncst.go.ug

APPENDIX D
INFORMATION SHEET

INFORMATION SHEET

Title of study: Exploring Student Teachers' Knowledge and Use of Problem Solving Teaching Strategy in a Science Classroom: A Case of a Selected P.T.C in Lira, Uganda.

Principal investigator: Okello Geofrey (Student/Principal Investigator)

Institute: Institute of Educational Development, Eastern Africa, Aga Khan University.

Introduction

I am Okello Geofrey, a Master of Education student at the above mentioned University. I am carrying out a research on Student Teachers' Knowledge and Use of Problem Solving Teaching Strategy in a Science Classroom. I wish to explore Student Teachers' Knowledge and Use of Problem Solving Teaching Strategy in a Science Classroom, since your school is of the required quality for this study, I would like you to participate in the research study.

Purpose of this research study

The purpose of the study is to explore student teachers' knowledge and use of problem solving teaching strategy in a science classroom.

Procedure

In this study I wish to explore Student Teachers' Knowledge and Use of Problem Solving Teaching Strategy in a Science Classroom. I will interview student teachers and have a look at lesson preparation documents, namely; schemes of work, lesson plans and learners exercise books. I will use observation guide to observe their science lessons, audio recorder will be used during the interview sessions and a camera will be used to capture evidence of learners' participation in the lesson. All the findings will be used for this study and nothing else.

Possible risks or benefits

There is no risk involved in this study except using a few minutes of the teachers' busy schedules during the interviews, document analysis and class observations. There is also no direct benefit to you. However, the research findings will be shared with the college science tutors and may help in informing science tutors on their teaching methodology.

Right of refusal to participate and withdrawal

You are free to choose to participate in the study. You may refuse to participate without any loss of benefit which you are otherwise entitled to. You may also withdraw at any time from the study without any adverse effect on management of your school or any loss of benefit which you are otherwise entitled to. You may also refuse to answer some or all the questions if you don't feel comfortable with the questions.

Confidentiality

The information obtained from your school will remain confidential. Nobody except principal investigator will have an access to it. The name and identity of your school and students will also not be disclosed at any time. However the data may be seen by Ethical review committee and may be published in a journal and elsewhere without giving your name or disclosing your identity.

Authorization

You will be asked to sign a consent form to indicate your voluntary participation. You will receive a copy of the form. Your consent does not take away any legal rights in the case of negligence or other legal fault of anyone who is involved in this study. Nothing in the consent form is intended to replace any applicable national, state or local laws.

Available Sources of Information

For further questions, you may contact Principal investigator Okello Geofrey
Phone no. +256777670773

In the unlikely event of a breach of ethics or any other emerging issues, inform Chairperson Ethical Review Committee of the Aga Khan University Tanzania, Dr. Fortidas Bakuza Salama House Urambo Street – Plot 10, P.O. Box 125, Dar es Salaam. Tel: +255-22-215229/2150051 Fax:+255-22-2150875 E-mail: fortidas.bakuza@aku.edu or iedea@aku.edu

APPENDIX E
INFORMED CONSENT

INFORMED CONSENT

4.1 How will you inform the research participants about the research study (e.g. about the objectives, processes and outcomes of the study)?

By availing the information sheet to the respondents to read and the researcher will explain for clarity and a deeper understanding of this study.

4.2 How will you obtain a research participants' agreement to be involved in the research? (Please explain if a consent form is not included with this form.)

The researcher will use a consent form and assent form.

4.3 Does your research involve children or young people under the age of 18? If so,

YES

4.3.1 How will you obtain permission of their parent(s) and/or guardian (s) and/or principal?

The head given the assent form to sign on behalf of these children for them to participate in the study.

4.3.2 Will you obtain assent from the child or young person, and if so how will this be done (include Assent form)

The assent of these children will be obtained from the head teacher who will sign on their behalf before they participate in the study.

5. 0 CONFIDENTIALITY DETAILS

5.1 How will you protect the research participants' confidentiality?

The researcher will use pseudonyms such as R1 up to R6 (respondent "R") to represent the six respondents who will actively participate in the interviews and "X" for respondents whose exercise books will be observed in order to protect their identities and secret of the information they will share.

5.2 How will you ensure that confidentiality of the data you collect will be maintained (e.g. only researchers have access to data, ethics committee, sponsors)?

The data collected will be kept in a lockable box which accessible by **only** the researcher and the soft data will be saved in the researcher's laptop and protected by password.

5.3 How will data be stored safely during and after the project (e.g. in a locked cabinet)?

Hard copies and soft copies in the computer will be protected through a lockable box and password respectively

6. 0 RECIPROCITY

6.1 How will you reciprocate with the research participants (both individuals and institutions, if involved) for their involvement in research (e.g. sharing a copy of the final study report)?

The final study report will be shared with science tutors, head teacher and college administrators.

If you are unable to provide any of the above documents, please provide a brief explanation.

N/A

7.0 ANY OTHER INFORMATION

7.1 Please provide any other information that may facilitate the ethical review process

NONE

We, the undersigned, agree to conduct this research in accordance with the ethical principles indicated in this approval form.

Note: ***All Principal Investigators, Co-Investigators, Team members or Supervisor are requested to sign this declaration.***

Name	Role e.g. Principal Investigator	Signature	Date
Okello Geofrey	Researcher		30th July 2022
Dr. Winston Edward Massam	Supervisor		1st August 2022

APPENDIX F
ETHICAL CONSENT FORM FOR PARENT/GUARDIAN OF MINOR

Ethical Consent Form for Parent/Guardian of minor

Research Topic: Exploring Student Teachers' Knowledge and Use of Problem Solving Teaching Strategy in a Science Classroom: A Case of a Selected P.T.C in Lira, Uganda.

