UNIVERSITY OF EDUCATION, WINNEBA

IMPLEMENTATION OF PROJECT-BASED LEARNING APPROACH: THE CASE OF JUNIOR HIGH SCHOOL MATHEMATICS TEACHERS IN THE NADOWLI-KALEO DISTRICT

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DECLARATION

Candidate's Declaration

I, Mohammed Hudu, declare that this thesis, with the exception of quotations and references contained in published works which have all been identified and duly acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, for another degree elsewhere.

Signature: …….

Date: ……..……

Supervisor's Declaration

I hereby declare that the preparation and presentation of this thesis were supervised in accordance with the guidelines on supervision of thesis laid down by the University of Education, Winneba.

MR. NIXON SABA ADZIFOME **(Supervisor)**

Signature: …….

Date: ……..……

DEDICATION

To my lovely parents, and my dear wife.

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I express my heartfelt gratitude to the Almighty Allah for guiding me through this phase of my education and equipping me with the knowledge, wisdom, and strength necessary to successfully complete this thesis.

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ABSTRACT

The purpose of this study was to investigate the implementation of project-based approach among Junior High School mathematics teachers in the Nadowli-Kaleo District. The study had four research questions and was supported by the social constructivist learning theory. A descriptive cross-sectional survey design was used, where the views of all the 77 JHS Mathematics teachers in the District were solicited using a structured questionnaire and an observation checklist. Descriptive data analysis techniques, including simple frequency counts, percentages, mean, and standard deviation, were employed to analyze the collected responses in answering the research questions. The study revealed that mathematics teachers in the Nadowli-Kaleo District generally had positive perceptions about project-based learning for mathematics. They believed the approach was effective and yielded several benefits, including fostering collaboration, aiding in identifying learners' strengths and weaknesses, and promoting learners' self-learning. Additionally, the findings indicated that Junior High School (JHS) mathematics teachers in the Nadowli-Kaleo District regularly employed a variety of instructional strategies to implement project-based learning in their lessons. Notably, they used 57% of identified project-based learning strategies regularly, while 43% of the strategies were used occasionally. Moreover, it came out from the study that mathematics teachers in the Nadowli-Kaleo District faced challenges such as time constraints, insufficient parental support, a scarcity of materials, and delays in lesson delivery. Lastly, it was found that these teachers strongly advocated for NaCCA-designed projects, spreading project-based learning culture, in-service training, rewards for top projects, exhibition day, standards in assessment, and familiarizing parents with project-based learning significance. Based on these findings, it was recommended for Heads of Schools, SISOs, and the Nadowli-Kaleo District Education Directorate to regularize additional training workshops and allocate resources to support the implementation of project-based learning in the District.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter discusses the introductory aspect of the study. It highlights key areas including the background to the study, statement of the problem, purpose of the study, research objectives and questions, significance of the study, delimitation as well as the organization of the entire study.

1.1 Background to the Study

Mathematics is an important subject in the school curriculum. The study of mathematics is notable for its contribution to the development of logical thinking, to the understanding of the natural world, as well as to the organization of our lives (Fokides & Alatzas, 2022). According to Agwagah (2017), the subject equips individual with the capacity to enumerate, calculate, measure, collate, group, analyse, and relate quantities and ideas, among others and these are everyday life activities. The author further asserts that everybody therefore uses, practices and thinks mathematics every day in life without knowing. It is for this reason that to most mathematical scholars, mathematics is tantamount to solving problems through activities such as looking for patterns, interpreting diagrams, word problem, proving theorem and so on (Parrot & Leong, 2018). Mathematics is therefore seen as a gadget that can be employed to train learners to be able to solve problems, and also to form their thinking ability that leads to supplementary solving of non-mathematical problems (Phonapichat et al., 2014). Due to the importance that mathematics engulfs, the subject has become a key component of every school curriculum with the goal of providing learners with knowledge and skills that are essential in the changing technological world.

As a result of this key role the subject plays, the government of Ghana and other stakeholders in the education sector have introduced a number of initiatives to promote effective teaching and learning of mathematics with the aim of making the subject enjoyable (Ampadu, 2012). The latest of these initiatives was the review of mathematics curriculum in September, 2019 buttressing the importance the country attaches to Mathematics education (NaCCA, Ministry of Education, 2019). The government's quest to improve teaching and learning has contributed greatly in initiatives such as the upgrading of teacher training colleges offering Cert 'A' then to Collages of Education which offered diplomas and now offering degree programs, the infrastructural projects aimed at attaining no school under trees, capitation grants, and school feeding programme (Anku, 2018).

Despite the efforts being made by the country as far as the teaching and learning of mathematics is concerned, learners face serious difficulties in understanding and managing mathematical concepts leading to poor academic outcomes. In Ghana, learners' attainment in mathematics is generally low (Mereku, 2010). Evidences of such poor performances are enshrined in various reports focusing on outcomes from national assessments (NEA, EGRA & EGMA), national examinations (BECE & WASSCE) including international examinations (Mereku, 2010). Internationally, Trends in International Mathematics and Science Studies (TIMSS) equally graded Ghana poorly in terms of performance (Anamuah-Mensah & Mereku, 2005; Anamuah-Mensah, et al., 2008; Butakor, Ampadu, & Cole, 2017). As a result, they develop negative feelings and anxiety for this subject; they perceive it as a pointless sequence of abstract processes and methods that they simply have to memorize and follow (Holm et al., 2017). On the other hand, learners' interest

increases when they realize that Mathematics have practical applications and that they can provide solutions to everyday problems (Mazana et al., 2019).

Literature has identified various interrelated variables ranging from personal factors, teacher teaching factors, school and home environment factors, peers' factors among many others as significantly influencing learners' performance in the study of mathematics (Mohamed & Waheed, 2011). These findings were reported by Ampadu & Anokye-Poku, (2022). Among these factors, the teacher's approach has been cited as a key predictor of learners' performance.

To avert this situation and promote better mathematics learning, it is critical that the instructional strategies used in teaching provoke curiosity and desire to learn. Teachers are to move from the traditional chalk and talk method of teaching to such innovative and creative pedagogies such as the project based-learning (NaCAA, 2019; 2020) to an approach where they see the teaching as not only providing learners with the content needed, but also the skills to use the learned knowledge and an interest in lifelong learning. It is important for educators to provide opportunities that allow learners to learn through inquiry, collaboration, and problem solving that encourages the learning process both now and, in the future (DeGone, 2021).

Educators have called for a creative and meaningful way to engage learners in mathematics learning. At the forefront of the professional dialogue is the Project based learning as opined by Philen (2016). Project-Based Learning abbreviated as PBL is an instructional approach that allows for learners to learn by doing while gaining content-related knowledge through the process of trying to solve problems and challenges that they may face in the real-world (Schuetz, 2018). Wallace and Webb (2016) adds that PBL is a collaborative process, and learners must research on their own with guidance by the teacher so that they can find a solution to the problem

(Wallace & Webb, 2016). A learner-designed product or presentation is the goal of PBL, but the process is as important as the outcome. The problems learners work to solve are real world and open ended. The problems are authentic and require an authentic product (Martelli & Watson, 2016; Petersen & Nassaji, 2016). Characteristics of PBL include focusing on a problem and integrating academic content and skills into project development. The lessons are inquiry-based and designed to give learners a voice and a choice in their learning. The integration of feedback and revision is designed to generate learner ownership of their learning and promote the ability to communicate their findings all while learning the skills to be successful professionals (DeGone, 2021).

It is therefore important that the mathematics teachers' knowledge and skills for implementing this innovative approach in the mathematics classroom be investigated. Inda (2013) opined that teachers' knowledge of the subject, teachers' attitudes, teachers' experience and academic qualifications among others influence their use of any approach in the classroom. Same assertion is shared by Key and Bryan where they assert that teacher's factors have also been seen as a way in which a given curriculum pedagogies are interpreted and implemented. It is against this background that this study seeks to examine the implementation of the project-based learning in teaching mathematics in some selected basic schools in the Nadowli-Kaleo District.

1.2 Statement of the Problem

The Common Core Program of Ghana emphasized the need for teacher to move from traditional approach to more creative, 21st century approaches CCP emphasizes creative and inclusive pedagogies that are anchored on authentic and enquiry-based learning, collaborative and cooperative learning, differentiated

learning, holistic learning, cross disciplinary learning as project-based learning (NaCCA, Ministry of Education, 2019;2020). It is clearly stated in the JHS mathematics curriculum that teachers are to provide "Mathematical problems that are connected to the context of the learners' world so that it presents authentic opportunities for learning" (NaCCA, Ministry of Education, 2020, pg. 13). These are all anchored in the problem-based learning (DeGone, 2021). According to Wan Husin et al. (2016), the use of project-based learning aligns with the way the world communicates and collaborates in the 21st century where the current educational environment requires a new skill set for teachers to make classrooms learner centered (Wan Husin et al., 2016).

However, according to Fredua-Kwarteng as cited in Dotse (2017), mathematics teaching in Ghana, especially, is characterized by transmission and command models. Thus, "learners are not encouraged to pose questions or engage in hands-on activities and problem-solving activities in order to attain both conceptual and procedural understanding of what they are taught" (Sarfo et al., 2014, p.768). Due to this, most basic school learners in Ghana lack the necessary conceptual understanding underlining mathematics and its concepts (Baffoe & Mereku, 2010).

The key role that such innovative and creative pedagogies plays in the life of learners and the country as a whole has compelled the Ministry of Education through the National Council for Curriculum and Assessment to included project-based learning as one of the most critical and core pedagogies in Mathematics in the Ghanaian basic school curriculum (NaCCA, Ministry of Education, 2019; 2020). The reason for this is that this skill leads to learners having the ability to solve real life problems as they progress through life. Therefore, teachers are required to introduce project-based learning into the teaching and learning of Mathematics at the end of

every concept and through the various stages of the children' education. Similarly, the introduction of STEM education is to help learners be able to use the concept studied in mathematics and science to address daily problems encountered in the Ghanaian society.

Dierker et al. (2018) found that active learning through project-based learning increases learner performance in science, engineering, and mathematics courses. By extension, engaging Ghanaian learners in hands-on real world context activities-based learning can, however, significantly counter these negative attitudes towards the subject (Babb & Stockero, 2022; Beem, 2020). Similarly, using the project-based learning collaborates in the 21st century learning where the current educational environment requires a new skill set for teachers to be make classrooms learner centered (Wan Husin et al., 2016). It can therefore be concluded that the use of project-based learning also makes teachers as facilitators, guiding learners in an interdisciplinary study (Martelli & Watson, 2016).

Several studies (Ash, 2021; Dorr, 2017; Brown, 2021; Ibrahim & Asiedu-Addo, 2019) have also confirmed how beneficial project-based learning can be for learners learning across the different school subjects. For instance, Ash (2021) investigated how the use of project-based learning in mathematics can facilitate learner motivation and preparedness for life after school (21st century skills). It was found among others that using the project-based learning increases learner motivation and preparedness for life through authentic, hands-on experiences. Hence the author recommended that project-based learning is a powerful tool that all teachers, but especially mathematics teachers can implement to increase learner motivation and engagement and provide them with authentic experiences that will provide them with understanding of the value of the skills they are learning.

Another study was conducted by Dorr (2017) examined the effectiveness of project-based learning in improving second-grade learners' performance of science standards. Using action research involving 27 learners, the study found a significant improvement in the performance of second-grade learners using higher-order thinking science standards when lessons were taught using the project-based learning approach.

Brown (2021) also investigated the effect of project-based learning on learners' academic achievement in Social studies, as compared to the traditional textbook-based instructional approach. Using an experimental study 198 learners, the study found that using the project-based learning as an effective approach in teaching social studies. The results of the independent samples t-test used in the study revealed a statistically significant difference between the PBL treatment group and the traditional textbook-based comparison group on social studies achievement.

In Ghana, Ibrahim and Asiedu-Addo (2019) investigated the effect of project-Based Learning on Colleges of Education learners' achievement in, and attitude toward Probability in Tamale Metropolitan of Ghana. Using a quasi-experimental of 100 learners, the results indicated that there was a statistically significant difference between learners of the experimental group exposed to project-Based Learning approach and control group exposed to Traditional Method. Problem-again, it was found that the project-based learning developed learners critical thinking, good problem solvers and self-directed learners which would lead to life-long memory of Probability concepts and its applications to real-life situations.

These studies have confirmed how effective project-based learning can be in multi-dimensional aspect of the curriculum. This key role that project-based learning plays in effective mathematics instruction has drowned the attention of many

educators and researchers as an avenue to find an antidote to the poor and negative attitude learners have towards mathematics yet these studies have centered on context other than Ghana. Studies in these contexts examined effect of problem-based learning in colleges of education learners, secondary school (Ibrahim and Asiedu-Addo, 2019; Wulandari, 2019; Dorr, 2017; Tucker, 2022), the comparison of project-based learning and traditional instructions (Brown, 2021). Similarly, the practice of project-based learning for motivation and promotion of 21st century skills have also been investigated (Mughrabi, 2021; Ash, 2021; Cole, 2022) as well as the perspective of project-based learning (Boyers, 2018; Bland, 2020)

A gap is also found in the subject area through which the project-based learning was investigated where most of these foreign studies centered on English language. Among these are the integration and implementation of project-based learning in English language; speaking and writing other than mathematics (Angelina, 2020; Aldabbus, 2018; Guo, 2020; Philen, 2016; Kanigolla, 2013 Kalabzová, 2019).

In the Ghanian context, studies on project-based learning are skewed towards the **e**ffect of problem-based learning in colleges of education learners (Ibrahim & Asiedu-Addo, 2019), the effectiveness on pre-service teachers in Ghana (Boye & Agyei, 2023), and on the acquisition of agricultural knowledge and skills (Ananga, 2013).

The case is even worse in the upper west Region, where accessible related studies is only found on the activity-based learning (Nudzor et al, 2015). In this study, the author examined how teachers in the northern region of Ghana practice activity-based learning (ABL) in public basic schools. Using teachers, headteachers, director of education in four districts, the study found that in almost all the schools and classrooms the authors visited, essential ingredients of activity-based learning such as

the display of learners' work in classrooms, organisation of the seating arrangements of learners in groups, use of teaching and learning materials, formative assessment and activity-oriented lessons among others were missing owing to congestion and lack of furniture and logistics.

The findings of the study by Nudzor et al. (2015) confirm the numerous challenges teachers in the various district of the Upper West region, especially the Nadowli-Kaleo District, face in teaching, with particular emphasis on mathematics. It further suggests the use of activity-based approaches such as the project-based learning may be lacking in the Northern Region of Ghana, of which the Nadowli-Kaleo District is no exception. The researchers attest to this finding through the personal observation made in the school of practice. The researcher observed how teacher mostly use the talk and chalk approach to the teaching of mathematics especially at the JHS level. This prompted the researcher to further explore how teachers are implementing the project-based learning in their mathematics lessons.

The unpopularity of activity-oriented lessons among teachers in the Nadowli-Kaleo District coupled with the limited studies conducted on the problem in the Ghanaian context necessitated this study. Furthermore, the absence of a study on project-based learning in the the Nadowli-Kaleo District which is notable for poor academic performance in mathematics, meant that something needed to be done about the problem. Hence the researcher decided based on the literature and personal sentiment of poor academic performance in mathematics to investigate how JHS mathematics teachers implement such as a modern approach as project-based learning in teaching mathematics in the Nadowli-Kaleo District.

1.3 Purpose of the Study

The purpose of the study was to investigate the implementation of the project-based learning approach in mathematics lessons among JHS mathematics teachers in the Nadowli-Kaleo District.

1.4 Objectives of the Study

The study aimed at achieving the following objective.

1. To investigate the perception of JHS Matematics teachers in the Nadowli-Kaleo District regarding the use of project-based learning in teaching mathematics.
2. To identify the instructional strategies JHS mathematics teachers in the Nadowli-Kaleo District use in implementing the project based learning in their lessons.
3. To examine the challenges faced by JHS mathematics teachers in the Nadowli-Kaleo District while implementing the project-based learning in their lessons.
4. To find out the support needed by JHS mathematics teachers in the Nadowli-Kaleo District in implementing the project-based learning in their lessons.

1.5 Research Questions

The study was guided by the following research questions:

1. What are the perceptions of JHS mathematics teachers in the Nadowli-Kaleo District about the use of project based-learning in teaching mathematics?
2. What instructional strategies do JHS mathematics teachers in the Nadowli-Kaleo District use in implementing the project-based learning in their lessons?

3. What challenges do JHS mathematics teachers in the Nadowli-Kaleo District face in implementing the project-based learning in their lessons?
4. What kind of supports do JHS mathematics teachers in the Nadowli-Kaleo District need to implement the project-based approach in their lessons?

1.6 Significance of the Study

This study hopes to contribute to practice, policy and theory in these ways:

To begin with, this study will help throw more light on teachers' perception, practice and challenges in using the project-based learning in their respective classroom to inform necessary redress actions. This will serve as reference material for the teacher's self-reflective practice on their own instructional practices and contribute to their professional development as teachers.

Again, it is hoped that the contribution will be of immense benefit to motivate learners and improve their interest towards the study of the mathematics in schools as teachers strive to improve their teaching methods by adopting such modern approaches to mathematics instructions.

Moreover, the Nadowli-Kaleo District Education Directorate and other policy makers will also benefit immensely from this study since the recommendations that will be made as part of the study will highlight the areas that need to be given more attention in the implementation of the project-based learning in the junior high schools in Ghana.

Lastly, this work contributes to the growing body of research on the promotion of project-based learning in mathematics instruction among educators. It would serve as a future reference for researchers interested in the integration of project-based learning into their mathematics lessons. It also adds to the validity and reliability of

theories and previous studies related to this topic, facilitating further research in the field of mathematics education and on project-based learning.

1.7 Delimitation

The study had several boundaries to restrict its scope. First, only junior high school teachers within the Nadowli-Kaleo District in the Upper West Region of Ghana were used. This choice of location is based on the observation the researcher made regarding how these categories of teachers were not using the project-based approach. Moreover, it was within the Nadowli-Kaleo District that the researcher observed this problem and was more familiar with. Again, the study specifically targets public junior high school teachers who teach mathematics as a subject. This choice is influenced by the fact that teachers at this level of the Ghanaian educational system specialize in teaching specific subjects. Furthermore, the study focuses on the implementation of project-based learning by examining their perception, practice, challenges and strategies for implementing the project-based learning in mathematics instruction. These boundaries were set to help combat the constraints of time and financial resources. By delimiting the study to these specific parameters, the researcher hoped to provide valuable insights into the status of the implementation of the project-based learning in the Nadowli-Kaleo District in the Upper West Region of Ghana.

1.8 Operational Definitions

Project Based Learning (PBL): In this study, it refers to the use of tasks that requires learners to work outside of the classroom to solve real life problems.

1.9 Organization of the Study

The study had five chapters. Chapter One introduces the study by presenting the background information, stating the problem, articulating the purpose of the study, and formulating research questions. Additionally, it highlights the significance of the study, delimits the scope, and acknowledges the limitations of the research.

Chapter Two provides an extensive literature review, encompassing three main aspects: theoretical, conceptual, and empirical. This literature review explores relevant scholarly works related to the study, offering a synthesis of existing knowledge and theories in the field.

Chapter Three outlines the methodology employed in the study. It describes the research design, specifies the study area, defines the target population, explains the sampling technique, identifies the research instruments, elaborates on the data collection procedure, presents the data analysis method, and addresses ethical considerations.

In Chapter Four, the study presents the findings and engages in a detailed discussion. The results obtained from the research are analyzed and interpreted, providing insights and explanations in relation to the research questions and objectives.

Chapter Five concludes the study by summarizing the key findings, drawing conclusions based on the results, and providing recommendations for practical implementation or further research. It also suggests potential areas for future studies to expand upon the current research.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.0 Overview

This chapter is concerned with the review of the related literature from various sources such as books, journals, articles and also from the internet. It deals with the theoretical, conceptual and empirical base to support this study in investigating the implementation of the project-based learning in mathematics lessons among JHS mathematics teachers in the Nadowli-Kaleo District..

2.1 Theoretical Framework

This study in anchored on the Constructivism Theory of Learning by Vygotsky. Constructivism theory belongs to a subset of cognitive theories that deal with learning and present propositions about information processing (Agarkar, 2019). This theory was developed by first introduced by Jean Piaget (Silva et al., 2017) and centers around two main concepts: learners construct knowledge based on what they already know and learning is active not passive. They are responsible for creating and maintaining "a collaborative problem-solving environment, where learners are allowed to construct their own knowledge" (Bada, 2015). According to Driscoll (2015), "Knowledge is constructed by learners as they attempt to make sense of their experiences" (p.387). Constructivists emphasize that to be able to acquire knowledge, it is necessary to experience that knowledge personally (Driscoll, 2015). They also underline that knowledge must be based on experience to understand any kind of information (Thompson, 2018). In constructivist learning, "process of learning" has more importance than "the products of learning" (Amineh & Asl, 2015).

Chowdhury (2016) explains constructivism as a theory about knowing and learning that knowledge cannot be directly transmitted but must be actively constructed by learners through interaction with their environment and based on their pre-existing knowledge. Learning, according to constructivism theory, is a dynamic procedure whereby learners acquire new ideas or concepts based on current or already acquired knowledge (Brandon & All, 2010).

To Bada (2015), constructivism is a learning theory based on the idea that learning is constructed by piecing new information together with what a person already knows. The theory is depicted as a circular pattern in the constructive theory model, with learners at the center, making learners the focal point of learning.

The constructivist approach defends that information which learners can effectively utilize should be improved. So, to be an active learner (life-long learner) is highly important in order to acquire the intended instruction. Learners are also responsible for what and how are they going to learn the new knowledge (Jaleel & Verghis, 2015). Driscoll said that instructors should provide the learners with "an opportunity to explore and learn something of personal interest" (p.391). In a constructivist classroom, every learner should be able to participate effectively, and to construct the knowledge the environment should be flexible and learner-based (Gomleksiz & Elaldi, 2011).

In the context of this study, Mathematics learning is seen as an active contextualized process of constructing knowledge based on learners' experiences rather than acquiring it. Learners are information constructors who operate as researchers with teachers serve as facilitators by providing the enabling environment that promotes the construction of learners' own knowledge, based on their previous

experiences. This makes learning more relevant to the learner and leads to the development of critical thinkers and problem solvers.

This theory was chosen over others because it is the most relevant to the situation at hand. Project based learning is one of the constructivist approaches to teaching as explained by the Ministry of Education (2019; 2020). As such, in implementing project-based lessons in mathematics, it is critical to focus on the learner in order to encourage interactions between the teacher and the learners, as well as among learners. The implication is that for project-based learning to be effective, aspect of constructivism should be seen in the lesson. For instance, project-based learning in mathematics cannot occur without social interaction. Similarly, teachers build on learners' prior knowledge while ensuring active engagement of learners through instructional materials and activities, which is why social constructivism is the ideal choice for this study that seeks to examine the implementation of the project-based learning in mathematics lessons among JHS mathematics teachers in the Nadowli-Kaleo District.

2.2 Conceptual Review

The study reviewed literature on key aspects of the study and its objectives as;

2.2.1The Concept of Project Based Learning

Project-Based Learning abbreviated as PBL, is often credited to John Dewey, who emphasized experiential learning. This approach combines Dewey's belief in learning through experience with the social aspects of learning proposed by Piaget and Vygotsky (DeGone, 2021). Schuetz (2018) explains that the project-based learning is an approach to instruction that provide the medium for learners to to learn by doing while gaining content-related knowledge through the process of trying to solve problems and challenges that they may face in the real-world. In this, learner are

placed at the center of the learning process, drawing from constructivism and constructionism theories.

Wallace and Webb (2016) add that PBL is a collaborative process, and learners must research on their own with guidance by the teacher so that they can find a solution to the problem. The primary goal is that through these learners would be able to design their own product or presentation while emphasizing the process is doing so. Angelina (2020) describes the project-based learning as an instructional using authentic, real-world project, based on a highly motivating and engaging question, task, or problem to teach learners academic content in the context of working cooperatively to solve the problem by providing strategy of empowering learners to pursue content knowledge on their own and demonstrate their new understanding through a variety of presentation modes.

According to Kanigolla (2013), PBL involves learners learning through the practical application of theoretical knowledge. This allows them to acquire practical skills while providing instructors with opportunities to engage learners effectively. PBL goes beyond the transmission of content knowledge and focuses on developing learners' psychomotor and social skills (Phillips et al., 1999). These skills include conducting research, critical thinking, problem-solving, self-evaluation, summarizing information, and delivering presentations—skills highly valued for lifelong learning. PBL aims to educate the whole child, considering various aspects of their development.

The Buck Institute of Education (BIE), a non-profit dedicated to the study and implementation of PBL, defines project-based learning (PBL) as “a teaching method in which learners gain knowledge and skills by working for an extended period of time to investigate and respond to a complex question, problem, or challenge”

(Larmer & Mergendoller, 2015, para. 1). Lattimer & Riordan (2011) characterize PBL as a pedagogical approach in which learners work for an extended period of time on an authentic, complex problem. Bell (2010) portrays PBL in a similar fashion, but claims learner involvement should direct PBL and learner learning should be facilitated by the instructor with the learner's interest being an integral component of PBL.

Project-based learning (PBL) is a pedagogy used across the globe in the 21st century (Bell, 2010; Lattimer & Riordan, 2011). PBL is a teaching method in which learners gain knowledge by working or investigating for an extended period on a particular question, problem, or challenge (Larmer, Mergendoller, & Boss, 2015). Markham (2012) offered a concise definition of PBL: "PBL can be defined as an extended learning process that uses inquiry and challenge to stimulate the growth and mastery of skills" (p. x).

In explaining this further, Bell (2010) opined that the PBL emphasize learner-centeredness with the teacher acting more as a facilitator than an instructor. Bell wrote, "learners pursue knowledge by asking questions that have piqued their natural curiosity" (2010, p.39). This is consistent with constructionism as learners ask questions about topics that interest them, they "construct meaning" to gain further insight into those topics. In its purest form, PBL is an approach where learners become facilitators of learning and ask questions relevant to research. While a wide-range of definitions exist concerning PBL, the Buck Institute (n.d.). Lattimer and Riordan (2011), and Larmer et al. (2015) all agree on the importance of an essential question, authentic research, and real-world inquiry where learners engage in a process of asking questions, finding resources, and the application of knowledge.

It must be emphasized that PBL is different from traditional instruction in which it emphasizes learning through learner-centered, interdisciplinary, and integrated activities in real world situations (Solomon, as cited by Poonpon, 2011). According to Patton (2012), 'Project-based learning' refers to learners designing, planning, and carrying out an extended project that produces a publicly exhibited output such as a product, publication, or presentation.

What makes projects based on PBL different from the regular projects that learners usually carry out at the end of the term or academic year is that the projects do not end up in a predefined results or take restricted paths decided in advance by the instructor. Projects based on PBL create more freedom for learners, so they can select the suitable topic, resources to be consulted, distributing responsibilities among group members and the way they design and display their final products (Marwan, 2015). The problems learners work to solve are real world and open ended. The problems are authentic and require an authentic product (Martelli & Watson, 2016; Petersen & Nassaji, 2016). Characteristics of PBL include focusing on a problem and integrating academic content and skills into project development. The lessons are inquiry-based and designed to give learners a voice and a choice in their learning. The integration of feedback and revision is designed to generate learner ownership of their learning and promote the ability to communicate their findings all while learning the skills to be successful professionals (Degone, 2022).

Unlike the traditional teaching methods, PBL provides opportunities for learners to engage individually and in groups, allowing them to formulate inquiry questions, set goals, and plan the project (Markham, 2012). Teachers in PBL act as facilitators and advisors, offering guidance and feedback to learners. This approach promotes learner independence as they choose their own approaches to tasks.

Moreover, learners collaborate in groups, distributing roles, supporting each other, searching for information, sharing experiences, designing activities, and reflecting on their knowledge and social skills essential for lifelong learning.

According to Thomas, as mentioned in Brown's work (2021), in order for a project to be considered an example of project-based learning, it must meet certain criteria:

1. The projects in project-based learning are not just peripheral activities but are at the core of the curriculum. In other words, the projects themselves form the curriculum.
2. The projects in project-based learning are focused on driving questions or problems that push learners to engage with and grapple with the central concepts. These projects are carefully designed to connect the activities with the underlying conceptual knowledge that is intended to be fostered.
3. Projects involve learners in a constructive investigation. This investigation is a purposeful process that includes inquiry, knowledge building, and resolution.
4. Projects are driven to a significant degree by the learners themselves. In project-based learning, the projects are not primarily led, scripted, or pre-packaged by the teacher.
5. Projects are designed to be realistic and authentic, rather than resembling typical school activities. They possess characteristics that make them feel genuine and relevant to the learners.

Project-based learning has gained considerable attention in the field of education, leading to its widespread popularity and implementation in educational institutions worldwide (Pereira et al., 2017; Eckersley et al, 2018). The main objective of project-based learning is to create meaningful learning experiences where learners collaborate in groups to address driving questions, solve problems, or face challenges. The

ultimate goal is for learners to produce tangible end products that demonstrate their understanding and application of knowledge (Bell, 2010). Throughout the process, learners engage in a shared project with defined outcomes, following elements of a project design.

It must be emphasized that the overall goal of project based learning is to engage learners in a common project, with defined outcomes through elements of a project design. Advocates of project-based learning emphasize that projects have a long history in education and argue that project-based learning serves as a powerful catalyst for increasing learner engagement and developing the skills necessary to adapt to an ever-changing world (Larmer and Mergendoller, 2015; Krajcik, 2014)

2.2.2 Pioneers of Project Based Learning

1. *John Dewey*

John Dewey, an influential educational scholar, emphasized the importance of experiential learning in shaping future decision-making. He believed in progressivism, which values diversity and aims to develop an engaged population capable of actively participating in community affairs (Lynch, 2016). Dewey applied this philosophy to education, advocating for learners to be active participants in their communities. He also emphasized the need for classrooms that reflect democratic values, enabling children to learn how to function in a democratic society (Holt, 2020). Dewey believed that individuals' minds expand and contract as they navigate different situations in their environment, and learning from these situations equips individuals with the knowledge and skills needed for continued learning (Holt, 2020). Furthermore, Dewey emphasized the importance of education capturing learners' natural interest through authentic real-life experiences that are relevant to their own lives (Holt, 2020).

2. *William Kilpatrick*

William Kilpatrick, a learner and colleague of John Dewey, shared the belief that learning by doing was crucial and that social development was more important than cognitive development through content mastery. He believed that combining school and community activities with a focus on socially-minded development would prepare learners to actively participate in their communities and become contributing members of a democratic society (Pecore, 2015). Kilpatrick developed the project method, which was a child-centered approach to learning involving four steps: purpose, plan, execute, and judge. He believed that the success of the project method relied on skilled teachers guiding learners through the process, allowing learners to take ownership of each step to provide a healthy level of challenge without discouragement (Pecore, 2015). This idea of scaffolding, from Kilpatrick's project method to modern-day project-based learning (PBL), has stood the test of time. The Progressive movement, which experienced a decline during the Cold War, resurfaced in the 1960s and 1970s with concepts such as Montessori education, open schools, experiential education, and schools without walls (Lynch, 2016).

3. *Marie Montessori*

Marie Montessori, renowned for her contributions to preschool and early elementary education, also focused on the needs of adolescents. The Erdkinder program, developed by one of Montessori's learners after her death, was designed for adolescents. Montessori believed that as adolescents developed their own study plans, projects, and roles in the community, they would realize their capacity and ability to shape their own future (Casquejo Johnston, 2019). In Montessori's approach, learner choice and contribution to the community were highly valued. The emphasis on choice and authenticity in a learner-centered environment aligns with the core

principles of modern-day project-based learning (PBL). The significance of community continued in the free school movement and the contributions of educators like Ted Sizer.

2.2.3 Importance of Project Based Learning as an Instructional Approach

Using project-based learning as an instructional approach has been found to have significant benefits for learners' understanding of mathematical concepts. These benefits are discussed below.

First, project-based learning promotes the application of knowledge. Kanigolla (2013) argues that project-based learning improves learners' learning by allowing them to apply theoretical knowledge to real-world problems, boosting their confidence and understanding of the course material. Studies have shown that when project-based learning is effectively implemented, it enhances learners' long-term retention of content (Vega, 2015). Additionally, project-based learning provides an opportunity for instructors to customize the learning experience and assess learners' opinions of the project (Khan, 2010).

By engaging in project-based learning, learners actively participate in their own education, taking ownership of their learning journey. They collaborate with peers, participate in hands-on activities, and apply their knowledge and skills to real-world challenges. This active involvement not only enhances their understanding of content but also cultivates essential interpersonal skills such as communication, teamwork, and problem-solving abilities.

Furthermore, project-based learning encourages learners to explore and integrate knowledge from different disciplines, promoting interdisciplinary thinking and a holistic approach to learning. The driving question or problem at the core of a

project-based learning project sparks curiosity, fosters inquiry, and motivates learners to seek solutions and deeper understanding. Through this process, learners develop critical thinking skills as they analyze information, evaluate multiple perspectives, and make informed decisions.

Another benefit of project-based learning is its capacity to promote self-directed learning. Learners take on more responsibility for their learning, exploring and discovering solutions to real-world challenges (Grant, 2011). Project-based learning accommodates learners' diverse needs and interests by providing a variety of activities, enhancing their overall learning experience (Bell, 2010). Learners also have opportunities for self-assessment, evaluating their own work and providing constructive feedback to their peers, which promotes reflection and self-awareness of their strengths and areas for improvement (Gubacs, 2004).

Additionally, project-based learning helps develop innovation in learners. It goes beyond traditional teaching methods by targeting a broader range of learning objectives. Along with enhancing content knowledge, project-based learning focuses on fostering innovative skills, higher-order thinking abilities, metacognition, and motivation. By placing learners at the center of the learning process and engaging them in authentic real-life learning situations, project-based learning enables active collaboration and independent knowledge construction. Learners become more aware of their own understanding and are motivated to learn (Fitriyani et al., 2018).

Moreover, project-based learning is essential for the development of higher-order thinking skills. Bloom's taxonomy, a framework for educational learning objectives, emphasizes the importance of higher-order thinking. Project-based learning environments provide opportunities for learners to engage in problem-solving and create solutions, cultivating higher-order thinking skills (Kwietniewski,

2017). Learners progress through the hierarchical steps of Bloom's taxonomy, starting with remembering relevant information and culminating in the creation of a final product for presentation.

Furthermore, project-based learning promotes metacognition among learners. Metacognition, the awareness and regulation of one's own thinking processes, is crucial for facilitating cognitive change and improving learning. Through project-based learning, learners develop higher-level thinking skills and enhance their metacognitive abilities. They reflect on their understanding, identify strengths and weaknesses, and take steps for cognitive growth. In a project-based learning environment, learners can identify problem-solving strategies that work best for them while receiving feedback and suggestions from teachers and peers. The choice, motivation, and autonomy inherent in project-based learning allow learners to discover effective learning tactics that suit their individual needs (Vygotsky's perspective on learning) and incorporate structured learner reflection as an integral part of their project-based learning experience.

There is also a higher level of motivation when learners engage in project-based learning. When learners are motivated to learn, the focus of the learning process shifts from being centered on the teacher to being centered on the learner. As the educator takes on the role of a facilitator, learners become more engaged in the activity. Project-based learning (PBL) initiates learning with a driving question that serves as a source of motivation. By presenting content through a problem or challenge, learners are eager to find a solution. Additionally, the act of presenting their findings serves as another motivating factor for learners' involvement in PBL (Darling-Hammond, 2008). The process of finding a solution to a challenge and sharing it with an audience makes the learners' educational experiences more relevant

to real-world applications. When learners can recognize the direct benefits of their learning opportunities, they are more likely to be motivated and engaged in the activity. PBL fosters both intrinsic and extrinsic motivation in learners. When learners find the content interesting, such as relevant real-world questions posed through PBL, they are intrinsically motivated (Kwietniewski, 2017). Extrinsic motivations involve reward-driven behavior, which is the traditional form of motivation learners often receive. In traditional instruction, learners are motivated by external rewards like grades, praise, and the pursuit of success. However, this type of extrinsic motivation can often lead to stress and a dislike for the learning process. By fostering motivation from within the learners themselves and incorporating external factors, learner engagement in education is enhanced.

Several studies have also highlighted key findings on the impact of project-based learning on learners' learning. In a study by Kim and Lim (2018), they highlight other key competencies that can be developed through social rather than lecture-based learning, including "teamwork, communication, leadership, collaboration, and interpersonal relations" (p. 214). Ilter (2014) enumerates these competencies as the 7 C's, which include "critical thinking and problem solving, creativity and innovation, cooperation, teamwork, leadership, intercultural understanding, fluency in communication and information, computer and communication technology, and career and self-development" (p. 489).

PBL can support the success of learners as they pursue higher education and employment. A 2014 study found that learners were most successful in college when their high schools included learner-centered instruction, which was defined as project-based teaching, collaborative learning, relevant curriculum, and performance-based assessments (Friedlaender et al., 2014). For example, Jollands, Jolly, and Molyneaux

(2012) point out the advantages of PBL in medical education because it "allows learners to acquire not only content knowledge but also knowledge of and practice in the professional behavior of a physician" (p. 144).

Condliffe et al. (2017) conducted a systematic literature review of PBL and suggested that the evidence of PBL's effectiveness in improving learners' outcomes is "promising but not proven" (p. iii). Some studies have found positive effects associated with the use of PBL curricula in science and social studies classes. The authors also suggested that some studies in schools that follow PBL approaches pointed to positive effects on learners' engagement, motivation, and beliefs in their own efficacy (Condliffe et al., 2017).

2.2.4 Essential Features of Project Based Learning in the Classroom

The Buck Institute of Education has done extensive research on PBL, creating curriculum, informational videos, implementation guides, and other resources for educators to use when aiming to use PBL in their classrooms. The vision is to provide access to quality PBL for learners, regardless of their location or background, “to deepen their learning and achieve success in college, career, and life” (What Is Project Based Learning? | PBLWorks, n.d.). The Buck Institute of Education provides a research-based model for “Gold Standard PBL”. There are two guides identifying key features: one on the seven essential elements of project design and another on the seven project-based teaching practices.

2.2.5 Seven Essential Project Design Elements

Boss and Larmer (2018) stressed well-designed and well-implemented projects had to be perceived as personally meaningful to learners, as well as fulfill an educational purpose, for them to serve their intended purpose. They further listed the following seven essential project design elements: (a) challenging problem or question; (b)

sustained inquiry; (c) authenticity; (d) learner voice and choice; (e) reflection; (f) critique and revision; and (g) public product. These are discussed below;

1. A Challenging Problem or Question:

According to Boss and Larmer (2018), in project-based learning, the project is centered around a meaningful problem or a thought-provoking question. This problem or question should be appropriately challenging for the learners, meaning it should require them to think critically, apply their knowledge and skills, and engage in deeper learning. The level of challenge should be suitable for the learners' developmental stage and academic level to ensure they are appropriately stretched and motivated by the project.

2. Sustained Inquiry:

Project-based learning involves an extended process where learners actively inquire, explore, and investigate the problem or question at hand. They pose their own questions, seek out relevant resources such as books, articles, and expert interviews, and apply the information they gather to deepen their understanding. This process is rigorous and requires a sustained effort from the learners over a significant period of time, allowing them to develop their research and inquiry skills (Boss and Larmer, 2018).

3. Authenticity:

Authenticity in project-based learning refers to the connection between the project and the real world. The project should have relevance and significance beyond the classroom. It may involve tasks, tools, or standards that are commonly found in professional or real-world settings. Alternatively, the project may address personal concerns, interests, or issues that are meaningful to the learners' lives, making it personally relevant and engaging (Boss and Larmer, 2018).

4. Learner Voice & Choice:

In project-based learning, Boss and Larmer (2018) argue that learners have the opportunity to make decisions and exercise autonomy. They can have a say in how they work on the project, such as choosing their research methods or selecting the tools they use. Additionally, learners can express their own ideas and perspectives in their own voice, allowing for individuality and creativity to flourish. This aspect of learner voice and choice empowers learners to take ownership of their learning and enhances their motivation and engagement.

5. Reflection:

Reflection is a critical component of project-based learning. Boss and Larmer (2018) explains that both learners and teachers engage in reflective practices to evaluate the learning process, the effectiveness of their inquiry and project activities, and the quality of learner work. Reflection involves analyzing the obstacles and challenges encountered during the project and identifying strategies to overcome them. By reflecting on their experiences, learners and teachers can gain insights and improve future projects and learning endeavors.

6. Critique & Revision:

Learners in project-based learning engage in giving, receiving, and applying feedback to enhance their work. They learn to provide constructive criticism to their peers, receive feedback from teachers and classmates, and use that feedback to revise and improve their process and products. This iterative process of critique and revision fosters growth mindset, encourages collaboration, and develops skills in evaluating and refining work based on feedback (Boss and Larmer, 2018).

7. Public Product:

In project-based learning, learners are encouraged to share their project work with audiences beyond the classroom. Boss and Larmer (2018) argue that this can involve presenting their findings, explaining their process, or showcasing their final products in a public setting. By making their work public, learners develop communication and presentation skills, gain a sense of purpose and accountability, and have the opportunity to make a meaningful impact on others. Sharing their work with a wider audience also promotes authentic and real-world applications of knowledge and skills.

By incorporating these seven project-based learning practices, educators can create a dynamic and engaging learning environment that promotes deep understanding, critical thinking, collaboration, and real-world application of knowledge and skills.

2.2.6 Seven Project Based Teaching Practices

1. **Design & Plan:**

In project-based teaching, educators undertake the critical role of designing or adapting projects that align with the specific context and needs of their learners (Barron & Darling-Hammond, 2008). This involves meticulous planning, considering the sequence of activities, required resources, and desired outcomes. While maintaining an overarching structure, teachers also incorporate opportunities for learner voice and choice, enabling learners to contribute to aspects such as the project's specific topic or the methods employed for exploration.

2. **Align to Standards:**

Teachers use educational standards as a guiding framework to ensure that the project effectively addresses key knowledge and understanding within relevant subject areas (Thomas, 2000). Alignment to standards ensures that the necessary content and skills

are covered, enabling learners to meet academic expectations while engaging in a meaningful and authentic learning experience.

3. **Build the Culture:**

Establishing a positive learning culture is integral to project-based teaching (Buck Institute for Education, 2015). Teachers actively promote learner independence, encouraging ownership of learning and the development of problem-solving skills. The learning environment emphasizes open-ended inquiry, where learners are empowered to ask questions, explore diverse perspectives, and think critically. Emphasis on teamwork, collaboration, and the pursuit of quality work fosters a culture of mutual respect and support within the classroom.

4. **Manage Activities:**

Teachers play a pivotal role in managing project activities, working closely with learners to organize tasks, set checkpoints, and establish deadlines for project milestones (Larmer et al., 2015). They guide learners in effective resource utilization, supporting them in creating products that showcase their learning. Opportunities for sharing work with a broader audience, whether through presentations, exhibitions, or online platforms, are also facilitated by teachers.

5. **Scaffold Learner Learning:**

To support all learners in reaching project goals, teachers employ diverse lessons, tools, and instructional strategies. They scaffold the learning process by breaking down complex tasks, providing clear instructions, and offering support as needed (Belland et al., 2018). Differentiated instruction ensures that diverse learner needs are met, with additional resources, clarifications, or alternative approaches provided to ensure inclusive participation and success.