I have been informed of the requirements of the study and fully understand what will be expected of my child/student as a participant. I therefore agree for my child to be amongst the participants in this study with the following conditions. *Put a tick (✓) as appropriate against each statement;*

- ☐ *This study focuses on exploring student teachers' knowledge and use of problem solving teaching strategy in a science classroom.*
- ☐ *The purpose of the study is The purpose of the study is to explore student teachers' knowledge and use of problem solving teaching strategy in a science classroom.*
- ☐ *The identity of my child/student as a research participant will remain confidential and his/her name and his/her responsibility/role in the school and the name of the school will not be use at any point in the research or in reporting the findings.*
- ☐ *My child/student maintains the right to withdraw from the study at any point in time.*
- ☐ *My child/student will not be judged by any answer that she/he gives.*
- ☐ *My child/student will participate in a focus group discussion*
- ☐ *The voice of my child/student can be recorded during focus group discussion*
- ☐ *My child's/student's XYXX exercise book will be checked and photographed.*
- ☐ *My child/student will participate in a focus group discussion*
- ☐ *My child/student will complete a test*
- ☐ Add any other issue relevant to your data collection as it relates to the child/student
- ☐ *My child/student holds the right to refuse to answer any question.*
- ☐ *A summary of the final report of the study will be shared with the school.*
- ☐ *Findings of this study may be used in conference presentations and in academic publications*

I express willingness for my child/student named _________________________ to participate in this study by signing this form.

Name of parent: ………………………………

Signature: ………………………… Date: ……………………………………

Name of school: ………………………………………………………………………

Researcher's Name: Okello Geofrey

Researcher's Contact: P.O. Box 125 Dar es salaam

Name of Institution: The Aga Khan University IED, EA

In the unlikely event of a breach of ethics or any other emerging issues, inform Chairperson Ethical Review Committee of the Aga Khan University Tanzania, Dr. Fortidas Bakuza Salama House Urambo Street – Plot 10, P.O. Box 125, Dar es Salaam. Tel: +255-22-215229/2150051 Fax:+255-22-2150875 E-mail: fortidas.bakuza@aku.edu or iedea@aku.edu

APPENDIX G
THE INTERVIEW GUIDE FOR STUDENT TEACHERS

1. What is your understanding of problem-solving teaching strategy?
2. How did you go about this strategy in teaching and learning science during your first school practice?
3. What skills do you use in your science classroom that embraces problem-based learning?
4. Does a problem-solving teaching strategy create room for the understanding of science concepts? Share your experience with this.
5. Have you ever designed a problem-based learning activity? Share with me how you have been doing it.
6. How do you assess your learners during problem-based learning?
7. Based on your teaching experience, could there be some challenges that you have encountered when using problem-solving teaching strategies in science lessons? Please share it.
8. In your science lessons, at what point in your lesson preparation do you always realize some of these challenges during problem-based learning?
9. What do you think brings about these challenges?
10. Do you think these challenges inform your preparation? Then how?
11. How have you been handling some of these challenges in your science classroom?
12. How do you involve your colleagues in managing these challenges?
13. Could there be possible solutions you are using to address these challenges? Please share.

APPENDIX H
CLASSROOM OBSERVATION PROTOCOL

TOPIC……………………………………………………………………………
CLASS.........

A. INTRODUCTION

OBSERVATION AREA	COMMENTS
1. Clear preliminary of the lesson plans. 2. Clear learning competencies and set learning targets. 3. Review of learning competencies and targets with students.	

B. CLASSROOM ENGAGEMENT/INTERACTION

1. Identification and definition of the ask. 2. Generating possible solutions. 3. Evaluating alternatives. 4. Deciding on a solution. 5. Implementing the solution. 6. Evaluating the outcome. • Evidence of practical /active learning • Evidence of dialogue between the teacher and pupils • Pupils' participation and involvement in the learning process	

C. EVALUATION

1. Authentic assessment (Journal writing, peer interview, self-rating scale, grading) 2. Nature of questions (oral or written questions) and questioning techniques. 3. The feedback is given 4. Evidence of monitoring the learners' work 5. Remediation	

D. REFLECTIVE PRACTICE

1. The strengths of the lesson 2. Areas of improvement 3. Way forward	

APPENDIX I
DOCUMENT ANALYSIS PROTOCOL

TYPE OF DOCUMENT	COMMENT
1. Syllabus • Topic • Sub-topic • Learning competencies • Learning aids/resources • Time • Assessment	
2. Schemes of work/lesson plans • Lesson preparation and learning process • Logical organization/management • Use of teaching aids • Assessment and evaluation	
3. Learners'ers exercise books • Nature of tasks given • Nature of assessment given • The language used in feedback • The follow-up	

Aga Khan University
Institute for Educational Development

DISSERTATION SUBMISSION FORM

Number of words in the dissertation content including footnotes 16204

The Dissertation report passes through Turnitin and the similarity index is 20

Dissertation Title: EXPLORING THE STUDENT TEACHERS' KNOWLEDGE AND USE OF PROBLEM SOLVING TEACHING STRATEGY IN A SCIENCE CLASSROOM.

Name of CP: OKELLO GEOFREY, Admission No: 568024

Name of Principal Supervisor: DR. WINSTON EDWARD MASSAM

I certify that the course participant complied with dissertation writing guidelines and has my recommendation to submit the dissertation for marking.

Signed on 08/12/2022

Principal Supervisor **Student**