6. **Assess Learner Learning:**

Teachers utilize both formative and summative assessments to evaluate learners' knowledge, understanding, and success skills throughout the project (Wiggins, 1998). Formative assessments offer ongoing feedback, allowing teachers to make instructional adjustments. Summative assessments, such as final presentations or project portfolios, measure overall learning outcomes. Teachers also encourage self-assessment and peer assessment, fostering metacognitive skills and a culture of continuous improvement.

7. **Engage & Coach:**

Teachers actively engage in the learning process alongside learners, modeling curiosity and a commitment to lifelong learning (Thomas, 2000). They identify when learners need skill-building or redirection, offering support, resources, or alternative strategies. Celebrating achievements, providing encouragement, and acting as coaches, teachers guide and facilitate learner learning while nurturing motivation and growth within a positive and supportive learning environment.

The discussion above means that project-based teaching practices encompass a range of strategies designed to create a dynamic and engaging learning environment. Larmer and Mergendoller (2015) highlighted in the discussion of the key practices that educators play a pivotal role in designing, planning, and implementing projects that align with both learner needs and educational standards. The emphasis on building a positive learning culture promotes learner independence, critical thinking, and collaboration. Effective project-based teaching involves meticulous management of activities, from organizing tasks to guiding learners in resource utilization and showcasing their work to a broader audience. The scaffolding of learner learning

ensures inclusivity and success by breaking down complex tasks and providing tailored support.

2.2.7 Procedure for Implementing Project based learning in the Mathematics Classroom

Project-Based Learning (PBL) is a dynamic instructional approach that involves a structured series of steps designed to engage learners and foster meaningful learning experiences. Drawing on insights from the Buck Institute for Education (BIE, n.d.) and Mergendoller (2018), the procedure for implementing PBL in the mathematics classroom unfolds as follows:

1. **Selecting Significant Content:**

The foundation of a successful PBL experience lies in the careful selection of content that meets learners' needs and captures their interest. Teachers can activate learners' prior knowledge through discussions, elicit questions, or incorporate multimedia resources to create an engaging context (BIE, n.d.).

2. **Formulating a Driving Question:**

Learners are encouraged to formulate a driving question that serves as the guiding force throughout the project. This question should be challenging, open-ended, and directly linked to the core of the project (Mergendoller, 2018). Importantly, the diversity of driving questions generated by different groups allows for individuality and varied learning paths.

3. **Voice and Choice in Project Design:**

An essential aspect of PBL is providing learners with the autonomy to have a voice and choice in designing their projects. Encouraging them to contribute ideas, select

materials, determine information sources, and decide on the presentation format fosters creativity and independence in their learning journey (BIE, n.d.).

4. **Skill Practice Opportunities:**

Throughout the project, teachers should ensure that learners have ample time and opportunities to practice essential skills such as effective communication, utilizing technology, critical thinking, and problem-solving. These skills are integral in the 21st-century job market and should be nurtured within the PBL framework (BIE, n.d.).

5. **Collaboration and Feedback:**

Collaboration and feedback are pivotal during the project. Peer and teacher feedback help learners evaluate and summarize their findings, generating additional sub-questions for more in-depth exploration (BIE, n.d.). This iterative feedback and revision process enable learners to refine their work based on insights and suggestions from their peers and teachers.

6. **Presenting to a Wider Audience:**

The final step involves presenting the end product to a wider audience. This adds a significant motivational element and instills a sense of pride in learners. Sharing projects with peers, teachers from other classes, parents, community members, and friends provides a platform for learners to showcase their work, discuss their projects, and respond to inquiries (BIE, n.d.).

By following this comprehensive procedure, PBL in the mathematics classroom promotes learner engagement, autonomy, collaboration, and the development of crucial skills. It creates a dynamic learning environment that fosters meaningful and enduring learning experiences for learners.

2.2.8 The Use of Group Project Based Learning in the Classroom

The utilization of collaborative or group projects in the classroom can serve as an effective approach to foster experiential learning through cooperation (Voyles et al., 2015). Nevertheless, there exist certain negative perceptions regarding group projects, as some learners may not exert their full effort when working in a group setting. This phenomenon, referred to as "social loafing," leads to a situation where certain individuals contribute less while others end up shouldering the majority of the workload. To counteract social loafing in educational environments, one viable strategy is the implementation of the jigsaw technique. Developed by Elliot Aronson in the early 1970s, the jigsaw classroom is an evidence-based cooperative learning technique (The Jigsaw Classroom, n.d.). It organizes classroom activities in a manner that necessitates interdependence among learners for success. Learners are divided into groups, and assignments are divided into segments or pieces. Each group is assigned a different piece, and subsequently, learners are rearranged into new groups, enabling them to share their work. This approach requires learners to bring together the pieces from their original groups and collaboratively assemble the complete puzzle.

In the study conducted by Voyles et al. (2015), the jigsaw technique was employed to enhance accountability and mitigate social loafing in learner group projects at the collegiate level. In addition to the core components of the original jigsaw method, such as promoting oral communication skills, teamwork skills, and critical thinking skills, Voyles et al. incorporated two additional skills: written and oral communication skills through the inclusion of note-taking and an oral presentation by the learners. The design of this classroom activity actively encouraged every member of the group to contribute, ensuring an equitable distribution of

contributions among group members (Voyles et al., 2015). Through this approach, educators could assess the individual contributions of group members and hold each learner responsible for their participation.

2.2.9 Teachers' Perception About Project based Learning

PBL implementation has been shown to be both successful and challenging, as perceived by teachers and learners (Baysura et al., 2016; Mahasneh & Alwan, 2018). The challenges in implementation often stem from inconsistencies in understanding and applying the components of PBL (Baysura et al., 2016). Moreover, many teachers struggle to put PBL theory into practice without adequate professional development or training (Baysura et al., 2016). Examining the experiences of teachers and learners sheds light on the key components necessary for a successful PBL implementation.

In a study conducted by Baysura et al. (2016), 58 teacher candidates participating in a Methods of Teaching II course in Istanbul, Turkey, demonstrated a lack of understanding of PBL. Their responses to the question "What is PBL?" revealed confusion about its definition and components. Some teacher candidates described PBL as an approach that involves producing a product, while others emphasized the importance of the learning process and the teacher's role. Their uncertainty about PBL was evident in their conflicting opinions about using PBL in the future, with some expressing enthusiasm for its potential benefits while others considered it too demanding for both learners and teachers. For instance, when asked the question, What is PBL?, this was the response given by one of the teachers'

> "It is an approach which results in a product and for which the process is important and, during the process, the teacher has a guidance role . . . A project-based learning approach means making the learning process real by using projects . . .The teacher gives daily or weekly performance

> homework and pursues instructional process based on the is project" (Baysura et al., 2016, p. 23).

Further responses regarding using PBL in the future indicated both affirmations and rejections of the strategy as per these comments:

> "Yes, I will apply. I think that the learning will be permanent if the learners have an active role in a project . . . Now when I graduate, I do not think that I will apply this method as I do not know the details of this method completely . . . I do not plan on applying it because this method is too much work for both learners and teachers" (Baysura et al., 2016, p. 23).

In contrast, Mahasneh and Alwan (2018) conducted a study with 79 preservice teachers enrolled in a course titled "Using Computers in Education." The study compared the self-efficacy and achievement of two groups: one taught using a project-based learning (PBL) approach and the other taught through traditional methods. The results showed significant differences in self-efficacy between the two groups, with the PBL group demonstrating higher levels of confidence in implementing PBL. The key difference between the two studies was the training on PBL provided in the college courses. The teachers in Mahasneh and Alwan's study received more meaningful training on PBL, which positively influenced their perceptions and confidence in implementing PBL.

Another study by Dole et al. (2016) explored the impact of in-depth professional development on teachers' perspectives of experiential learning, including PBL. The case study involved in-service teachers pursuing a license in gifted education. The teachers participated in courses centered around PBL and were exposed to essential questions related to PBL implementation. The results revealed several themes, including teachers' ability to apply theory to practice, their understanding of the

logistics of PBL, and their recognition of the teacher's role as a facilitator. The teachers expressed the importance of components such as generating ideas, promoting critical thinking, creating timelines and rubrics, assessing learner comprehension, and providing learner choice. The positive perceptions of teachers confirmed that consistent implementation of key PBL components, such as promoting inquiry, aligning with standards, and offering choice, led to successful outcomes. The following specific comments from the teacher participants point to the most critical components in successful PjBL and PrBL:

> The processes such as generating and brainstorming ideas, promoting critical and creative thinking, creating timelines and rubrics were put to use immediately . . . I now know how to create problems for my learner inquiry . . . I learned how to assess learner comprehension of an objective or unit of study . . . You start with the curriculum standards, add application, mix in relevance and authenticity and add in open endedness . . . I learned that I need to let my learners take more leadership in demonstrating their own learning . . . I saw the benefits of allowing more learner choice in projects. (Dole et al., 2016, p. 28)

The findings of the study revealed that teachers' positive perceptions confirmed that certain PBL components were implemented consistently in the following areas: promote inquiry by posing a problem or question, assess the standards and objectives that are embedded, and provide choice in how to demonstrate learners' learning.

Evans (2019) conducted a case study of a high school chemistry teacher named Sheila who designed a high-quality PBL (HQPBL) unit after receiving PBL 101 training. Sheila's unit incorporated the key knowledge and understanding, a challenging problem or question, sustained inquiry, authenticity, learner voice and

choice, reflection, critique and revision, and a public product. Additionally, the study highlighted seven teacher practices: design and plan, align to standards, build the culture, manage activities, scaffold learning, assess learner learning, and engage and coach. The structured implementation of PBL components and teacher practices resulted in a consistent and successful PBL experience for Sheila's learners.

The findings from Evans's (2019) HQPBL study, along with the studies by Dole et al. (2016) and Mahasneh and Alwan (2018), underscore the importance of applying PBL theory to practice through quality training and professional development. Furthermore, Mahasneh and Alwan's (2018) study highlighted positive results in terms of teacher efficacy in the implementation of PBL after experiencing their coursework in a PBL framework. All three studies share the commonality of the importance of PBL training and coaching. Finally, the consistency of implementation was clear in the final study by Evans, driving home the importance of PBL design features and their relationship to teacher perspectives and training.

The significance of these studies is that they highlights a key aspect of project based learning such as the need for a driving question, authenticity, voice and choice, sustained inquiry, reflection, critique and revision, and public product/presentation. Furthermore, the teacher must incorporate the teacher practices, namely build a culture, design and plan, assess the learning, and scaffold the learning. Finally, implementation of both the PBL components and teacher practices outline the tools for the teacher to leverage to promote learner behavioural, cognitive, and emotional engagement.

2.2.10 Barriers/Challenges of Implementing Project based Learning

Project-based learning (PBL) has emerged as a promising instructional approach that fosters deeper understanding, critical thinking, and collaboration among learners (Habok & Nagy, 2016). However, the successful implementation of PBL in classrooms requires addressing several concerns that educators face. Among these are the lack of teacher support and guidance, the impact on standardized testing, and the time requirements associated with PBL.

One challenge highlighted by Habok and Nagy (2016) is that PBL can be a highly time-consuming activity that requires careful attention to detail. The process of designing and implementing projects may require more time than initially anticipated, which can pose challenges for teachers who have a set curriculum to cover within limited instructional time.

Another potential challenge arises from learners who lack the necessary skills for working effectively in groups. Johnson and Johnson (1989) pointed out that some learners may struggle with collaborative work, which is a fundamental aspect of PBL. Group dynamics, communication, and division of tasks can sometimes present difficulties for learners who are not accustomed to working in a cooperative learning environment.

Furthermore, Ladewski et al. (1994) highlighted a potential resistance from teachers when it comes to implementing PBL. Teachers may hold deep-seated beliefs about their preferred teaching methods, making it challenging for them to embrace and transition to more advanced approaches such as PBL. This resistance can hinder the successful adoption and implementation of PBL in classrooms.

Another set of challenges identified by Marx et al. (1997) relates to the implementation of PBL itself. One issue is the difficulty faced by some teachers in effectively monitoring and scaffolding learners' activities during the project. Teachers may struggle to strike the right balance between providing learners with enough freedom to explore and learn independently while also offering sufficient guidance and modeling. Some teachers may provide too much freedom, leaving learners without proper structure and support, while others may provide too little modeling, making it challenging for learners to understand expectations and engage effectively in the project.

In addition, some learners may encounter difficulties in various aspects of the PBL process. Marx et al. (1997) noted that some learners may struggle to formulate effective driving questions, maintain motivation throughout the project, and actively engage in all stages of the project until completion. Additionally, limited access to necessary technology for information search can hinder learners' ability to fully participate in PBL.

Lack of teacher support and guidance: Implementing PBL effectively necessitates teachers receiving proper guidance, targeted professional learning experiences, and support from their administration (Harris et al., 2015). Without these essential elements, educators may find it daunting to implement PBL in their classrooms. Teachers need assistance in understanding the principles and strategies of PBL, as well as guidance on how to structure and facilitate PBL lessons. Professional development opportunities and ongoing support from administrators can play a vital role in empowering teachers to confidently implement PBL.

Standardized testing concerns: A concern often raised regarding PBL is its potential impact on standardized testing outcomes. While research suggests that learners learn content knowledge better through project-based instruction compared to traditional methods, standardized tests such as the SAT, ACT, or AP exams continue to hold significance for learners' collegiate opportunities. PBL's emphasis on deeper understanding and application of knowledge may present challenges for learners in performing well on standardized tests, which often assess more superficial knowledge and test-taking skills. It is crucial to strike a balance between incorporating PBL and adequately preparing learners for standardized tests to ensure their future academic success.

Time constraint: Time is another obstacle teachers believe they face when it comes to project-based learning (Vasiliene-Vasiliauskiene et al., 2020). It is not just the time it takes to plan a project, but the time it takes to execute a project that is the concern. After a project is planned for the first time it can easily be changed and adapted for future use. This makes the initial planning time extensive, but there is a time saver in the long run. PBL typically demands more time for both design and implementation compared to traditional instruction. Teachers need to invest time in developing engaging driving questions, designing authentic projects, and planning for learner collaboration and inquiry. Initially, this time investment may appear as a drawback for teachers, especially when faced with a prescribed curriculum and limited instructional time. However, it is important to note that PBL allows for the integration of multiple concepts into the driving question, facilitating a more holistic and interconnected understanding of the content. Furthermore, once learners grasp the content through PBL, teachers may save time by avoiding the need to revisit and reteach certain concepts (Kwietniewski & Macho, 2017). For instance, what is often

heard is: how can you spend three weeks on a project? The number of topics that can be covered in that time can surely exceed the topics covered on a project. A teacher from Chicago has the answer: “At first, I was concerned about spending three weeks on this project, but when I look back, I realize how much my learners learned and how much time I saved by not having to reteach the same thing over and over again,” This was said by Kristine Kurpiewski, who is a teacher at an early college high school in Chicago (Yeugn, 2008).

Critics also worry about social loafing in PBL. Critics also worry about social loafing in PBL, where not all group members contribute equally, making it challenging to measure individual learner understanding (Kim & Lim, 2018). Social loafing is a concern raised by critics of project-based learning (PBL), referring to a situation where not all group members contribute equally to a project, which can make it challenging to measure individual learner understanding. Kim and Lim (2018) discuss this issue and highlight the potential impact on the effectiveness of PBL. In group-based projects, some learners may rely on the efforts of their peers, leading to disparities in individual contributions. This can make it difficult for teachers to assess the level of understanding and engagement of each learner. It also raises concerns about the fairness and accuracy of individual grading within a group context.

Furthermore, PBL may not be as effective for learners with learning difficulties who lack certain skills. Filippatou and Kaldi (2010) emphasize this point in their research. Learners with learning difficulties may struggle with the demands of PBL, particularly in areas such as reading, writing, or complex problem-solving. The open-ended nature of PBL tasks and the requirement for independent thinking and self-directed learning can pose challenges for these learners. Teachers must provide

additional support and scaffolding to ensure that all learners, including those with learning difficulties, can actively participate and benefit from PBL experiences.

Teacher preparedness is a critical factor that influences the success of PBL implementation. A concern of teachers is they are not adequately prepared to implement project-based learning into their curriculum. They feel as though they are inexperienced and need more training in the area before they can use it in their classroom. Teachers also unsure of the effectiveness of evaluation when learners use technology (Efstratia, 2014). Sunyoung Han et al. (2015) conducted a study to examine the impact of teacher experience with PBL on its effectiveness. The researchers found that teachers who had prior PBL experience were more effective in implementing PBL compared to those who were new to it. Experienced teachers demonstrated a better understanding of the principles and strategies underlying PBL, and they were more adept at designing and facilitating meaningful projects. In contrast, teachers without prior PBL experience faced challenges in effectively implementing this approach, as they may not have had sufficient training, support, or familiarity with the pedagogical shifts required for successful PBL implementation.

Another of the major concerns of teachers surrounding project-based learning is learner performance on high stakes testing. Many teachers fear if they utilize project-based learning as opposed to more traditional testing methods their learners will not perform as well on standardized or state tests (Harris, 2014). This leads to the worry of teachers and how confidently standards can be implemented into a project based curriculum. While switching to an entirely different teaching method is overwhelming, finding a way to incorporate standards into the curriculum can bring that overwhelming factor to an all-time high. This challenge or hesitation can easily be relieved by utilizing online resources, such as the Buck Institute of Education

website, that provides examples of projects that can be used and adapted to fit a teacher's needs in the classroom (BIE Resources, 2017).

While also fearing their learners are not ready to be put into to collaborating group work, the final concern of teachers is losing control of their classroom. David Ross, director of professional development at the Buck Institute of Education, states "Control and command are not the same thing… you give up control, but you always retain command of your classroom" (Yeugn, 2008: 16). Project based learning allows for learner choice, which means the teacher needs to relinquish some control, however they maintain command. They are still the overseer of the room. They provide behavioural control, academic support and guidance for the learners. The teacher does not allow for the learners to run them out, they still maintain the role of supporter and provide the guidance needed to meet all learners' needs.

Another criticism of PBL is that grading can be subjective since a large portion of it is based on rubrics, observations, and performance assessments (Larmer et al., 2015). Grant (2011) conducted a study with middle school learners in a PBL environment and found that participants often chose the easiest route to complete projects. The result was watered down PBL and learning lacking rigor. Learners in Grant's study felt projects were easier than test grades even though they were weighted equally. It is important to note the learners and teachers in Grant's study had not engaged in a PBL environment and the teachers had not been trained in effective PBL instructional strategies. Learners may not have received enough training and scaffolded support to engage in a rigorous project experience. The results may not accurately portray the effect of PBL on 21st century skills due to the inexperience of the teachers and learners as Grant wrote teachers used primarily "didactic instructional methods" such as lectures and teacher directed instruction before the

study was conducted (Grant, 2011, p.40). Teachers with minimal PBL experience have not had the opportunities to adapt, change, or fine-tune their practice through experience. As such, researchers must carefully evaluate studies such as Grant's before determining PBL's effectiveness

There are studies that confirm the challenges faced in implementing PBL. Grant (2011) found that learners struggled with PBL due to lack of prior experience, while Filippatou and Kaldi (2010) highlighted difficulties in retaining content and applying vocabulary. Grading in PBL can be subjective and learners may opt for easier routes, leading to watered-down learning experiences (Grant, 2011; Larmer et al., 2015). In Grant's (2011) study, learners struggled with PBL in large part because the learners had no prior experience. Filippatou and Kaldi (2010) found learners had difficulty retaining content and applying vocabulary. Additionally, learners struggled to express their learning through open-ended questions. The teachers in this study had similar levels of experience with PBL, but the amount of training and experience was unknown. This project lasted eight weeks, but learners only engaged in PBL for two to three hours per week. Walker and Leary (2009) found lecture-based instruction might be more effective in learners' retaining content knowledge than PBL due to the structure and greater teacher support. These researchers found negative characteristics of PBL, which may relate to the limited experience and time teachers and learners had to work with PBL (Filippatou & Kaldi, 2010; Grant, 2011;

These challenges have been grouped by Aldabbus (2018) into five areas; parents, school, learners, curriculum and teachers. These are discussed as follows

Teacher-Related Challenges: The implementation of Project-Based Learning (PBL) presents challenges for teachers, Difficulties included uncertainty in selecting appropriate topics from the curriculum designed for traditional teaching methods

(Aldabbus, 2018). Integrating PBL within the constraints of the school schedule proved challenging, as it often requires more time than traditional methods. Some teachers expressed concerns about classroom management and noise levels, fearing that PBL would disrupt the learning environment. Additionally, providing support and monitoring the progress of a larger number of learners during the project-based process was perceived as challenging. Teachers also struggled with addressing all elements of PBL comprehensively and faced uncertainties regarding assessment strategies.

Learners-Related Challenges: The challenges associated with learners in the implementation of Project-Based Learning (PBL) are diverse and multifaceted. Findings from the study underscore instances where certain learners exerted dominance over the project, impeding active participation and contributions from their peers. In contrast, high-achieving learners were noted to steer the project according to their own interests, potentially sidelining the perspectives of their classmates. This imbalance in participation led to feelings of frustration and disengagement among those marginalized within the group. The lack of prior exposure and training in collaborative work skills, coupled with ineffective group working rules, may have contributed to this issue (Hussein, 2021).

Furthermore, a notable challenge identified was the restricted access to technology for some learners, either due to the absence of personal devices or insufficient access to technological resources. This limitation hindered their ability to conduct research and share information effectively within their project groups (Beckett & Slater, 2018). Additionally, some learners exhibited a tendency to prioritize completing the project quickly rather than focusing on the learning process itself. This behavior may be influenced by the prevailing exam-oriented mindset and a

strong emphasis on achieving high grades, rather than valuing the acquisition of essential skills (Hussein, 2021).

Addressing these challenges requires proactive measures from educators. Teachers can play a pivotal role in setting learners up for success by providing scaffolds and supporting the development of robust foundations in collaborative work skills (Hussein, 2021). Furthermore, ensuring equitable access to technology is essential to promoting an inclusive learning environment and overcoming barriers to effective project participation (Beckett & Slater, 2018). A shift in classroom culture, emphasizing collaboration and inclusivity, is imperative to mitigate dominance-related challenges and foster a more equitable distribution of responsibilities and contributions within project teams. Moreover, educators should advocate for a paradigm shift, emphasizing the intrinsic value of the learning process over an exclusive focus on outcomes or grades (Hussein, 2021). By addressing these challenges holistically, educators can enhance the overall effectiveness of PBL, creating an environment where every learner can thrive and actively contribute to meaningful learning experiences.

Curricular-Related Challenges: The nature of some curriculum poses difficulties for teachers in adapting it to meaningful project-based instruction. Some teachers resorted to treating it as a regular project or task-based learning, overlooking the essential elements of PBL. This issue arises because the curriculum was not originally designed to be taught through PBL. To address this challenge, teachers need to analyze and modify the lesson content to contextualize it effectively within the framework of PBL, while still aligning with the intended objectives of the lesson. However, it is important to note that the focus of PBL should not solely be on the end product but rather on fostering inquiry, exploring real-world contexts, and promoting

the sharing of learning experiences with others (Holland, 2015). Educators should strive to strike a balance between achieving curriculum objectives and integrating the principles and practices of PBL to create authentic and engaging learning experiences for learners.

*School-Related Challenges**:*** Challenges related to schools play a significant role in the implementation of Project-Based Learning (PBL). The findings highlighted that schools often lack the necessary materials and facilities required for conducting projects. This limitation may stem from inadequate financial resources allocated for such projects. Different projects have varying material and facility needs, and if schools do not have sufficient budgetary support, it becomes challenging for teachers to effectively implement PBL. Another noteworthy finding related to schools is that some school administrations prefer simpler teaching methods to avoid disruptions, minimize expenses, and adhere strictly to the prescribed teaching plan provided by the Ministry of Education (MOE). This resistance to change or the imposition of obstacles on teachers can hinder their adoption of unfamiliar teaching methods. School-related factors have been consistently identified as major barriers in previous research, including insufficient resources, inflexible schedules, and a lack of access to technology (Pereira et al., 2017). Moreover, limitations imposed by the number of learners and district curricular policies further impede the successful implementation of PBL. Addressing these school-level challenges is crucial to creating an environment conducive to the effective integration of PBL in educational settings**.**

Parents-Related Challenges: The involvement of parents in the educational process is paramount for the success of Project-Based Learning (PBL). However, challenges related to parents' participation were identified in the study, underscoring the importance of addressing these issues with contemporary insights. A central

challenge surfaced in the lack of effective communication and collaboration between teachers and parents. The absence of robust communication hindered the establishment of a strong school-parent partnership, impacting parents' understanding and support for PBL initiatives. Some parents, lacking clear information about the nature and benefits of PBL, underestimated its value and, consequently, did not fully endorse their children's involvement in projects (Milloy, 2017).

Moreover, an observed phenomenon revealed that in certain instances, parents exceeded their supportive role and assumed the responsibility of completing projects on behalf of their children. This behavior may be attributed to a lack of awareness regarding the significance of project-based learning and the developmental benefits it offers to learners (Sanders, Epstein, & Connors-Tadros, 2016). Such overinvolvement not only diminishes the authenticity of learners' work but also hinders the intended learning outcomes of PBL.

To address these challenges, there is a pressing need to foster improved communication channels between teachers and parents. Providing parents with clear and comprehensive information about the principles and advantages of PBL is essential (Milloy, 2017). This knowledge empowers parents to actively support and guide their children's engagement in these learning experiences. Additionally, workshops or informational sessions can be organized to enhance parents' understanding of the collaborative and inquiry-based nature of PBL, fostering a supportive environment for learners' project involvement.

2.2.11 Strategies for Improving Project-based Learning

Project-based learning (PBL) is an innovative approach that promotes learner engagement, critical thinking, and problem-solving skills. However, effectively implementing PBL in the classroom requires careful planning and support. In this

essay, we will explore a range of strategies recommended by Aldabbus (2018) to improve the practice of PBL. These strategies encompass creating a supportive culture, providing professional development opportunities, engaging parents, integrating various approaches, designing an authentic curriculum, allocating budgets, showcasing learner work, recognizing achievements, fostering teacher collaboration, promoting cross-curricular integration, and utilizing effective assessment tools.

1. Creating a Supportive Culture:

To cultivate a culture of PBL within schools, it is essential to organize workshops, seminars, and training sessions. These events serve as platforms to disseminate PBL principles, share best practices, and inspire teachers to embrace this innovative approach (Aldabbus, 2018). By creating a supportive culture, schools can foster an environment where PBL thrives and is embraced by educators, learners, and administrators.

2. Professional Development Opportunities:

Teachers require in-service training to effectively implement PBL. Professional development programs should be designed to equip educators with the knowledge and skills necessary to design and facilitate engaging PBL experiences. Providing teachers with professional development opportunities is essential for enhancing their understanding and implementation of PBL (Johnson & Johnson, 2004). Teachers benefit from participating in training programs that provide access to internet resources, coaching support, and opportunities for collaboration (Miller, 2017; Ravelle, 2019; Paskevicius & Bortolin, 2016). It is crucial to provide ongoing support, coaching, and relevant feedback to teachers as they implement PBL in their classrooms (McKeown et al., 2019; Bowe & Gore, 2017). Training teacher leaders first and then having them facilitate smaller professional development sessions can

efficiently train a large number of teachers (Baghoussi & El Ouchi, 2019; Maaß, 2018).

3. Engaging Parents:

Parents play a crucial role in supporting PBL. It is important to communicate with parents and help them understand the value of PBL in fostering critical thinking, problem-solving, and collaboration skills. Regular parent-teacher meetings, workshops, and informative sessions can bridge the communication gap and encourage parental involvement in supporting their children's PBL experiences (Mergendoller, 2018). When parents are well-informed and engaged, they can provide additional support and reinforce the skills and knowledge developed through PBL.

4. Integration of Approaches:

PBL should be taught alongside other inquiry-based approaches, such as problem-based learning, inquiry-based learning, and task-based learning. Integrating these methodologies offers a comprehensive learning experience that combines real-world problem-solving with independent and collaborative learning. This integration allows learners to develop a broader range of skills and prepares them for future challenges (Helle et al., 2006). By integrating different inquiry-based approaches, educators can provide learners with a well-rounded and balanced learning experience.

5. *Designing an Authentic Curriculum:*

An authentic curriculum is essential for successful PBL implementation. The curriculum should be designed to align with PBL principles and offer opportunities for learners to explore real-world problems, conduct meaningful investigations, and develop innovative solutions. By aligning the curriculum with PBL, educators can create cohesive learning experiences that foster deep understanding and practical application of knowledge (Larmer et al., 2015). An authentic curriculum enhances

learner engagement and motivation in PBL.To address concerns related to social loafing, it is important for teachers to establish clear expectations and individual accountability within group projects. Lee and Lim (2012) suggest implementing strategies such as individual assessment components, peer evaluations, and group reflection activities to mitigate social loafing and ensure that each learner actively participates and contributes to the project.

6. *Differentiated instruction*

For learners with learning difficulties, teachers should provide differentiated support and accommodations to ensure their inclusion and success in PBL activities. This may involve scaffolding tasks, providing additional resources or guidance, and offering targeted interventions to address specific learning needs (Filippatou & Kaldi, 2010). Collaboration with special education teachers or support staff can also be beneficial in designing inclusive PBL experiences.

7. *Professional Development and Training Programs*

To enhance teacher preparedness for PBL implementation, professional development and training programs should be provided. Sunyoung Han et al. (2015) highlight the importance of equipping teachers with the necessary knowledge, skills, and resources to effectively implement PBL. Training programs can focus on understanding the key principles of PBL, developing project design and facilitation skills, and providing ongoing support and collaboration opportunities. By investing in teacher preparation, schools and districts can ensure that educators feel confident and competent in implementing PBL approaches.

8. *Informal Learning.*

Informal learning which takes place in the workplace, plays a significant role in professional development. Unlike formal training, informal learning is contextually

relevant and addresses the specific challenges that arise during the implementation phase (Lecat, Raemdonck, Beausaert, & März, 2019). Teachers engage in informal learning throughout their daily work, acquiring new knowledge that influences their teaching practices. Informal learning occurs through various activities such as discussions with colleagues, sharing strategies, conducting individual research, and reflecting on practice. Teachers should have the opportunity to discuss their informal learning experiences while benefiting from formal professional development (Sefton, 2018). The knowledge gained through informal learning is often as valuable as structured training. Ongoing collaboration among teachers enables the sharing of information and strategies, leading to improved implementation of practices like project-based learning (PBL) and increased self-efficacy (Kyndt et al., 2016). Informal learning can manifest in different ways, including hands-on learning, exchanging ideas with peers, reflecting on practice, and trial and error. These activities can take place before, during, or after formal training sessions. While formal training is typically prescribed by districts or administrators, teachers often supplement it with informal activities to enhance their knowledge and implementation skills (Sefton, 2018).

9. *Teacher Commitment*

Sustaining teacher commitment to innovative strategies and initiatives can be challenging due to the demanding nature of these approaches (Odongo & Davidson, 2016). Commitment plays a crucial role in successful implementation, as teachers must remain dedicated to the process despite the challenges. Without commitment, teachers may abandon the implementation process altogether (Zalles & Manitakos, 2016). Teacher perception also influences commitment to implementation. Teachers must approach new strategies or initiatives with an understanding of the expected

benefits (Zalles & Manitakos, 2016). Additionally, teachers need to possess deep knowledge of the content they are expected to implement to validate their work. Shallow knowledge leads to superficial commitment. Belief in the usefulness and positive influence of the initiative further strengthens teachers' commitment (Martinez, 2016).

10. Use of Technology in PBL

Technology plays a vital role in enhancing the rigor and effectiveness of PBL. It enables a shift from teacher-led to learner-led instruction by transforming how learners interact with information. Technology fosters authenticity as learners can access resources beyond the classroom, becoming independent learners responsible for their own questions, answers, and research (Shukie, 2017). It empowers learners to connect with the process of inquiry and problem-solving. Improved collaboration is one of the significant contributions of technology to PBL implementation. Learners gain better access to resources and instructional materials, enhancing their ability to collaborate even outside the classroom (Dumitrache & Gheorghe, 2018). Technology enables teachers to create more rigorous and intricate projects that engage learners in authentic learning experiences. It also equips learners with essential 21st-century skills, enhancing their ability to use online resources effectively (Alharbi, Athauda, & Chiong, 2018).

2.3 Conceptual Framework

The framework presented highlights the interplay between various variables that directly or indirectly impact the implementation of project-based learning (PBL) in mathematics instruction. When teachers effectively utilize PBL, it not only enhances their teaching methods but also improves learners' learning outcomes in mathematics. However, the effectiveness of PBL implementation is influenced by several factors,

including teachers' perceptions, instructional strategies, and challenges confronted. Therefore, the provision of a support system becomes crucial to assist teachers in utilizing PBL effectively in their mathematics classrooms and enhance the overall implementation of this instructional approach.

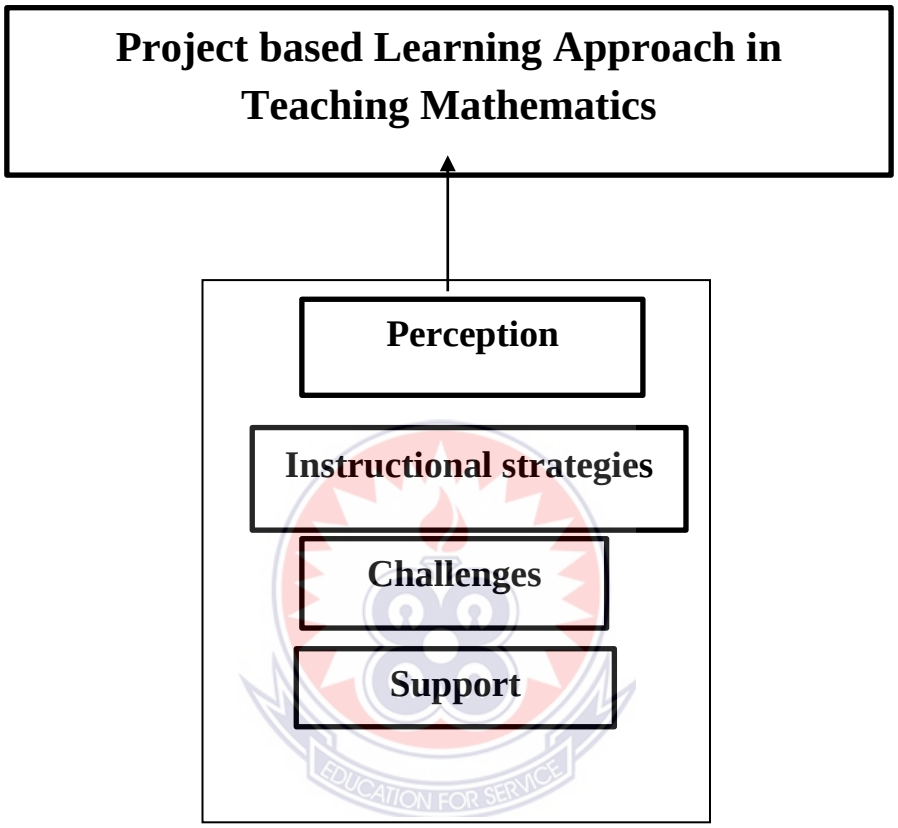


Figure 1: Conceptual Framework

Conceptual framework showing the implementation of project-based learning among JHS mathematics teachers in the Nadowli-Kaleo District.

(Source: Researcher's Own construct, 2023)

Teachers' perception of PBL plays a significant role in its successful implementation. For instance, research by Van Rens, Pilot, and Van Boxtel (2017) examined teachers' perceptions of PBL in mathematics education. The study found that teachers who held positive attitudes towards PBL were more likely to implement it effectively in their instruction. Conversely, teachers with reservations or

misconceptions about PBL may face challenges in its implementation. Addressing these perceptions through professional development and support can contribute to improved implementation.

Teachers' practices also influence the successful integration of PBL in mathematics instruction. For example, a study by Hmelo-Silver, Duncan, and Chinn (2007) examined how teachers' instructional practices influenced the effectiveness of PBL in mathematics classrooms. The findings indicated that teachers who provided scaffolding and guidance throughout the PBL process were more successful in facilitating learners' mathematical learning. On the other hand, teachers who solely relied on learners' self-directed exploration without appropriate support encountered challenges in achieving desired learning outcomes. Therefore, professional development programs should focus on equipping teachers with effective instructional strategies and pedagogical approaches for PBL implementation.

Challenges faced by teachers can also impact the implementation of PBL in mathematics instruction. These challenges may include time constraints, limited resources, and assessment-related concerns. For instance, a study by Kolodner et al (2003) explored teachers' experiences with implementing PBL in mathematics classrooms. The findings revealed that time constraints and concerns about aligning PBL with standardized assessments were common challenges faced by teachers. Addressing these challenges requires providing teachers with necessary resources, time allocation, and assessment strategies that align with the goals of PBL.

To enhance the implementation of PBL in mathematics instruction, a support system should be established. This support system can include professional development opportunities, collaboration platforms for sharing best practices, and ongoing mentoring and coaching. For instance, a study by Blomhøj and Kjeldsen

(2011) examined the impact of teacher collaboration on PBL implementation in mathematics. The results showed that collaborative professional development activities, such as lesson study and joint planning, significantly enhanced teachers' implementation of PBL. Additionally, ongoing support from instructional coaches or mentors can help address individual teachers' needs and challenges during the implementation process.

2.4 Empirical Review

Project based learning has received much attention in literature. Several studies have also confirmed how beneficial project-based learning can be for learners learning across the different school subjects. These studies have confirmed how effective project-based learning can be in multi-dimensional aspect of the curriculum.

This key role that project-based learning plays in effective mathematics instruction has draw the attention of many other educators and researchers as an avenue to find an antidote to the poor and negative attitude learners have towards mathematics yet these studies have centered on context other than Ghana. Studies in these contexts examined effect of problem-based learning in colleges of education learners, secondary school (Ibrahim and Asiedu-Addo, 2019; Wulandari, 2019; Dorr, 2017; Tucker, 2022), the comparison of project-based learning and traditional instructions (Brown, 2021). Similarly, the practice of project-based learning for motivation and promotion of 21st century skills have also been investigated (Mughrabi, 2021; Ash, 2021; Cole, 2022) as well as the perspective of project-based learning (Boyers, 2018; Bland, 2020)

For instance, Ash (2021) investigated how the use of project-based learning in mathematics can facilitate learner motivation and preparedness for life after school (21st century skills). It was found among others that using the project-based learning

increases learner motivation and preparedness for life through authentic, hands-on experiences. Hence the author recommended that project-based learning is a powerful tool that all teachers, but especially mathematics teachers can implement to increase learner motivation and engagement and provide them with authentic experiences that will provide them with understanding of the value of the skills they are learning.

Also, Dorr (2017) examined the effectiveness of project-based learning in improving second-grade learners' performance of science standards. Using action research involving 27 learners, the study found a significant improvement in the performance of second-grade learners using higher-order thinking science standards when lessons were taught using the project-based learning approach.

Brown (2021) also investigated the effect of project-based learning on learners' academic achievement in Social studies, as compared to the traditional textbook-based instructional approach. Using an experimental study 198 learners, the study found that using the project-based learning as an effective approach in teaching social studies. The results of the independent samples t-test used in the study revealed a statistically significant difference between the PBL treatment group and the traditional textbook-based comparison group on social studies achievement.

A gap is also found in the subject area thorough which the project-based learning was investigated where most of these foreign studies centered on English language. Among these are the integration and implementation of project-based learning in English language; speaking and writing other than mathematics (Angelina, 2020; Aldabbus, 2018; Guo, 2020; Philen, 2016; Kanigolla, 2013 Kalabzová, 2019).

For instance, Dorr (2017) investigated the challenges that might occur during the application of PBL in actual classroom situation in some Bahraini Primary Schools. A total of 24 pre-service teachers in 8 schools took part in this study during the academic year 2016/2017. The findings of the study revealed that more than 3/4 of the participants were unable to implement PBL with their learners. The various challenges they encountering were also identified. These included choosing a significant content, time management, monitoring and assessment, and lack of facilities.

Similarly, Kalabzová (2019) investigated the application of project-based learning in the English classrooms. It explores the genuine works of fifteen English teachers and their experiences with the PBL execution. The research focuses on listing the problematic areas that were considered troublesome by the teachers. The results of the research present eight major problematic themes and subsequently their subthemes that confirm the need of careful preparation for PBL and propose what fields English teachers should concentrate on when preparing learners for PBL stages. The results also reveal that teachers should not to underestimate PBL time management and the decrease of initial motivation.

In the Ghanian context, studies on project-based learning are skewed towards the **e**ffect of problem-based learning in colleges of education learners (Ibrahim & Asiedu-Addo, 2019), the effectiveness on pre-service teachers in Ghana (Boye & Agyei, 2023), and on the acquisition of agricultural knowledge and skills (Ananga, 2013).

For instance, Ibrahim and Asiedu-Addo investigated the effect of project-Based Learning on Colleges of Education learners' achievement in, and attitude toward Probability in Tamale Metropolitan of Ghana. Using a quasi-experimental of

100 learners, the results indicated that there was a statistically significant difference between learners of the experimental group exposed to project-Based Learning approach and control group exposed to Traditional Method. Problem-again, it was found that the project-based learning developed learners critical thinking, good problem solvers and self-directed learners which would lead to life-long memory of Probability concepts and its applications to real-life situations.

The case is even worse in the upper west Region, where accessible related studies is only found on the activity-based learning (Nudzor et al, 2015). In this study, the author examined how teachers in the northern region of Ghana practice activity-based learning (ABL) in public basic schools. Using teachers, headteachers, director of education in four districts, the study found that in almost all the schools and classrooms the authors visited, essential ingredients of activity-based learning such as the display of learners' work in classrooms, organisation of the seating arrangements of learners in groups, use of teaching and learning materials, formative assessment and activity-oriented lessons among others were missing owing to congestion and lack of furniture and logistics.

The findings of the study confirm the numerous challenges teachers in the various district of the Upper West region, especially the Nadowli-Kaleo District, face in teaching, with particular emphasis on mathematics. It further suggests the use of activity-based approaches such as the project-based learning may be lacking in the Northern Region of Ghana, of which the Nadowli-Kaleo District is no exception. The researchers attest to this finding through the personal observation made in the school of practice. The researcher observed how teacher mostly use the talk and chalk approach to the teaching of mathematics especially at the JHS level. This prompted

the researcher to further explore how teachers are implementing the project-based learning in their mathematics lessons.

The unpopularity of activity-oriented lessons among teachers in the Nadowli-Kaleo District coupled with the limited studies conducted on the problem in the Ghanaian context necessitated this study. Furthermore, the absence of a study on project-based learning in the the Nadowli-Kaleo District which is notable for poor academic performance in mathematics, meant that something needed to be done about the problem. Hence the researcher decided based on the literature and personal sentiment of poor academic performance in mathematics to investigate how JHS mathematics teacher implement such as a modern approach as project-based learning in teaching mathematics in the Nadowli-Kaleo District.

2.5 Summary of Literature Review

In conclusion, this chapter of the study has provided a review of selected research and literature. The literature review reported the view of scholars on the concept of project-based learning, its pioneers and contributions, the importance, as well as the stages or features of project-based learning. Also, teacher's perspective, implementation, challenges and strategies for enhancing the implementation of project-based learning were examined.

A conceptual framework was also used to illustrate the relationship among the variables in the study. The framework explains how the various variables have direct or indirect relationship on the implementation of the project-based learning in mathematics instruction. The diagram shows that when teachers effectively use the project-based learning, it leads to improvement in how learners also learn mathematics. However, effective use of project-based learning is also influenced by other factors such the teachers' own perception, practice and challenges. There is

therefore the need for support system to be provided for teachers in using the project-based learning in their mathematics classroom to enhance the implementation of the approach.

Lastly, several empirical studies were equally examined. The review of these studies showed that though the problem has received much attention, its focus is on contexts other than Ghana, with the majority of these studies skewed towards the effect of problem-based learning. In the Ghanaian context, studies on project-based learning are skewed towards the **e**ffect of problem-based learning in colleges of education learners with none conducted in the Nadowli District. Studies in the District have rather examined how teachers in the Northern Region of Ghana practice activity-based learning (ABL) in public basic schools.

The review has shown that learners become engaged when they are involved in the way the learning takes place through problem-based learning as they enjoy the collaboration with their peers, the authentic real-world connection of the projects, and the rich discussions in a tolerant environment (Virtue & Hinnant-Crawford, 2019).

It was again realized from the review that the use of the project-based learning may be lacking in the Northern Region of Ghana, of which the Nadowli-Kaleo District is no exception. This prompted the researcher to further explore how teachers are implementing the project-based learning in their mathematics lessons.

CHAPTER THREE

METHODOLOGY

3.0 Overview

This chapter presents the methodology employed in the conduct of the study. It discusses the research design, population and sampling procedures adopted in the study. The chapter also delved into the instrumentation and its validity and reliability. The data collection procedures, data analysis as well as the ethical principles that were ensured are also some of the issues discussed under this chapter.

3.1 Research Paradigm

In explaining what a research paradigm is, Cohen, Manion and Morrision (2017) opined that the paradigm forms the philosophical or motivation for undertaking a study. In this study, the objectives that were set to guide the researcher in examining the implementation of project-based learning in teaching mathematics among JHS teachers in the Nadowli-Kaleo District, necessitated the use of the positivist research paradigm. Alharahsheh and Pius (2020) argued that the positivism hang on quantifiable interpretations that lead themselves to statistical analysis. According to Saunders, Lewis and Thornhill (2015), the positivist research paradigm is of the belief that the reality of what is obtaining in a phenomenon can only be accurate and concluded on when the phenomenon's influencing constructs are subjected to numeric significances. This means that researchers of the positivist tradition assume that reality is "out there" (i.e. external and independent of the researcher) and therefore it can be accessed through natural scientific means (Cohen et al, 2017).

This study therefore assumes the perception, practice and challenges of project-based learning in teaching mathematics among the JHS teachers in the Nadowli-Kaleo District, are social reality existing out there that could be investigated through the scientific approach. Hence, the researcher set out to investigate this reality using scientific instrument in the form of structured questionnaire and observation checklist that was numerically statistical analysis to yield numeric significances.

3.2 Research Approach

Positivism is often associated with quantitative research method. This suggest that researcher who subscribe to the positivist paradigm are seen as adopting quantitative approach to research. Accordingly, this study adopted the quantitative approach. A quantitative research approach is a research approach in which assertions about a research phenomenon are quantified numerically (Hair et al., 2016). Contributing to the discourse, Blumberg, Cooper and Schindler (2016) argue that a quantitative research method is designed with structured and close-ended enquiries whose assertions are subjected to a measuring instrument or device with numerical variables.

In this study, the perception, practice and challenges of project-based learning in teaching mathematics among the JHS teachers in the Nadowli-Kaleo District, were measured using a questionnaire and subjected to statistical analysis. Hence, this use of the quantitative approach was justified in this context.

3.3 Research Design

Research designs are also set of guidelines and instruction that are followed in conducting research (Creswell, 2014). The choice of research design for a particular study is based on the purpose of the study (Cohen, Manion & Morrison, 2017). Therefore, research design could be described as a blueprint that guides a researcher

in the process of collecting, analyzing and interpreting data. This study employed descriptive survey design.

Survey design is a quantitative approach and is sometimes called the scientific method, or doing science research. It is also called positivist/ postpositivist research, empirical science, and post positivism. This is called post-positivism because it represents the thinking after positivism, challenging the traditional notion of the absolute truth of knowledge (Gibson et al., 2014) and recognizing that we cannot be positive about our claims of knowledge when studying the behavior and actions of humans.

Cohen et al. (2017) suggest that cross-sectional surveys employ any mode of data collection including telephone interviews, face-to-face interviews, and questionnaires. Therefore, the choice of this design was based on the view that it allows for mixing both quantitative and qualitative data because one approach has limitations in providing complete answers to issues. The descriptive research design makes possible the prediction of the future on the basis of findings on prevailing conditions. Descriptive survey design gives a better and deeper understanding of a phenomenon which helps as a fact-finding method with adequate and accurate interpretation of the finding. The descriptive study systematically describes a situation, problem, phenomenon, service or programme, or provides information about, say, the living conditions of a community, or describes attitudes towards an issue. The main purpose of descriptive studies is to describe what is prevalent with respect to the issue or problem under study (Kumar, 2011).

However, the researcher also acknowledges the limitations of descriptive survey as a design. Among these is the inability to ask probing questions as well as seek clarifications, inability to determine the conditions under which the respondent

responded to the questionnaire items as well the ability to generate high unresponsive rate as suggested by Sarantakos (2013).

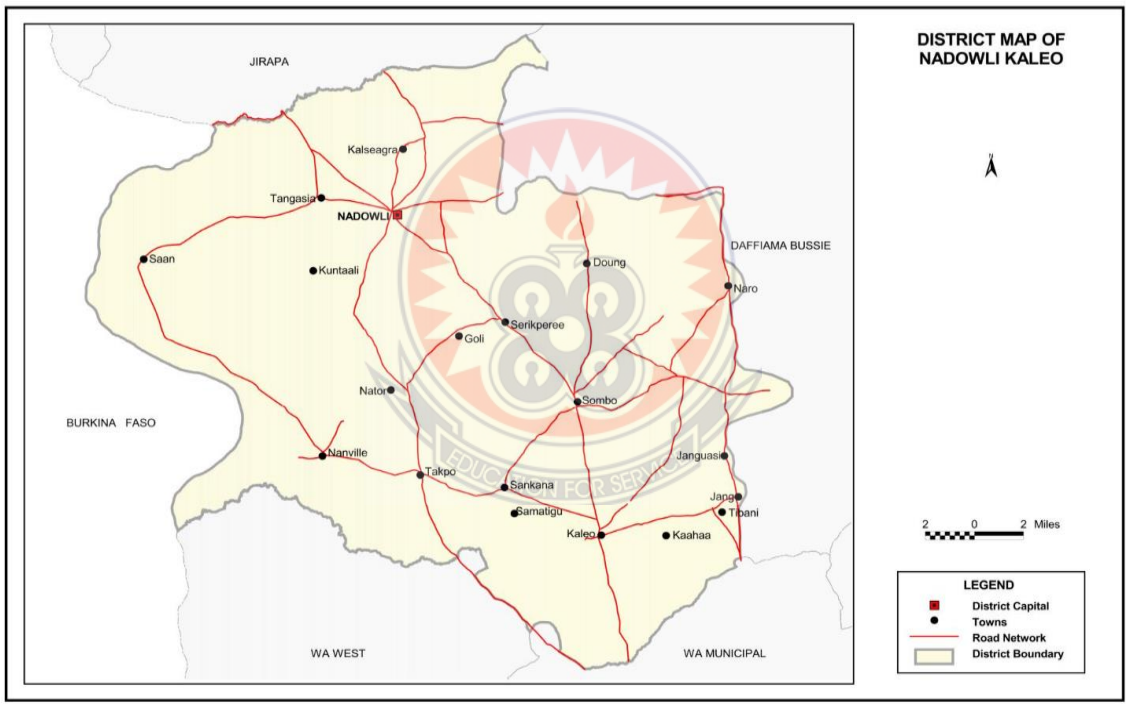
In this study, the survey was an appropriate design since it helped to answer the stated research questions and achieve the objective of this research. The survey was also chosen because its strength in this research outweighs its weakness hence it is suitable for this study. Another justification for the adoption of descriptive survey design is that it helps to gather data at a particular point in time with the intention of describing the nature of existing condition or identifying standards against which existing conditions can be compared or determining the relationship that exist between specific events (Cohen, Manion & Morrisson, 2017). Again, there is greater anonymity associated with surveys and the fact that it also provides consistent and uniform measures and respondents are not affected by the presence and or attitudes of the researcher (Sarantakos, 2013). Lastly, survey was chosen based on its ability to provide descriptive, inferential and explanatory information that can be used to ascertain correlations and relationships between the items and themes on the implementation of the project-based learning in their mathematics lessons among JHS teachers in in the Nadowli-Kaleo District.

3.4 Study Area

The study was conducted in public Junior High Schools in Nadowli-Kaleo District of the Upper West Region of Ghana. Nadowli-Kaleo District is one of the eleven administrative districts of the Upper West Region of Ghana. It was formerly part of the Nadowli District until it was split into 2 districts. According to statistics from the Nadowli-Kaleo District Education Office (2023), the District has a total of two hundred and twenty seven (227) educational institutions comprising; Eighty nine (89) Kindergarten Schools, eighty-four (84) Primary Schools, forty-six (46) Junior

High Schools, One (1) Technical/ Vocational School, Five (5) Senior High Schools, one (1) special school and one (1) College of Education. Out of the above, there thirteen (13) private educational institutions comprising seven (7) Kindergarten Schools, Five (5) Primary Schools and One (1) Junior High School. These schools are spread across ten (10) circuits, in the district. namely, Charikpong, Jang, Kaleo, Nadowli, Nator, Sankana, Kalsegra, Sombo, Takpo and Naro. The map of the District is shown as follows;

Figure 2: Map of Nadowli-Kaleo District



3.5 Population

Kusi (2012) defines a population as a group of individuals or people with the same characteristics as the researcher and in whom the researcher is interested. The population for this study comprised of all mathematics teachers in the junior high schools within the Nadowli-Kaleo District. The population was discussed under target and accessible population. The target population for the study consisted of all junior high school mathematics teachers in the Nadowli-Kaleo District. The accessible

population were therefore all the public and private Junior High Schools mathematics teachers in the Nadowli-Kaleo District.

3.6 Sample

A sample, as defined by Alvi (2016), refers to a smaller group of individuals selected from a larger population for the purpose of investigation. Kothari (2015) further explains that a sample typically comprises representative cases chosen from a target population on which a study is conducted. A sample of all 77 Junior High Schools mathematics teachers in the Nadowli-Kaleo District was be used for the study. This sample was chosen because the infrequent use of project-based learning was informally observed among the junior high school teachers and since the number of JHS mathematics teachers within the Nadowli-Kaleo District was limited, using all the teachers will provide a more comprehensive view of the implementation of the project-based learning in teaching JHS mathematics within the district.

3.7 Sampling Technique

This study used census frame and purposive sampling techniques. The census frame was used to select all 77 public Junior High School mathematics teachers in the Nadowli-Kaleo District for the questionnaire administration.

The rationale for opting for a census sampling technique was due to the relatively limited number of JHS mathematics teachers in the district, aligning with the recommendation of Tourangeau et al. (2014) that census sampling is particularly effective when the study population is not extensive. By adopting a census approach, the study aimed to achieve a comprehensive understanding of the perceptions, instructional strategies, and challenges faced by every mathematics teacher in the district. Again, the number of JHS mathematics teachers was a manageable size of the population of interest, in the Nadowli-Kaleo District. Additionally, census sampling

ensured that every teacher was accounted for in the study, mitigating sampling bias and enabling a thorough investigation of the perceptions and practices related to project-based learning. Finally, the geographical scope of the study area, being limited to the Nadowli-Kaleo District, further supports the suitability of census sampling in providing an exhaustive representation of the population.

Conversely, the purposive sampling technique was applied in the selection of 10 mathematics teachers for classroom lesson observation. In selecting the ten teachers, the researcher selected one teacher with the highest teaching experience in mathematics, from each of the ten circuits in the Nadowli-Kaleo District. In doing this, the researcher first selected 3 teachers who reported on their questionnaire, highest level of mathematics experience from each of the ten circuits. Then, out of this number, teachers who were available for observation on the day of the observation were used. The choice of the initial 3 teachers from each of the circuits was to overcome unexpectedly absence of the teachers on the day of the observation such that in the absence of a teacher, another with equivalent level of mathematics experience could be used as replacement. As posited by Etikan et al (2016), purposive sampling involves selecting participants with characteristics relevant to the study but distributed across a wide spectrum. In the context of this study, purposive sampling allowed for the selection of teachers with high teaching experience and with more exposure to varied instructional strategies in mathematics.

3.8 Research Instrument

In order to examine the implementation of the project-based learning in their mathematics lessons among JHS teachers in in the Nadowli-Kaleo District, two principal instruments were used for collecting data for the study: structured questionnaire and observation checklist.

1. Structured Questionnaire

According to Kusi (2012) a structured questionnaire contains predetermined standardize questions or items meant to collect numerical data that can be subjected to statistical analysis. The items on the questionnaire were self-constructed by the researcher with assistance from the researcher's supervisor. The researcher initially consulted and reviewed previous work on project-based learning. After a comprehensive examination of the literature and earlier research on this, the researcher extracted key ideas from these studies and formulated them into appropriate statements aligned with each of the research questions. As a result of this process, a structured questionnaire was self-developed, guided by the research objectives and the insights gleaned from the literature review.

In this study, a questionnaire was used because it is advantageous to use whenever the sample size is large enough to make it uneconomical for reasons of time or funds to observe or interview every subject. Again, with questionnaires, large amounts of information can be collected from a large number of people in a short period of time and in a relatively cost-effective way as suggested by Creswell, 2013). The results of the questionnaires can usually be quickly and easily quantified by either a researcher or through the use of a software package, can be analyzed more 'scientifically' and objectively than other forms of research instruments. This is because positivists believe that quantitative data can be used to create new theories and/or test existing hypotheses (Creswell, 2013).

Again, Dampson and Mensah (2014) on their part suggested that, in order to gather information about respondents (learners and teachers) opinion on how far they agree or disagree on a statement given, the questionnaire is the ideal instrument. For these reasons, a structured questionnaire was used to gather to examine the

implementation of the project-based learning in their mathematics lessons among JHS teachers in in the Nadowli-Kaleo District. Items on perception of project-based learning were adapted from Boyers (2018) and Bland (2020). Also, items on instructional strategies and challenges were adapted from Aldabbus (2018). Lastly, items on support needed were self-developed from the recommendations made by previous studies (Boyers, 2018; Aldabbus, 2018).

The structured questionnaire consisted of five sections, each addressing the research questions formed. It was a five-point Likert scale questionnaire that incorporated closed-ended questions on mathematics teachers project-based learning strategies. The questionnaire consisted of forty-five items on the implementation of project-based learning. Section A consisted of four (7) items collecting information with regards to respondents' biographical data. Personal information such as gender, age, highest qualification, the years of teaching mathematics and the number of in-service trainings on mathematics attended. Section B consisted of eleven (11) closed ended questions which sought to examine the perception of JHS Matematics teachers in the Nadowli-Kaleo District regarding the use of project-based learning in teaching mathematics. Section C consisted of items thirteen (13) items which sought to find the instructional strategies that JHS mathematics teachers in the Nadowli-Kaleo District use in implementing project based learning in their lessons. Section D, consisted of eleven (11) items which sought to find out the challenges that JHS mathematics teachers in the Nadowli-Kaleo District face in implementing the project-based learning in their lessons. Finally, Section E, which is the last part of the questionnaire, consisted of ten (10) items which sought to find the kind of support needed by JHS mathematics teachers in the Nadowli-Kaleo District in implementing the project-based learning in their lessons.

Sections B, D and E were also rated based on a five-point Likert scale, where 1 = strongly Disagree, 2 = Disagree, 3 = Undecided, 4 = Agree, and 5 = Strongly Agree. Sections C was rated based on a five-point Likert scale, where 5 = Always, 4 = Often, 3 = Sometimes, 2 = Rarely and 1 = Never. Every section of the questionnaire began with specific instructions as to the intent of the items as well as how to respond to items in that section. Respondents were required to carefully read each statement and answer it as accurately as possible by putting a ring (◌) around a number that best describes your view on each of the items on the questionnaire.

2. Classroom Lesson Observation Checklist

To validate the responses provided by JHS teachers in the Nadowli-Kaleo District regarding the implementation of project-based learning in their mathematics lessons, the researcher conducted classroom lesson observations involving ten (10) teachers. The study employed a structured non-participant observation checklist designed to systematically monitor and describe the extent to which teachers put project-based learning into practice during their lessons. As Mulhall (2013) suggests, lesson observation serves as an invaluable tool for obtaining a comprehensive understanding of social phenomena, particularly the behavior of learners in a classroom setting. Leveraging this approach allowed the researcher to discern the actual implementation of project-based learning, focusing on the behaviors of both teachers and learners, as well as the interactions between them, a construct best studied through naturalistic observation. The observations were conducted after the entire questionnaire administration was successfully and had been retrieved by the researcher for insights. The entire observation process started on 1st November, 2023 and was completed on 27th November, 2023 with each observation session spanning a single lesson period of 30 minutes.

In so doing, this checklist helped to validate responses provided by teachers regarding their implementation of project-based learning in their mathematics lessons. The observation checklist had two distinct sections, A and B. Section A gathered essential data on teacher information, including gender, class, lesson topic, circuit, and the observation date. Meanwhile, Section B comprised sixteen (16) items organized into four (4) subheadings: teacher's instructional strategies, learner engagement, classroom assessment and feedback, and challenges. Notably, the subheadings of teachers' instructional strategies and challenges each encompassed five (5) items, while learner engagement and classroom assessment included three (3) items each.

3.10 Validity and Reliability of the Data Collection Instrument

3.10.1 Validity

According to Yakubu (2015), validity of a measurement tool has to do with the degree to which the tool measures what it claims to measure. Through the measure of validity, the researcher is assured of the usefulness and dependability of the instrument. Oluwatayo (2012) adds that validity is defined as the ability of the research instrument to measure what it is intended to measure.

Several measures were put in place to ensure that the instrument used in the study was valid. First, in order to determine the content validity of the questionnaire, the researcher presented the drafts to his supervisor at the Department of Basic Education, University of Education, Winneba) to assess the items to be sure the statements actually measured the perceptions and implementation of project-based learning. Also, copies of the drafts were given to other mathematics lecturers to examine the face validity of the questionnaire in terms of typographical mistakes, ambiguities, grammatical errors and these were incorporated in putting the instrument

to shape before the actual data collection. Lastly, the researcher also gave copies of the drafted questionnaire to other colleagues to go through for similar errors and mistakes before finally administering the instrument. Issues such as length of the items and general format of the questionnaire were some of the concerns of which the researcher addressed in the final draft.

3.10.2 Reliability

The concept of reliability deals with the likelihood of obtaining the same or similar results when the instrument measures the same variables more than once, or when more than one person measures the same variable as opined by Noble and Smith (2015). Yakubu (2015) further defines reliability as a "measure of consistency of research instruments to obtain the same result with the same measure" (p. 63).

In ensuring reliability, the questionnaire was pilot-tested and modified before the actual research was carried out. To determine the reliability of the questionnaire used in this study, the internal consistency of the items was established. This was done using data collected in a pilot study involving 25 mathematics teachers in the Daffiama-Bussie-Issa District, a district that shares boundaries with the Nadowli-Kaleo District to the East, and has comparable environmental conditions in terms of school and classroom settings, as well as learner-teacher ratios.

After the pilot test, several issues came up with the instrument which warranted changes in the final instrument. For instance, the first draft of the questionnaire had 54 items, but after the pilot test, this was reduced to 46 items. This was due to the detection that some questions were ambiguous to the teachers. Additionally, the teachers complained that some items were too long to read. It was also found that other questions did not accurately reflect 'perception' as they were all positively worded. Regarding demographics, the teachers asked whether the

researcher meant years of teaching or years of teaching mathematics; hence, this item was modified to "How long have you been teaching mathematics?" All these suggestions were implemented to shape the final draft of the questionnaire.

Consequently, the reliability coefficient of the instrument was 0.763 which is greater than the generally accepted value of 0.70 (Langdridge & Hagger-Johnson, 2013). Therefore, the instrument was deemed to have the ability to generate reliable data. The reliability statistics of the instrument based on the data from the pilot test is shown on Table 3.1

Table 3.1: Reliability Results for Questionnaire Items

Variable	**No. of items**	**Cronbach's Alpha**
Perception of Project Based Learning	11	0.769
Strategies of Project Based Learning	14	0.819
Challenges of Using Project Based Learning	11	0.749
Support to improve the use of Project Based Learning	10	0.715
Overall scale	**46**	**0.763**

Source: Field data (2023)

Table 3.1 showed the reliability results for various dimensions assessed by the questionnaire in the study. The first variable, "Perception of Project-Based Learning," consisted of 11 items and demonstrated a Cronbach's Alpha of 0.697. While this value slightly falls below the commonly accepted threshold of 0.70, it still suggests a reasonable level of internal consistency. It indicates that the items probing teachers' perceptions of PBL generally align with each other.

Moving to the "Strategies of Project-Based Learning," the variable consisted of 14 items and Cronbach's Alpha of 0.819 was attained. This high value implies a strong correlation among the items related to the strategies employed in PBL.

The third variable, that examined the "Challenges of Using Project-Based Learning," comprised 11 items and exhibited a Cronbach's Alpha of 0.749, signifying good internal consistency. This meant that the items related to challenges faced in implementing PBL reliably measured the intended construct, demonstrating a strong interrelation among these items.

Similarly, in terms of "Support to Improve the Use of Project-Based Learning," which had 10 items, the variable yielded a Cronbach's Alpha of 0.715, indicating a satisfactory level of internal consistency.

Lastly, considering the entirety of the questionnaire with 46 items, a Cronbach's Alpha of 0.742 was obtained. This value suggests a generally good level of internal consistency across the items on the questionnaire. This generally affirms the questionnaire's reliability in measuring different facets of the implementation of project-based learning by JHS mathematics teachers within the Nadowli-Kaleo District.

3.9 Data Collection Procedures

The data collection process commenced with the researcher initiating the ethical clearance procedure by drafting a letter addressed to the Nadowli-Kaleo District Education Directorate. This formal request sought approval to conduct the study among junior high school teachers. Subsequently, armed with an official letter of introduction (refer to Appendix C) from the Education Directorate, the researcher visited the various junior high schools within the Nadowli-Kaleo District. At each school, permission was sought from the heads to proceed with the study.

Upon gaining approval from the school heads, the researcher focused on organizing the mathematics teachers for participation in the study. Initial interactions involved introducing the purpose and methodology of the study to the teachers, emphasizing the forthcoming data collection processes. Clear explanations were provided regarding the completion of questionnaires and the upcoming classroom observations.

To ensure a smooth and non-disruptive integration of the study into the teaching and learning environment, the researcher discussed and coordinated time schedules and appointments with the participating teachers. Some teachers, demonstrating eagerness, opted to complete the questionnaires immediately, with the researcher on standby for any clarifications. The questionnaire itself employed a rating scale of 1-5, guiding teachers to mark (√) the number that best reflected their views on each statement.

Following the questionnaire phase, a subset of ten (10) teachers was selected for subsequent classroom observations. The observations were conducted after the entire questionnaire administration was successfully and had been retrieved by the researcher for insights. The entire observation process started on 1st November, 2023 and was completed on 27th November, 2023 with each observation session spanning a single lesson period of 30 minutes. This focused observation aimed to evaluate the implementation of project-based learning in their mathematics lessons. This approach to data collection ensured a comprehensive understanding of the teachers' perspectives through surveys and an in-depth examination of their actual classroom practices through observations. By following these steps, the researcher was able to collect data within the context of junior high school teachers in the Nadowli-Kaleo District.

3.11 Data Analysis Procedures

With the aid of Statistical Products for Service Solution (SPSS) software, descriptive statistics such as frequency counts, percentages and the mean and standard deviation were used to analyse the questionnaire responses in answering the research questions as follows;

In addressing the first research question, which explored the perception of JHS Mathematics teachers in the Nadowli-Kaleo District regarding the use of project-based learning in teaching mathematics, respondents utilized a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Mean and standard deviation were computed for the analyzed ticked responses.

For the second research question, focusing on instructional strategies employed by JHS mathematics teachers, respondents rated their usage on five-point Likert scale ranging from 1 (never) to 5 (always). Mean and standard deviation were applied for the analysis, and the observational data was additionally scrutinized through frequency count and percentages.

Addressing the third research question on challenges faced by JHS mathematics teachers in implementing project-based learning, respondents used a five-point Likert scale, and the data were analyzed using mean and standard deviation. Concurrently, observational data underwent examination through frequency count and percentages.

Finally, the fourth research question investigated the support needed by JHS mathematics teachers in the Nadowli-Kaleo District for implementing project-based learning. Statements were rated on a five-point Likert scale, and mean and standard deviation were applied for data analysis.

3.12 Ethical Considerations

This research took into consideration several ethical issues. According to Kusi (2012), ethics in educational research are those issues that are related to how the educational researchers conduct themselves or their practices and the consequences of these on the people who participate in their research. Ethical issues that were considered in this study are the permission to collect data, informed consent, confidentiality, and anonymity.

1. **Permission to Collect Data**

The researcher obtained permission from the various heads of the Junior High Schools selected for the study before administering the instrument to the respondents. This was done so as not to violate any ethical rules because, it is unethical to enter into an organization or social groups to collect data without permission from the 'gate-keepers' of the organization (Kusi, 2012 citing Creswell).

2. **Informed Consent**

Participants were informed about the purpose of the study, how it will be carried out and the role they (participants) are expected to play, the kind of data to be collected and how it would be reported. This was to give the participants the choice to decide whether to participate or not to participate in the study. This kind of information was also necessary because people make decisions to participate in a study depending on the quality of information they receive about it (Kumar, 2011). It was therefore very prudent to equip participants with the needed information so as to get them to participate in the study. Respondents' consent and permission were sought before administering the questionnaire to them.

3. Confidentiality and Anonymity

Cohn, Manion and Morrison cited in Kusi (2012) explain that confidentiality means that although researchers know who has provided the information or are able to identify participants from the information given, they will in no way make the information known publicly. By this, the researcher made sure that the information provided by participants was treated with care so that it does not get to unauthorized persons who are not connected to the study in any way. The data collected from participants was also used for the purpose of the study only. These ethical issues were protected by ensuring that participants do not provide their names and addresses on the questionnaire. The researcher also ensured that information about school did not appear in the report of the study.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.0 Overview

This chapter deals with the analysis of the data and discussions of findings. The analysis was presented in two main stages. The first stage involves analysis of demographic data whereas the second stage involves the analysis of data to respond to research questions for the study. Descriptive statistical tools were used to analyze the data gathered. Specifically, simple frequency tables and percentages were used to analyzes the observational data while mean and standard deviation were used to analyze the responses of the questionnaire in answering the research questions.

4.1 Questionnaire Return Rate

Eighty (80) questionnaires, were distributed to all the Mathematics teachers within the Nadowli District and seventy-seven (77) were retrieved, representing a return rate of 96%. This return rate is in line with the recommended minimum threshold of 80% for survey research as proposed by Keding et al (2016).

4.2 Results on Demographic Information

Data were gathered from the teachers on their background information including gender, age category, highest qualification, number of years spent in teaching Mathematics as a subject as well as the number of in-service trainings on Mathematics attended. The data gathered are presented on table 4.1 as follows;

Table 4.1: Demographic Distribution of Respondents

Variables	Category	Frequency	Percent
Gender of Participants	Male	60	77.9
	Female	17	22.1
	Total	**77**	**100.0**
Age Category of Participants	20-30 Years	15	19.5
	31-40 Years	47	61.0
	41-50 Years	15	19.5
	Total	**77**	**100.0**
Highest Academic Qualification of Participants	Post Sec (Cert A)	1	1.3
	Diploma	31	40.3
	Bachelor's Degree	38	49.4
	Master's Degree	7	9.1
	Total	**77**	**100.0**
Years of Experience	1-5 years	33	42.9
	6-10 years	19	24.7
	11-15 years	18	23.4
	16-20 years	6	7.8
	21 years and above	1	1.3
	Total	**77**	**100.0**
Number of In-Service Training on Mathematics Attended	None	23	29.9
	1-2	17	22.1
	3-4	15	19.5
	5-9	11	14.3
	10 and above	10	13.0
	Total	**77**	**100.0**

Source: Field Data (2023)

Data from Table 4.1 shows the demographic profile of the JHS Mathematics teachers in the Nadowli-Kaleo District. The gender distribution indicates that 77.9% (60) of participants are males, while 22.1% (17) are females, resulting in a total

sample of 77 teachers. This reveals a very wide gender disparity, with a more males handling JHS mathematics than females in the Nadowli-Kaleo District.

In terms of age categories, the majority of respondents, 61.0% (47), fall within the 31 to 40 years range, followed by 19.5% (15) in the 20 to 30 years category and another 19.5% (15) in the 41 to 50 years category. The data also shows that a small percentage, 1.3% (1), comprises teachers aged 51 and above. This means that the majority of JHS mathematics in the Nadowli-Kaleo District are in the middle-age brackets, with the largest group aged between 31 and 40 years.

Looking at the highest academic qualification, the majority of teachers, 49.4% (38), hold a Bachelor's Degree, followed by 40.3% (31) with a Diploma, and a smaller percentage, 9.1% (7), possessing a Master's Degree. Only a negligible portion, 1.3% (1), has a Post Sec. Cert A. This data shows the prevalence of Bachelor's degree holders among JHS mathematics teachers in the Nadowli-Kaleo District.

Considering the years of experience, 42.9% (33) have 1-5 years, 24.7% (19) have 6-10 years, 23.4% (18) have 11-15 years, 7.8% (6) have 16-20 years, and 1.3% (1) have 21 years and above. The highest percentage falls within the 1-5 years category, indicating a relatively young and less experienced cohort of JHS mathematics teachers in the Nadowli-Kaleo District.

Finally, the distribution of in-service training attendance shows that 29.9% (23) attended none or 1-2 sessions, 22.1% (17) attended 3-4 sessions, 14.3% (11) attended 5-9 sessions, and 13.0% (10) attended 10 or more sessions. This suggests a varied level of participation in in-service training sessions, with a huge number of

JHS mathematics teachers in the Nadowli-Kaleo District having attended a limited number of sessions.

4.3 Analysis of Data

The data that collected in the study were analyzed based on the four (4) research questions as follows:

Research Question One: What are the perceptions of JHS Matematics teachers in the Nadowli-Kaleo District about the use of project based-learning in teaching mathematics?

This research question consisted of eleven (11) closed ended questions which sought to examine the perception of JHS Matematics teachers in the Nadowli-Kaleo District regarding the use of project-based learning in teaching mathematics. Respondents were required to tick an option that show consent on these statements considering a five-point Likert scale, where 1 = strongly Disagree, 2 = Disagree, 3 = Undecided, 4 = Agree, and 5 = Strongly Agree. The ticked responses were analysed using mean and standard deviation. The mean score was calculated with the formular; mean ($\bar{x}$) = 1 + 2 + 3 + 4 + 5 = 15/5 =3. Therefore, ($\bar{x}$) = 3 implying that for any item with a mean score of 3, this means that the respondents chose “Undecided”, while ($\bar{x}$) greater than 3 means that the majority of the respondents agreed to the statement. Similarly, mean scores less than 3 was interpreted to mean that the majority of the respondents disagreed with the statement. For the standard deviation, an obtained value below 1.0 indicates the homogeneity or similarity of the responses given to the item while a standard deviation 1.0 or above indicate the heterogeneity or variation in the responses given. The result is shown on Table as follows;

Table 4.2: Perceptions of JHS Mathematics Teachers On Using Project Based Learning in Mathematics

Statements	N	Mean	Std. Dev.	**Remarks**
Learners who learn mathematics through PBL fail in developing better social interactions.	77	1.26	0.57	Disagreed
PBL gives learners the chance to self-assess their own end products while evaluating their classmate's projects.	77	4.18	0.70	Agreed
PBL help learners to become aware of their own strengths and weaknesses.	77	4.31	0.69	Agreed
PBL provides valuable opportunities for learners to be engaged individually and in groups.	77	4.26	0.87	Agreed
PBL provides creates an avenue for learners to formulate enquiry questions, set goals and plan for real life investigations.	77	4.01	0.73	Agreed
PBL makes teachers to lose their authority in the class since they become facilitators providing learners with guidance and feedback.	77	2.72	0.57	Disagreed
PBL give motivates learners to be more independent in choosing the way to learn.	77	3.97	0.73	Agreed
PBL kills learners' motivation to be fully engaged in the process of learning mathematics.	77	1.34	0.64	Disagreed
PBL encourages learners to collaborate with each other in solving problems outside of the classroom.	77	4.47	0.64	Agreed
PBL promotes self-learning as learners become more responsible in their learning.	77	4.32	0.82	Agreed
PBL does not apply to the teaching and learning of mathematics	77	1.81	1.12	Disagreed

Source: Field Data (2023)

The data presented in Table 4.2 shed insight on the responses from Junior High School (JHS) Mathematics teachers in the Nadowli-Kaleo District regarding their perception of project-based learning (PBL) in teaching mathematics. It was revealed that teachers disagreed (M=2.26, SD=0.57) that learners who learn mathematics through PBL fail in developing better social interactions. The relatively low standard deviation indicates shared similar opinions on this statement. Also, with a mean of 4.18 and standard deviation of 0.70, teachers agreed that PBL gives learners the chance to self-assess their own end products while evaluating their classmates' projects. The standard deviation suggests varied opinions among the teachers. Similarly, an agreement was reached that PBL helps learners become aware of their own strengths and weaknesses (M=4.31, SD=0.69). The standard deviation is relatively low, indicating a consistent agreement among teachers on this statement. Moreover, teachers confirmed that PBL provides valuable opportunities for learners to be engaged individually and in groups (M=4.26, SD=0.87). The higher standard deviation suggests some variability in opinions among the teachers. Furthermore, it was agreed upon that PBL creates an avenue for learners to formulate inquiry questions, set goals, and plan for real-life investigations (M=4.01, SD=0.73). The standard deviation means that teachers somehow had consistent result.

The idea of teachers losing their authority in the class by becoming facilitators in providing learners with guidance and feedback was also rejected (M=2.72, SD=0.57) by the teachers. The low standard deviation indicates a strong and consistent agreement among teachers on the facilitative role of educators in a PBL environment. Moreover, teachers agreed that PBL motivates learners to be more independent in choosing the way to learn (M=3.97, SD=0.73). The standard deviation suggests some variability in opinions among the teachers. Additionally, the notion

that using PBL kills learners' motivation to be fully engaged in the process of learning mathematics was rejected by the teachers (M=1.34, SD=0.64). The standard deviation is relatively low, indicating a consistent response among teachers. Furthermore, on the statement that "PBL encourages learners to collaborate with each other in solving problems outside of the classroom", teachers agreed (M=4.47, SD=0.64). The low standard deviation means that the responses of the teachers were homogenous. Lastly, it was acknowledged by the teachers that PBL promotes self-learning as learners become more responsible in their learning (M=4.32, SD=0.82). The standard deviation suggests some varied responses among the teachers. In contrast, there was disagreement that PBL does not apply to the teaching and learning of mathematics (M=1.81, SD=1.12). The high standard deviation stills show a wide range of opinions among teachers regarding the applicability of PBL to mathematics education.

The data suggests that, generally, JHS Mathematics teachers in the Nadowli-Kaleo District hold positive perceptions of project-based learning in teaching mathematics. They recognized project-based learning in teaching mathematics as beneficial in encouraging collaboration (M=4.47), helping learners identify strengths and weaknesses (M=4.31), promoting self-learning (M=4.32), providing valuable individual and group engagement opportunities (M=4.26), offering self-assessment chances (M=4.18), fostering inquiry-based learning (M=4.01), motivating independence in learning (M=3.97). In contrast to this, they disagreed with all statements that portrayed the use of project-based learning as not beneficial in mathematics lessons. Accordingly, they rejected the idea of the teacher losing his/her authority in the class, (M=2.72, SD=0.57), PBL not applying to mathematics teaching (M=1.81), PBL killing learners' motivation (M=1.34, SD=0.64) as well as PBL inhibiting the development of social interactions (M=1.26).

Research Question Two: What instructional strategies do JHS mathematics teachers in the Nadowli-Kaleo District use in implementing the project-based learning in their lessons?

The second research question consisted of items thirteen (13) items which sought to find the instructional strategies that JHS mathematics teachers in the Nadowli-Kaleo District use in implementing project based learning in their lessons. The statements had options for teachers to rate their use of the various strategies using a five-point Likert scale, where 5 = Always, 4 = Often, 3 = Sometimes, 2 = Rarely and 1 = Never. The responses were analysed using mean and standard deviation. The mean score was calculated with the formular; mean ($\bar{x}$) = 1 + 2 + 3 + 4 + 5 = 15/5 =3. For the purpose of the discussion, ($\bar{x}$) = 3.0 implying that for any item with a mean score of 3.0 to 3.4, this means that the teachers chose "Occasionally used" the strategy, while ($\bar{x}$) greater than 3.5 means that the majority of the teachers "Regularly Used" the strategy. Similarly, mean scores less than 3 was interpreted to mean that the majority of the teachers "Rarely Used" that instructional strategy in lesson. For the standard deviation, an obtained value below 1.0 indicates the homogeneity or similarity of the responses given to the item while a standard deviation 1.0 or above indicate the heterogeneity or variation in the responses given. The results is presented on table 4.3 as follows;

Table 4.3 Teachers' Practice of Project-Based Learning in Mathematics

Statements	N	Mean	Std. Dev.	**Extent of Usage**
I organize my learners learning around projects works	77	3.29	0.67	Occasionally Used
I assign my learners to challenging questions or problems, that involve investigative activities.	77	3.70	0.86	Regularly Used
I assign learners to real life situation tasks involving parents and others from learner surroundings.	77	3.44	0.95	Occasionally Used
I give learners tasks that is draws on their knowledge of different subjects/ discipline.	77	3.78	0.79	Regularly Used
I set learners to tasks usually carried out in groups.	77	3.74	0.77	Regularly Used
I ensure tasks given to learners connects school with its neighbourhood, broader society and actual life.	77	3.41	1.14	Occasionally Used
I give learners the opportunity to work autonomously over extended periods of time to bring out realistic products or presentations.	77	3.49	1.14	Occasionally Used
I engage learners in a range of activities to meet the various learning needs and interests of learners.	77	4.09	0.80	Regularly Used
I ensure project work given to learners do not end up in a predefined results or take restricted paths decided in advance by the instructor.	77	3.49	1.06	Occasionally Used
I create more freedom for learners, so they can select the suitable topic, resources, responsibilities and the way they design and display their final work.	77	3.64	1.04	Regularly Used
I ensure that learners work becomes public through display/presentation.	77	3.48	1.08	Occasionally Used
I engage learners in asking questions, finding resources to answer the questions and applying the new information.	77	4.21	0.85	Regularly Used
Together with learners, I give opportunity to reflect on the work and assignment.	77	4.43	0.73	Regularly Used
I make sure feedback is given and received by learners to improve the work and tasks.	77	4.60	0.59	Regularly Used

Source: Field Data (2023)

From Table 4.3, it was revealed that in implementing the project-based learning, JHS mathematics teachers in the Nadowli-Kaleo District, teachers occasionally structured learners' learning around projects, as reflected in a mean score of 3.29 (SD=0.67). The relatively low standard deviation suggests a moderate level of consensus among teachers. Similarly, teachers occasionally incorporated investigative activities into their lessons, yielding a mean of 3.70 (SD=0.86). However, the higher standard deviation of 0.86 suggests a varying level of diversity among teachers. In the realm of real-life application, teachers occasionally integrated tasks involving real-life situations (M=3.44, SD=0.95). The higher standard deviation (SD=0.95) indicates significant variability in teachers' responses. Conversely, interdisciplinary elements found their way into assignments often, with a mean of 3.78 (SD=0.79). This indicates that teachers occasionally included interdisciplinary elements in their assignments, with a moderate level of agreement. The relatively low standard deviation reflects a consistent level of agreement among teachers.

Teachers occasionally structured tasks for collaborative group work (M=3.74, SD=0.77). The standard deviation of 0.77 indicates a moderate level of agreement among teachers on this collaborative approach. In the dimension of connecting tasks with broader society and actual life, teachers occasionally made this connection in their lessons (M=3.41, SD=1.14). The higher standard deviation (SD=1.14) indicates considerable diversity in responses of the teachers. The provision of autonomy for extended work periods received a mean score of 3.51 (SD=1.14), suggesting that teachers occasionally allowed learners autonomy. The higher standard deviation (SD=1.14) implies diverse practices among teachers. On the positive side, teachers regularly employed diverse activities to meet learning needs and interests (M=4.09, SD=0.80), with a moderate level of agreement. The standard deviation of 0.80

indicates a consistent level of agreement among teachers. Ensuring open-ended project work received a mean score of 3.49 (SD=1.06), indicating that teachers occasionally ensured project work was open-ended. The higher standard deviation (SD=1.06) suggests that teachers had varied opinions on this statement.

Similarly, creating freedom for topic selection and presentation was occasionally practiced, with a mean of 3.64 (SD=1.04). The higher standard deviation (SD=1.04) indicates varied practices among teachers. Teachers occasionally ensured the public visibility of learners' work (M=3.48, SD=1.08), showcasing diverse practices. The higher standard deviation (SD=1.08) indicates a considerable variation in its application among teachers. Moving towards more positive practices, teachers frequently involved learners in inquiry-based activities (M=4.21, SD=0.85). The standard deviation (SD=0.85) indicates a consistent level of agreement on this statement. Reflective practices were often engaged in by teachers, as indicated by a mean score of 4.43 (SD=0.73). The lower standard deviation (SD=0.73) indicates a high and more consistent level of agreement. Finally, teachers regularly ensured feedback was given and received by learners to enhance their work (M=4.60, SD=0.59), revealing a more consistent agreement. The lower standard deviation (SD=0.59) suggests a more consistent agreement among teachers in implementing this crucial feedback component.

The data revealed that JHS mathematics teachers in the Nadowli-Kaleo District regularly utilized various instructional strategies in implementing project-based learning in their lessons. It was found that 8 (57%) of the project-based strategies were used on a regular basis, including providing feedback for improvement (M=4.60), engaging learners in reflective practices (M=4.43), involving learners in inquiry-based activities (M=4.21), employing diverse activities to meet learning needs

(M=4.09), involving learners in group tasks (M=3.74), assigning learners to tasks that draw on their interdisciplinary knowledge (M=3.78), assigning challenging investigative questions or problems (M=3.70), and creating more freedom to choose topics and present their work with varied practices (M=3.64). However, 6 (43%) of these strategies, including structuring learners' learning around projects occasionally (M=3.29), assigning learners to tasks that connect with broader society and actual life (M=3.41), allowing learners autonomy over extended periods (M=3.49), ensuring project work is open-ended with diverse practices (M=3.49), and ensuring the public visibility of learners' work with diverse practices (M=3.48), were occasionally used.

Lesson Observational Data on Teachers' Practice of Project-Based Learning in Mathematics

To further confirm the responses given by these teachers on the implementation of the project-based learning in their mathematics lessons among JHS teachers in in the Nadowli-Kaleo District, the researcher conducted classroom lesson observations with ten (10) of the teachers. A structured observation checklist was designed to monitor and describe the extent to which the teachers actually implement project-based learning in their lessons. The researcher used this to augment and confirm responses provided by the teachers on their own implementation of project-based learning. Each observation lasted for a single period of 30 minutes. The results of the observation are presented in table 4.4.

Table 4.4: Observational Data on Teachers' Practice of Project-Based Learning in Mathematics

Observation Criteria	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	N (%)
Instructional Strategies Used by Teacher											
Use of tasks that draws on learner knowledge of different subjects.	√	√	√	√	√	√	√	√	√	√	10(100)
Use of tasks that connect school with the broader society.	√	√	√	×	√	√	√	×	×	√	7 (70)
Use of tasks that bring out realistic products or presentations.	√	√	√	×	√	×	×	×	√	√	6 (60)
Learners have the freedom to work and display their final work.	√	√	√	×	√	×	×	×	×	√	5 (50)
Teacher ensures that learners work becomes public through display/presentation.	√	√	√	×	√	×	√	√	×	√	7 (70)
Learner Engagement by Teachers											
Teacher assigns learners to tasks usually carried out in groups.	√	×	×	×	√	√	√	√	×	√	6 (60)
Teacher engages learners in a range of activities based on learners learning needs and interests.	√	√	√	×	√	√	√	√	×	√	8 (80)
Teacher engages learners in asking questions, finding resources to answer the questions and applying the new information	√	√	√	×	√	√	√	√	×	√	8 (80)
Teachers' Classroom Assessment and Feedback											
Teacher ensures	√	√	√	×	√	×	×	√	×	√	6 (60)

learners project work do not end up in a predefined results or take restricted paths decided in advance by the instructor.											
Teacher makes sure feedback is given and received by learners to improve the work and tasks.	√	√	√	×	√	√	×	√	×	√	7 (70)
Teacher together with learners reflect on the work and assignment	×	×	√	×	√	×	×	×	×	√	3 (30)

Keys: (√)- observed practice Present, (×)- observed practice Absent
(T1)- 1st JHS Mathematics Teacher observed

Source: Field Data (2023)

The observation data in Table 4.4 revealed the instructional strategies, learner engagement practices, and classroom assessment approaches employed by Junior High School (JHS) mathematics teachers in using the project-based learning in the Nadowli-Kaleo District. Notably, all teachers (100%) were observed utilizing tasks that draw on learners' knowledge from different subjects or disciplines, emphasizing a holistic approach to learning. However, challenges were observed in other areas, with 7 (70%) of teachers incorporating tasks connecting the school with the broader society, and only 6 (60%) ensuring tasks led to realistic products or presentations. In terms of learner engagement, 6 (60%) of teachers assigned learners tasks usually carried out in groups. On the positive side, 8 (80%) engaged learners in a variety of activities to meet diverse learning needs and interests, while 8 (80%) also encouraged learners to ask questions, find resources, and apply new information. Concerning teachers' classroom assessment and feedback, 6 (60%) of teachers were observed ensuring that learners' project work did not follow predefined results or restricted

paths. Additionally, 7 (70%) of teachers provided feedback for learners to enhance their work. However, only 3 (30%) engaged in reflective practices with learners on the work and assignments.

Through this observation, it was identified that JHS mathematics teachers in the Nadowli-Kaleo District primarily utilized instructional strategies that drew on learners' knowledge from different subjects or disciplines, with a notable 100% adoption. Additionally, 80% of teachers engaged learners in diverse activities to cater to various learning needs and interests, encouraging them to ask questions, find resources, and apply new information. Furthermore, 60-70% of teachers incorporated tasks connecting the school with the broader society, provided feedback to enhance learners' work, ensured tasks resulted in realistic products or presentations, and assigned group tasks to learners and, also in preventing learners' project work to have predefined results or restricted paths. Sadly, only 30% of the teachers engage in reflective practices with learners on their work and assignments. Hence, the project-based strategies were commonly used by the Mathematics teachers in the Nadowli-Kaleo District.

The questionnaire data and observational data provide both alignment and disparities in the implementation of project-based learning (PBL) instructional strategies by JHS mathematics teachers in the Nadowli-Kaleo District.

Aligning the teachers' responses with their actual classroom practices shows consistent use of certain strategies reported in the questionnaire, such as assigning challenging investigative questions or problems (M=3.70) and involving learners in inquiry-based activities (M=4.21), which align with the observational data indicating that all teachers (100%) incorporated tasks drawing on learners' interdisciplinary knowledge and engaged learners in a variety of activities. However, disparities

emerged in the occasional use of strategies like structuring learners' learning around projects (M=3.29) and ensuring project work is open-ended (M=3.49) in the questionnaire data. The observational data reveals that all teachers (100%) employed tasks drawing on learners' knowledge from different subjects, but only 70% connected tasks with the broader society, and 60% ensured tasks led to realistic products or presentations. Similarly, the questionnaire reports occasional use of strategies like assigning tasks connecting with broader society (M=3.41), ensuring autonomy over extended periods (M=3.49), and ensuring public visibility of learners' work (M=3.48). However, the observational data highlights that 70% of teachers incorporated tasks connecting the school with the broader society, and 80% encouraged learners to ask questions, find resources, and apply new information.

Research Question Three: What challenges do JHS mathematics teachers in the Nadowli-Kaleo District face in implementing the project-based learning in their lessons?

The third research question had consisted of eleven (11) items which sought to find out the challenges that JHS mathematics teachers in the Nadowli-Kaleo District face in implementing the project-based learning in their lessons**.** Teachers were required to tick an option that best rate their view based on a five-point Likert scale, where 1 = strongly Disagree, 2 = Disagree, 3 = Undecided, 4 = Agree, and 5 = Strongly Agree. These responses were analysed using mean and standard deviation. The mean score was calculated with the formular; mean ($\bar{x}$) = 1 + 2 + 3 + 4 + 5 = 15/5 =3. Therefore, ($\bar{x}$) = 3 implies that for any item with a mean score of 3, the teachers chose "Undecided", while ($\bar{x}$) greater than 3 means that the majority of the teachers agreed to the statement. Similarly, mean scores less than 3 was interpreted to mean that the majority of the teachers disagreed with the statement. For the standard deviation, an

obtained value below 1.0 indicates the homogeneity or similarity of the responses given to the item while a standard deviation 1.0 or above indicate the heterogeneity or variation in the responses given. The results of the data collected on this research question is presented on table 4.5 as follows;

Table 4.5 Challenges in Implementing the Project-Based Learning in Mathematics Lessons

Statements	N	Mean	Std. Dev.	Remarks
I am not sure which topic in mathematics can be taught with using project-based learning.	77	2.27	1.12	Not a challenge
My lesson period is too short to allow me to use the project-based learning in teaching	77	3.73	1.26	A challenge
Using the project-based learning approach takes more time than the other approaches.	77	3.90	1.15	A challenge
Using the project-based approach delays my lessons presentation and delivering.	77	3.76	1.08	A challenge
Using the project-based learning approach does not allow me to cover all the lessons scheduled for the day or term.	77	2.14	1.27	Not a challenge
I do not have the knowledge and confident to use the project-based learning approach.	77	2.14	1.25	Not a challenge
How to score the end product of the project is problematics for me.	77	2.16	1.09	Not a challenge
Some learners dominate the project and do not allow their mates to partake in the group work.	77	2.01	1.39	Not a challenge
Choosing a project that will meet the interest of learners becomes difficult for me.	77	2.42	1.16	Not a challenge
My school does not offer the necessary materials and facilities needed for projects learning.	77	3.84	1.38	A challenge
Parents of learners were unwilling to offer them the necessary materials to facilitate the project	77	3.90	1.40	A challenge

Source: Field Data (2023)

Data in Table 4.5 revealed that Junior High School (JHS) mathematics teachers in the Nadowli-Kaleo District faced several challenges in implementing project-based learning (PBL) in their lessons. On the matter of selecting suitable topics for PBL, teachers expressed disagreement with an average mean of 2.27 (SD=1.12), indicating a moderate concern with moderate variability. Additionally, the limited duration of lesson periods was identified as a significant obstacle, as teachers generally agreed that their lesson periods were too short to effectively incorporate PBL (M=3.23, SD=1.26), with a notable level of agreement and variability. Moreover, teachers acknowledged the time-intensive nature of PBL, with a mean of 3.90 (SD=1.15), signifying a notable consensus on the extended time required compared to other teaching approaches. Also, delays in lesson presentation and delivery due to PBL were also recognized, as indicated by a mean of 3.76 (SD=1.08), reflecting a moderate level of agreement with a high level of variability. Teachers disagreed with the challenge of covering all scheduled lessons arose (M=2.14, SD=1.27), with variability in their responses.

Furthermore, teachers expressed disagreement about their lack of knowledge and confidence in utilizing the PBL approach, as evidenced by a mean of 2.14 (SD=1.25), indicating some teachers held varied views. Scoring the end product of the project was deemed problematic for some teachers (M=2.16, SD=1.09) though the response seems varied. Issues related to learner dynamics within group work, such as dominance by some learners, received disagreement with a mean of 2.01 (SD=1.39), indicating that teachers were not sure of it, with a high level of variability. Challenges in choosing projects aligned with learner interests were rejected (M=2.42, SD=1.16), with a standard deviation showing varied responses. The inadequacy of materials and facilities in schools was recognized as a significant challenge (M=3.84, SD=1.38),

with a notable level of agreement and variability. Finally, parental reluctance to provide necessary materials was acknowledged as a noteworthy challenge, as reflected by a mean of 3.90 (SD=1.40), indicating a notable level of agreement with a high level of variability.

The analysis of the data indicates that JHS mathematics teachers in the Nadowli-Kaleo District face various challenges in implementing project-based learning, including time consuming-nature of PBL, lack of parental support, lack of necessary instructional materials, a delay in lesson delivery, and short lesson period in using project-based learning.

The obtained results were further reinforced through the lesson observation, as outlined below:

Table 4.5.1: Observational Data on Teachers' Challenges in Implementing the Project-Based Learning in Mathematics Lessons

Challenges	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**	**T9**	**T10**	N (%)
No designated place for learners' project	×	√	√	√	×	√	√	√	√	√	8 (80)
Difficulty in choosing project topic	√	√	√	√	√	×	√	√	×	×	7 (70)
Lack of instructional resources to support learners' project.	×	√	√	√	√	√	√	√	×	×	7 (70)
Lesson duration too short for learners' project.	√	√	√	√	×	√	√	√	√	√	9 (90)
Some learners dominating group project work.	√	√	√	√	×	√	×	√	√	√	8 (80)

Keys: (√)- observed practice Present, (×)- observed practice Absent

(T1)- 1st JHS Mathematics Teacher observed

Source: Field Data (2023)

Table 4.5.1 revealed that JHS mathematics teachers in the Nadowli-Kaleo District face several challenges in implementing the project-based learning in their lessons, with 8 (80%) of teachers facing issues related to designated project spaces, 7 (70%) encountering difficulties in selecting topics, and another 7 (70%) expressing concerns about instructional resource availability. Additionally, 9 (90%) of teachers noted challenges with short lesson durations, emphasizing the need for more time for meaningful exploration. Furthermore, 8 (80%) of teachers observed issues with some learners dominating group project work.

This classroom observation revealed that the most commonly observed challenge in implementing project-based learning in their lessons in the Nadowli-Kaleo District was the short lesson period (90% of teachers), followed by some learners dominating group project work (80%), lack of a designated place for learners' projects (80%), difficulty in choosing a project topic (70%), and finally, the lack of instructional resources to support learners' projects (70%).

The observational data generally aligns with the questionnaire responses, confirming certain challenges reported by JHS mathematics teachers in the Nadowli-Kaleo District. The high prevalence (90%) of short lesson periods observed corresponds with the teachers' uncertainty about whether short lesson durations were a challenge. Similarly, the significant observation (80%) of some learners dominating group project work corresponds with the teachers' uncertainty about learner dominance as a challenge or not. Furthermore, the classroom observation supports the questionnaire's indication of concerns about insufficient instructional resources, as 70% of teachers observed faced a lack of resources to support learners' projects. However, the observational data contradicted teachers' response that choosing a

project topic was not a challenge, as it was found as a challenge among 7 (70%) of the teachers observed.

Research Question Four: What kind of supports do JHS mathematics teachers in the Nadowli-Kaleo District need to implement the project-based approach in their lessons?

This final research question consisted of ten (10) items which sought to find the kind of support needed by JHS mathematics teachers in the Nadowli-Kaleo District in implementing the project-based learning in their lessons. The statements were rated based on a five-point Likert scale, where 1 = strongly Disagree, 2 = Disagree, 3 = Undecided, 4 = Agree, and 5 = Strongly Agree. The data was analysed using mean and standard deviation. The mean score was calculated with the formular; mean ($\bar{x}$) = 1 + 2 + 3 + 4 + 5 = 15/5 =3. Therefore, ($\bar{x}$) = 3 implying that for any item with a mean score of 3, this means that the teachers chose "Undecided", while ($\bar{x}$) greater than 3 means that the majority of the teachers agreed to the statement. Similarly, mean scores less than 3 was interpreted to mean that the majority of the teachers disagreed with the statement. For the standard deviation, an obtained value below 1.0 indicates the homogeneity or similarity of the responses given to the item while a standard deviation 1.0 or above indicate the heterogeneity or variation in the responses given. This data is presented below;

Table 4.6 Support Needed In Implementing the Project-Based Learning in Mathematics Lessons

Statements	N	Mean	Std. Dev.	Supports needed (in Ranks)
The culture of using PBL should be spread among schools throughout workshops, seminars and training sessions.	77	4.90	1.23	2nd
Teachers should receive in-service training on how to integrate PBL into their lessons.	77	4.56	0.53	3rd
Parents should be familiarized with the importance of PBL to support their wards' project.	77	4.26	0.72	7th
Special budget for learners' projects should be offered by school heads.	77	3.83	1.02	10th
Display area where distinctive projects can be displayed to motivate other learners should be made available to learners.	77	4.05	0.84	9th
Rewards for best projects of learners should be instituted in our basic schools.	77	4.51	0.74	4th
Schools should be provided with a standard and guidelines for assessing the process and the end product of learners' project.	77	4.27	0.76	6th
NaCCA should design and attach suitable project for each of the topics in mathematics.	77	4.98	1.94	1st
Special exhibition day for learners' mathematics project should be established in the District.	77	4.35	0.66	5th
End of term mathematics group project should form a major part of learners' assessment.	77	4.19	0.92	8th

Source: Field Data (2023)

The data presented in Table 4.6 helps to understand the kind of support preferences of Junior High School (JHS) mathematics teachers in the Nadowli-Kaleo District concerning the implementation of project-based learning (PBL) in their lessons. The responses revealed that teachers overwhelmingly supported the idea that the culture of using PBL should be disseminated among schools through workshops, seminars, and training sessions (M=4.90, SD=1.23). The relatively high standard

deviation hinted at some diversity in their opinions. In addition, teachers expressed a consensus that in-service training for integrating PBL into lessons was crucial (M=4.56, SD=0.53), with a low standard deviation indicating a high level of agreement. Moreover, there was agreement among teachers that parents should be familiarized with the importance of PBL to support their wards' projects (M=4.26, SD=0.72), with a moderate standard deviation indicating some variability in teachers' perceptions. The proposal for a special budget for learners' projects received a slightly higher mean score (M=3.83), and the standard deviation was relatively higher (SD=1.02), indicating acceptance and more varied opinions on this matter.

Teachers also agreed on the importance of providing display areas for showcasing distinctive learner projects (M=4.05, SD=0.84). The moderate standard deviation indicated some diversity in opinions regarding this aspect. Furthermore, the responses revealed a consensus among teachers on instituting rewards for the best projects (M=4.51, SD=0.74). The relatively low standard deviation suggested a high level of consensus. In terms of assessment, teachers expressed agreement on the need for standards and guidelines for assessing the process and the end product of learners' projects (M=4.27, SD=0.76), with a moderate standard deviation indicating some diversity in opinions. An exceptionally strong consensus emerged on the idea that the National Council for Curriculum and Assessment (NaCCA) should design suitable projects for each mathematics topic (M=5.18, SD=1.94). The high mean and standard deviation suggested agreement as well as some diversity in teachers' opinions. Furthermore, there was agreement among teachers on establishing a special exhibition day for learners' mathematics projects (M=4.35, SD=0.66), with a low standard deviation indicating a high level of consensus. Lastly, teachers expressed agreement on the importance of including end-of-term group projects in learner assessments

(M=4.19, SD=0.92), with a moderate standard deviation suggesting some diversity in their opinions.

The data revealed that mathematics teachers in the Nadowli-Kaleo District strongly advocate for NaCCA to design and attach suitable projects for each mathematics topic (M=5.18, SD=1.94). Additionally, they emphasize the need to spread the culture of using PBL through workshops and training sessions (M=4.90, SD=1.23), highlight the importance of in-service training for teachers on PBL integration (M=4.56, SD=0.53), and propose the institution of rewards for the best learner projects (M=4.51, SD=0.74). Moreover, they suggest the establishment of a special exhibition day for learner projects (M=4.35, SD=0.66), the provision of standards and guidelines for project assessment (M=4.27, SD=0.76), and the familiarization of parents with the significance of PBL (M=4.26, SD=0.72). Additionally, they recommend incorporating end-of-term mathematics group projects into learner assessments (M=4.19, SD=0.92), providing display areas for learner projects (M=4.05, SD=0.84), and offering special budgets for learner projects by school heads (M=3.83, SD=1.02).

4.4 Discussion of Results

Research Question One: What are the perceptions of JHS Mathematics teachers in the Nadowli-Kaleo District about the use of project based-learning in teaching mathematics?

This study found, based on the data gathered on perceptions of teachers about the use of project based-learning in teaching mathematics, that, generally, JHS Mathematics teachers in the Nadowli-Kaleo District hold positive perceptions of project-based learning in teaching mathematics. Teachers acknowledged the positive impact of PBL on various aspects of their instructional practices, including

encouraging collaboration, helping learners identify strengths and weaknesses, promoting self-learning, providing valuable individual and group engagement opportunities, offering self-assessment chances, fostering inquiry-based learning, motivating independence in learning. In contrast to this, they rejected the idea of PBL making the teacher to lose his/her authority in the class, PBL not applying to mathematics teaching, PBL killing learners' motivation, and PBL inhibiting the development of social interactions.

The positive perception held by these teachers regarding the nature and benefits of project-based learning supports the assertions of various scholars. The teachers' view of project-based learning as a collaborative activity aligns with Wallace and Webb's (2016) assertion that PBL is a collaborative process, emphasizing learners' independent research guided by the teacher to find solutions to problems. The idea that project-based learning fosters inquiry-based learning resonates with Angelina's (2020) description of PBL as an instructional method using authentic, real-world projects to teach learners academic content, encouraging cooperative problem-solving and empowering learners to pursue content knowledge independently. Furthermore, the nature of project-based learning promoting investigative learning is supported by Larmer and Mergendoller (2015), who define PBL as a teaching method in which learners investigate and respond to complex questions, problems, or challenges over an extended period. The concept of PBL casting teachers as facilitators aligns with Bell's (2010) perspective that PBL emphasizes learners-centeredness, with teachers acting more as facilitators than instructors. Bell emphasizes that learners pursue knowledge by asking questions that have piqued their natural curiosity.

These positive perceptions of project-based learning have been confirmed in previous studies. In a study by Ibrahim and Asiedu-Addo (2019) on the effect of project-based learning on learners' achievement and attitude toward Probability in the Tamale Metropolitan area of Ghana, it was found that PBL developed learners' critical thinking, problem-solving skills, and self-directed learning, leading to a lifelong understanding of Probability concepts and their real-life applications. Brown (2021) also discovered the effectiveness of using project-based learning in teaching social studies. Additionally, Ash (2021), in investigating how project-based learning in mathematics can facilitate learner motivation and preparedness for life after school (21st-century skills), found, among other outcomes, that using project-based learning increases learner motivation and preparedness for life through authentic, hands-on experiences.

Research Question Two: What instructional strategies do JHS mathematics teachers in the Nadowli-Kaleo District use in implementing the project-based learning in their lessons?

The findings of this research question indicated that Junior High School (JHS) mathematics teachers in the Nadowli-Kaleo District regularly employed a variety of instructional strategies to implement project-based learning in their lessons. Notably, 57% of the identified project-based strategies were used consistently, including providing feedback for improvement, engaging learners in reflective practices, involving them in inquiry-based activities, employing diverse activities to meet learning needs, assigning tasks drawing on interdisciplinary knowledge, assigning challenging investigative questions or problems, and allowing freedom to choose topics and present work with varied practices. However, 43% of these strategies, such as structuring learners' learning around projects occasionally, connecting tasks with

broader society and actual life, allowing autonomy over extended periods, ensuring open-ended project work with diverse practices, and ensuring public visibility of learners' work with diverse practices, were occasionally used. Observational data further supported these findings, revealing that JHS mathematics teachers primarily utilized instructional strategies that drew on learners' knowledge from different subjects or disciplines, with a notable 100% adoption rate. Additionally, 80% of teachers engaged learners in diverse activities to cater to various learning needs and interests, encouraging questions, finding resources, and applying new information. However, challenges were noted, with only 30% of teachers engaging in reflective practices with learners on their work and assignments. Hence, the study found that the project-based strategies were commonly used by the Mathematics teachers in the Nadowli-Kaleo District.

The consistent use of challenging questions in the implementation of project-based learning aligns with the essential project design elements proposed by Boss and Larmer (2018). According to their framework, seven essential features include a challenging problem or question, sustained inquiry, authenticity, learner voice and choice, reflection, critique and revision, and a public product.

However, the popularity of project-based learning in the District contradicts findings from a study by Nudzor et al. (2015) on how teachers in the northern region of Ghana practice activity-based learning (ABL) in public basic schools. The study, which involved teachers, headteachers, and the director of education in four districts, revealed that essential components of activity-based learning, such as displaying learners' work in classrooms, organizing seating arrangements of learners in groups, using teaching and learning materials, implementing formative assessments, and conducting activity-oriented lessons, were largely absent due to issues of congestion,

lack of furniture, and logistical challenges in almost all the visited schools and classrooms.

Research Question Three: What challenges do JHS mathematics teachers in the Nadowli-Kaleo District face in implementing the project-based learning in their lessons?

The examination of challenges associated with the implementation of project-based learning exposed a range of obstacles faced by Junior High School (JHS) mathematics teachers in the Nadowli-Kaleo District. These challenges encompassed issues such as the time consuming-nature of PBL, lack of parental support, lack of necessary instructional materials, a delay in lesson delivery, and short lesson period in using project-based learning. The observational data significantly aligned with the questionnaire responses, confirming specific challenges acknowledged by JHS mathematics teachers. Notably, the high prevalence (90%) of short lesson periods observed corresponded with teachers' uncertainty regarding the challenge posed by brief lesson durations. Similarly, the substantial observation (80%) of certain learners dominating group project work resonated with the teachers' uncertainty about the significance of learner dominance as a challenge. Moreover, the classroom observations substantiated concerns related to insufficient instructional resources, with 70% of observed teachers grappling with a lack of resources to support learners' projects. However, certain discrepancies emerged between questionnaire responses and observational data. While the observational data highlighted that selecting a project topic was a challenge for 70% of observed teachers, the questionnaire responses indicated that teachers did not consider it a significant challenge.

The time-consuming nature of Project-Based Learning (PBL) is a challenge acknowledged by scholars such as Habok and Nagy (2016), who emphasize the meticulous attention to detail required in designing and implementing projects. They contend that the PBL process may demand more time than initially anticipated, posing challenges for teachers adhering to a set curriculum within limited instructional time. Similarly, Aldabbus (2018) argues that integrating PBL within the constraints of the school schedule proves challenging, often surpassing the time required for traditional methods. Additionally, Hussein (2021) observes that the approach can lead to some learners dominating the project, hindering active participation and contributions from their peers.

The issue of assessment poses significant concerns for teachers, particularly in relation to learner performance on high-stakes testing, as highlighted by Harris (2014). Pereira et al. (2017) further note that many teachers fear that adopting PBL over traditional testing methods may result in lower performance on standardized or state tests. The identified school-related factors, including insufficient resources, inflexible schedules, and a lack of access to technology, contribute to the challenges associated with PBL, according to Pereira et al. (2017). Dorr's (2017) study on challenges during the application of PBL in actual classrooms identified time constraints, difficulty in selecting relevant topics, and a lack of instructional resources as factors negatively impacting PBL implementation. Similarly, Kalabzová's (2019) research on the application of PBL in English classrooms reported a similar challenge of time constraint. These findings align with previous studies on the reluctance toward constructivist-based teaching approaches, particularly in the Northern region of Ghana.

Research Question Four: What kind of supports do JHS mathematics teachers in the Nadowli-Kaleo District need to implement the project-based approach in their lessons?

In addressing the requisite support for Junior High School (JHS) mathematics teachers in the Nadowli-Kaleo District to implement the project-based learning approach effectively, it was found that these teachers strongly advocated for NaCCA to design and attach suitable projects for each mathematics topic. Additionally, they emphasized the need to disseminate the culture of using PBL through workshops and training sessions, highlighted the importance of in-service training for teachers on PBL integration, and proposed the institution of rewards for the best learner projects. Moreover, they suggested the establishment of a special exhibition day for learner projects, the provision of standards and guidelines for project assessment, and the familiarization of parents with the significance of PBL.

The perspectives shared by these educators align with the insights of scholars regarding the effective implementation of project-based learning (PBL). Milloy (2017) underscores the importance of cultivating enhanced communication channels between teachers and parents to overcome challenges. Providing parents with transparent, comprehensive information about PBL principles and benefits is crucial. In addressing these challenges, Aldabbus (2018) advocates for multifaceted strategies, including fostering a supportive culture, offering professional development opportunities, involving parents, integrating diverse approaches, designing an authentic curriculum, allocating budgets, showcasing learner work, acknowledging achievements, fostering teacher collaboration, promoting cross-curricular integration, and employing effective assessment tools. Ravelle (2019) emphasizes the necessity of providing teachers with professional development opportunities to enhance their

understanding and implementation of PBL, enabling them to access internet resources, coaching support, and collaborative opportunities. Sunyoung Han et al. (2015) stress the importance of equipping teachers with the requisite knowledge, skills, and resources for effective PBL implementation through training programs focused on understanding PBL principles, honing project design and facilitation skills, and providing ongoing support. To bridge the communication gap and foster parental involvement in supporting their children's PBL experiences, Mergendoller (2018) advocates for regular parent-teacher meetings, workshops, and informative sessions.

4.5 Chapter Summary

This chapter had provided insights into the data collected to address the four research questions of the study. An analysis of demographic background information was conducted, followed by an analysis of the data based on research questions. Finally, a discussion supported by the views of various scholars has been presented to enhance the relevance of the findings.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 Overview

This chapter presents a summary of findings, conclusion, recommendations, and areas for further research as follows;

5.1 Summary of the Study

The purpose of this study was to investigate the implementation of the project-based learning in mathematics lessons among JHS mathematics teachers in the Nadowli-Kaleo District. The investigation was guided by four research questions, and supported by the constructivist learning theory. A descriptive cross-sectional survey design, of the quantitative research approach underpinned by the positivist paradigm was used. In doing this, a survey involving 77 Mathematics teachers from junior high schools in the Nadowli-Kaleo District was conducted using a structured questionnaire and an observation checklist and. Descriptive data analysis technique, including simple frequency counts, percentages, mean, and standard deviation, were employed to analyze the collected responses in answering the following research questions:

1. What are the perceptions of JHS Matematics teachers in the Nadowli-Kaleo District about the use of project based-learning in teaching mathematics?
2. What instructional strategies do JHS mathematics teachers in the Nadowli-Kaleo District use in implementing the project-based learning in their lessons?
3. What challenges do JHS mathematics teachers in the Nadowli-Kaleo District face in implementing the project-based learning in their lessons?

4. What kind of supports do JHS mathematics teachers in the Nadowli-Kaleo District need to implement the project-based approach in their lessons?

5.2 Key Findings

The major findings of the study are summarized in line with the research questions as follows:

1. **Perceptions of Matematics Teachers about the Use Of Project Based-Learning In Teaching Mathematics**

First, the study found that Mathematics teachers in the Nadowli-Kaleo District generally hold positive views about project-based learning for Mathematics. They believed the approach is effective in fostering collaboration, helping learners identify their strengths and weaknesses, promoting self-learning, providing valuable individual and group engagement opportunities, offering self-assessment chances, fostering inquiry-based learning, motivating independence in learning. However, they objected to the assertion that PBL makes the teacher to lose his/her authority in the class, PBL not applying to mathematics teaching, PBL killing learners' motivation, and PBL inhibiting the development of social interactions.

2. **Instructional Strategies Used in Implementing the Project-Based Learning**

Also, the findings of this research question indicated that Junior High School (JHS) mathematics teachers in the Nadowli-Kaleo District regularly employed a variety of instructional strategies to implement project-based learning in their lessons. Notably, they employed 57% of identified project-based learning strategies, including providing feedback and engaging learners in various activities, while 43% of strategies, such as structuring learning around projects occasionally and connecting tasks with broader society, were used occasionally.

3. Challenges of Mathematics Teachers in Implementing the Project-Based Learning

In addition, it came out from the study that Mathematics teachers in the Nadowli-Kaleo District faced challenges such as the time consuming-nature of PBL, lack of parental support, lack of necessary instructional materials, a delay in lesson delivery, and short lesson period in using project-based learning.

4. Kind of Supports Needed by Mathematics Teachers to Implement the Project-Based Approach

Lastly, on the requisite support for Junior High School (JHS) mathematics teachers in the Nadowli-Kaleo District to implement the project-based learning approach effectively, it was found that these teachers strongly advocated for NaCCA-designed projects, emphasize spreading PBL culture, highlight the importance of in-service training, propose rewards for top projects, suggest an exhibition day, call for standards in assessment, and recommend familiarizing parents with PBL significance.

5.3 Conclusions

In conclusion, this study has revealed insightful findings on the perceptions, instructional strategies, challenges, and support needs of Junior High School (JHS) mathematics teachers in the Nadowli-Kaleo District regarding the implementation of project-based learning (PBL) in teaching mathematics. The findings reveal a generally positive outlook among teachers towards PBL, recognizing its effectiveness in promoting collaborative learning, motivating learner engagement, and supporting various aspects of learner development.

Furthermore, the study highlights the diverse instructional strategies employed by JHS mathematics teachers to implement PBL in their lessons. While a significant percentage of identified strategies like feedback, learners reflection, inquiry-activities, group tasks, multi-disciplinary tasks, challenging questions, freedom to choose topics are consistently used, there are others like the use of project works, real life tasks, learners autonomy, open-ended tasks, and public visibility of learners' works that are employed occasionally.

The challenges faced by teachers, including time constraints, lack of parental support, material scarcity, and delays in lesson delivery, underscore the need for targeted interventions and support mechanisms.

In addressing the requisite support for effective PBL implementation, the teachers emphasize the importance of NaCCA-designed projects, the dissemination of PBL culture through workshops, in-service training for teachers, rewards for outstanding projects, an exhibition day, standards in assessment, and parental familiarization with the significance of PBL. These insights provide valuable guidance for educational stakeholders and policymakers in enhancing the successful implementation of project-based learning in mathematics education in the Nadowli-Kaleo District.

5.4 Recommendations

1. Given the generally positive views held by Mathematics teachers in the Nadowli-Kaleo District regarding project-based learning, the Nadowli-Kaleo District Education Directorate, should continue to develop and implement professional development programs that further enhance teachers' understanding and positive perceptions of project-based learning. They are to provide resources and training to empower teachers to effectively integrate

collaborative and inquiry-based approaches into their mathematics lessons.

2. To address the variation in the frequency of project-based learning used by Mathematics teachers in the Nadowli-Kaleo District, it is recommended for Heads of Junior High Schools and School Improvement Support Officers (SISO) to establish a system for monitoring and encouraging the use of a wider range of project-based learning strategies to address different learning styles and adapt to the needs of diverse learners. This can help teachers embrace more strategies and boost learner engagement. Also, organizing regular in-service training and peer-to-peer sharing sessions can inspire teachers to incorporate project-based learning strategies more regularly.
3. To tackle the challenges faced by Mathematics teachers in the Nadowli-Kaleo District in implementing project-based learning, it is recommended for educational authorities and district administrators in Nadowli-Kaleo to provide targeted support in the form of allocation of resources for materials, provision of additional support for time management, and establishment of mechanisms for parental involvement.
4. Based on the strategies affirmed by the Mathematics teachers in the Nadowli-Kaleo District in enhancing the implementation of project-based learning, it is recommended for the district and its mathematics teachers to adopt such measures like collaborating with NaCCA to design and attach suitable projects for each mathematics topic, organizing workshops and training sessions to spread the culture of project-based learning, establishing systems for in-service training, rewarding outstanding projects, as well as instituting special exhibition days, and standards in assessment.

5.5 Suggestions for Further Research

Future researchers can consider conducting the same study in other classes within the District to gain broader insights into the use of project-based learning in teaching Mathematics in the District. Also, researchers can explore the effect of using the project-based learning approach in teaching Mathematics within and outside the Nadowli-Kaleo District.

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APPENDIX A

UNIVERSITY OF EDUCATION, WINNEBA

DEPARTMENT OF BASIC EDUCATION

QUESTIONNAIRE FOR JHS TEACHERS

Dear Sir/Madam,

Thank you for accepting to be part of this research. This questionnaire aims to collect information on the operationalization of the project-based learning in mathematics lessons among JHS mathematics teachers in the Nadowli-Kaleo District. This study does this by examining the perception, practice, challenges and possible support needed to make its implementation effective in their mathematics lessons. This questionnaire is strictly for an academic exercise and you are please requested to provide accurate and forthright information that will assist the researcher in obtaining the correct data for this exercise. Your responses will be treated in strict confidence. You are please requested to tick (√) on the column that best describes your habit. Thank you.

SECTION A: Personal Information

Instruction: Please tick (√) as appropriate or write in the space provided.

1. **Gender**: Male [ ] Female [ ]
2. **Age**: 20-30 [ ] 31- 40 [ ] 41- 50 [ ] 51 and above [ ]
3. **Highest Academic Qualification**: Post Sec. Cert A. [ ] Diploma [ ]
   Bachelor's Degree [ ] Master's Degree [ ]

4. How long have you been teaching mathematics?

1-5[ ] 6-10[ ] 11-15[ ] 16-20[ ] 21+ [ ]

SECTION B

The following statements seeks to find out the perception of JHS Matematics teachers in the Nadowli-Kaleo District regarding the use of project-based learning in teaching mathematics. Carefully read each statement and rate it as accurately as possible. Tick (√) a number that best describes your view on each of the items. **On a scale of 1-5, rate your views on the following statements**.

S/N	Perception of Project Based Learning	Please **TICK** a number to rate EVERY option				
		Strongly Disagree	**Disagree**	**Undecided**	**Agree**	**Strongly Agree**
1	Learners who learn mathematics through PBL fail in developing better social interactions.	1	2	3	4	5
2	PBL gives learners the chance to self-assess their own end products while evaluating their classmate's projects.	1	2	3	4	5
3	PBL help learners to become aware of their own strengths and weaknesses.	1	2	3	4	5
4	PBL provides valuable opportunities for learners to be engaged individually and in groups.	1	2	3	4	5
5	PBL provides creates an avenue for learners to formulate enquiry questions, set goals and plan for real life investigations.	1	2	3	4	5
6	PBL makes teachers to lose their authority in the class since they become facilitators providing learners with guidance and feedback.	1	2	3	4	5
7	PBL give motivates learners to be more independent in choosing the way to learn.	1	2	3	4	5
8	PBL kills learners' motivation to be fully engaged in the process of learning mathematics.	1	2	3	4	5
9	PBL encourages learners to collaborate with each other in solving problems outside of the classroom.	1	2	3	4	5
10	PBL promotes self-learning as learners become more responsible in their learning.	1	2	3	4	5
11	PBL does not apply to the teaching and learning of mathematics.	1	2	3	4	5

SECTION C

This section of the questionnaire seeks your opinion on the instructional strategies JHS mathematics teachers in the Nadowli-Kaleo District use in implementing the project-based learning in their lessons. Carefully read each statement and rate it as accurately as possible. Tick (√) a number that best describes your view on each of the items. **On a scale of 1-5**, **rate your views on the following statements**.

S/N	Instructional Strategies For Practicing The Project Based Learning	Perceived frequency of use of teaching strategies and methods				
		Never	Rarely	Sometim	Often	Always
12	I organize my learners learning around projects works	1	2	3	4	5
13	I assign my learners to challenging questions or problems, that involve investigative activities.	1	2	3	4	5
14	I assign learners to real life situation tasks involving parents and others from learner surroundings.	1	2	3	4	5
15	I give learners tasks that is draws on their knowledge of different subjects/ discipline	1	2	3	4	5
16	I set learners to tasks usually carried out in groups	1	2	3	4	5
17	I ensure tasks given to learners connects school with its neighborhood, broader society and actual life.	1	2	3	4	5
18	I give learners the opportunity to work autonomously over extended periods of time to bring out realistic products or presentations.	1	2	3	4	5
19	I engage learners in a range of activities to meet the various learning needs and interests of learners.	1	2	3	4	5
20	I ensure project work given to learners do not end up in a predefined results or take restricted paths decided in advance by the instructor.	1	2	3	4	5
21	I create more freedom for learners, so they can select the suitable topic, resources, responsibilities and the way they design and display their final work.	1	2	3	4	5
22	I ensure that learners work becomes public through display/presentation.	1	2	3	4	5
23	I engage learners in asking questions, finding resources to answer the questions and applying the new information	1	2	3	4	5
24	Together with learners, I give opportunity to reflect on the work and assignment.	1	2	3	4	5
25	I make sure feedback is given and received by learners to improve the work and tasks.	1	2	3	4	5

SECTION D

The following statements are about the challenges faced by JHS mathematics teachers in the Nadowli-Kaleo District while implementing the project-based learning in their lessons. Carefully read each statement and rate it as accurately as possible. Tick (√) a number that best describes your view on each of the items. **On a scale of 1-5, rate your views on the following statements**.

S/N	Challenges in the Use of Project Based Learning	Please **TICK** a number to rate EVERY option				
		Strongly Disagree	**Disagree**	**Undecided**	**Agree**	**Strongly Agree**
26	I am not sure which topic in mathematics can be taught with using project-based learning	1	2	3	4	5
27	My lesson period is too short to allow me to use the project-based learning in teaching	1	2	3	4	5
28	Using the project-based learning approach takes more time than the other approaches.	1	2	3	4	5
29	Using the project-based approach delays my lessons presentation and delivering.	1	2	3	4	5
30	Using the project-based learning approach does not allow me to cover all the lessons scheduled for the day or term	1	2	3	4	5
31	I do not have the knowledge and confident to use the project-based learning approach	1	2	3	4	5
32	How to score the end product of the project is problematics for me	1	2	3	4	5
33	Some learners dominate the project and do not allow their mates to partake in the group work.	1	2	3	4	5
34	Choosing a project that will meet the interest of learners becomes difficult for me.	1	2	3	4	5
35	My school does not offer the necessary materials and facilities needed for projects learning.	1	2	3	4	5
36	Parents of learners were unwilling to offer them the necessary materials to facilitate the project	1	2	3	4	5

SECTION E

The following statements talk about the kind of support JHS mathematics teachers in the Nadowli-Kaleo District need to implement project-based learning in their lessons. Carefully read each statement and rate it as accurately as possible. Tick (√) a number that best describes your view on each of the items. **On a scale of 1-5, rate your views on the following statements**. Thank you.

S/N	Strategies for improving the use of Project Based Learning	Please **TICK** a number to rate EVERY option				
		Strongly Disagree	**Disagree**	**Undecid**	**Agree**	**Strongly Agree**
37	The culture of using PBL should be spread among schools throughout workshops, seminars and training sessions.	1	2	3	4	5
38	Teachers should receive in-service training on how to integrate PBL into their lessons.	1	2	3	4	5
39	Parents should be familiarized with the importance of PBL to support their wards' project.	1	2	3	4	5
40	Special budget for learners' projects should be offered by schools heads.	1	2	3	4	5
41	Display area where distinctive projects can be displayed to motivate other learners should be made available to learners.	1	2	3	4	5
42	Rewards for best projects of learners should be instituted in our basic schools.	1	2	3	4	5
43	Schools should be provided with a standard and guidelines for assessing the process and the end product of learners' project.	1	2	3	4	5
44	NaCCA should design and attach suitable project for each of the topics in mathematics	1	2	3	4	5
45	Special exhibition day for learners' mathematics project should be established in the District.	1	2	3	4	5
46	End of term mathematics group project should form a major part of learners' assessment.	1	2	3	4	5

THANK YOU!!

APPENDIX B

CLASSROOM OBSERVATION GUIDE: IMPLEMENTATION OF PROJECT BASED LEARNING IN MATHEMATICS LESSONS

This observation checklist is meant to gather classroom observational data on how teachers implement the project based learning in mathematics lessons among JHS mathematics teachers in the Nadowli-Kaleo District.

SECTION A: Teacher Information:

Teacher Gender: Male [ ] Female [ ]

Class Level: JHS 1 [ ] JHS 2 [ ] JHS 3 [ ]

Lesson Topic:……

Circuit: ……

Date of Observation: ……

SECTION B: Teacher Practice of Project Based Learning in Mathematics Lessons

	Teacher classroom instructional practice	Please **TICK** to rate EVERY statement. **Practice observed (√) Not Observed (×)**
A	***Teacher's Instructional Strategies:***	
1	Teachers give learners tasks that is draws on their knowledge of different subjects/ discipline	
2	Teacher ensures tasks given to learners connects school with its neighbourhood, broader society and actual life.	
3	Teacher gives learners the opportunity to work autonomously over extended periods of time to bring out realistic products or presentations	
4	Teacher creates more freedom for learners, so they can select the suitable topic, resources, responsibilities and the way they design and display their final work.	
5	Teacher ensures that learners work becomes public through display/presentation.	
B	***Learner Engagement:***	
6	Teacher assigns learners to tasks usually carried out in groups	
7	Teacher engages learners in a range of activities to meet the various learning needs and interests of learners	
8	Teacher engages learners in asking questions, finding	

	resources to answer the questions and applying the new information	
	Assessment and Feedback:	
9	Teacher ensures project work given to learners do not end up in a predefined results or take restricted paths decided in advance by the instructor.	
10	Teacher makes sure feedback is given and received by learners to improve the work and tasks.	
11	Teacher together with learners reflect on the work and assignment	
	Classroom Challenges:	
12	No designated place for learners' projects.	
13	Difficulty in choosing project topics.	
14	Lack of instructional resources to support learners' projects.	
15	Lesson duration too short for learners' projects.	
16	Some learners dominating group project works.	

Keys:
Practice observed (√) means statement applies to the lesson observed.
Not Observed (×) means statement does not apply to the lesson observed.

APPENDIX C

LETTER OF PERMISSION FROM THE NADOWLI-KALEO DISTRICT

GHANA EDUCATION SERVICE
DISTRICT EDUCATION OFFICE

In case of reply the number and date of this letter should be quoted.

Our Ref No GES/UWR/NAD.5/Vol.6/115

REPUBLIC OF GHANA

POST OFFICE BOX 5
NADOWLI, UW/R
Email:nadowlikaleo@yahoo.com

DATE: 1st September, 2023

PERMISSION TO CARRY OUT A RESEARCH ON THE TOPIC "JUNIOR HIGH SCHOOL TEACHER IMPLEMENTATION OF PROJECT-BASED LEARNING IN TEACHING MATHEMATICS IN THE NADOWLI-KALEO DISTRICT"

With reference to your letter dated 26th June, 2023 requesting for permission to carry out the above mentioned project, I wish to inform you that you have been granted permission to carry out the exercise in the Nadowli-Kaleo district.

You are however reminded that your project should not interfere with teaching /learning in the district.

You are therefore advised to administer your questionnaires outside schooling hours.

Thank you.

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KUTINA CHRISTOPHER
DISTRICT DIRECTOR OF EDUCATION
NADOWLI –KALEO

MR. MOHAMMED HUDU
JANG D/A JHS
BOX 5
NADOWLI