UNIVERSITY OF EDUCATION, WINNEBA

UPPER PRIMARY SCHOOL TEACHERS' USE OF CONSTRUCTIVIST APPROACH IN TEACHING MATHEMATICS IN EFFUTU MUNICIPALITY

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MASTER OF PHILOSOPHY

2023

UNIVERSITY OF EDUCATION, WINNEBA

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A thesis in the Department of Basic Education,
School of Education and Life-long Learning,
Submitted to the School of Graduate Studies, in partial fulfilment
of the requirements for the award of the degree of
Master of Philosophy
(Basic Education)
in the University of Education, Winneba

DECEMBER, 2023

DECLARATION

Candidate's Declaration

I, Margaret Mary Amissah, 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 / We 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.

DR. CLEMENT ALI **(Principal Supervisor)**

Signature: …………………………..……….

Date: ……………………………..……….

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

Signature: ………………………………..…….

Date: ………………………………..….…….

DEDICATION

To my lovely family.

ACKNOWLEDGEMENTS

My first and foremost appreciation goes to God Almighty for guiding me through this academic journey successfully. My next gratitude goes to entire family for the support in completing this work. I really appreciate this support.

I am also very grateful and indebted to my supervisors, Dr. Clement Ali and Mr. Nixon Saba Adzifome for their invaluable interest, guidance and contributions in making this master piece.

Finally, I am thankful to all the lecturers in the Department of Basic Education, University of Education, for their valued suggestions and inputs in making this work scholarly.

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ABSTRACT

This study investigated the use of constructivist approach in teaching Mathematics by Upper Primary School teachers in the Effutu Municipality. The study was guided by four research questions. By employing a quantitative approach, a survey involving 82 teachers was conducted using a census frame. Data were collected through observation checklists and structured questionnaires. Descriptive data analysis techniques, including simple frequency counts, percentages, mean, and standard deviation, were utilized to analyze the collected responses, to address the research questions. Four key findings emerged from the study. Firstly, Upper Primary Mathematics teachers in the Effutu Municipality perceived the principles of constructivism in teaching Mathematics as the use of familiar examples, creating a positive mathematics classroom environment, teachers serving as guides, incorporating hands-on activities, promoting critical thinking, and integrating technology resources into mathematics lessons. Also, Upper Primary mathematics teachers in the Effutu Municipality practice the constructivist approach to a higher extent, employing most of its strategies "Always," while strategies like technology integration, reflection, and context-based assessment are occasionally used. Again, the challenges faced by Upper Primary mathematics teachers in the Effutu Municipality while employing constructivism in their mathematics lessons included a scarcity of instructional resources needed for hands-on and constructivist lessons and a heavy workload. Lastly, upper primary mathematics teachers in Effutu highly supported various strategies to enhance the use of constructivist approaches in teaching mathematics, including ongoing mentorship and coaching, advocating for additional funds, teachers' collaboration, conducting regular assessments with timely feedback, and providing regular in-service and CPD trainings. Based on these findings, recommendations, including investing in professional development programmes, exploring technology integration, addressing resource scarcity, and heavy workloads, were offered to teachers and the Effutu Municipal education directorate to further support teachers in the use of the constructivist approach in their lessons.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter of the study presents the background to the study, statement of the problem, purpose of the study. It further looks at the objectives of the study, research questions, the significance of the study, delimitation, operational definition of terms as well as organization of the entire study.

1.1 Background to the Study

Mathematical ability plays a vital role in the economic success of societies (Lipnevich et al., 2011). According to Acharya (2019), Mathematics holds immense significance in our day-to-day lives, which is why it is a core component of school curricula in most countries. This notion is supported by Enu, Agyeman and Nkum (2015), who describe Mathematics as crucial for the scientific and technological advancement of nations. The reason behind this is that mathematical skills are essential for comprehending other disciplines, including engineering, sciences, social sciences, and even the arts (Patena & Dinglasan, 2013; Phonapichat, Wongwanich, & Sujiva, 2014). Ngussa and Mbuti (2017) affirm that due to the pervasive importance of mathematics, it has become a key subject in school curricula, aimed at equipping students with the knowledge and skills necessary in an ever-changing technological world. Considering its numerous benefits, Serebour (2013) argues that the primary purpose of teaching mathematics is to ensure that all Ghanaian youth acquire the skills, ideas, attitudes, and mathematical values they need to succeed in their careers and everyday lives.

Consequently, there has never been a greater need for mathematical literacy than in our current rapidly expanding society and economy. In countries like Australia, mathematics results serve as a critical determinant for higher education and future career paths, highlighting the significant importance placed on mathematics worldwide (Collis as cited in Asoma et al., 2022). Similarly, in Ghana, the inability to pass mathematics papers at both the basic education level (Basic Education Certificate Examinations) and secondary school level (Senior Secondary School Certificate Examinations [SSSCE] or the West African Senior Secondary School Certificate Examinations [WASSCE]) organized by the West African Examinations Council (WAEC) hinders students' progression to the next educational level (Asoma et al., 2022; Addae & Agyei, 2018). This underscores the paramount importance of mathematics education in Ghanaian schools.

Despite its significance and inherent beauty, mathematics remains one of the least favored subjects among students (Lin, Chen, & Chang, 2015). The performance in mathematics has become a global concern in recent times (Owusu, 2015), and Ghana is no exception. The academic achievement of students in mathematics, both nationally and internationally, is an issue that deeply concerns educators, governments, parents, and stakeholders worldwide, and in Ghana (Poku, 2019; Ampadu & Danso, 2018). The persistent poor performance of students in mathematics has been a significant challenge for Ghana, as indicated by national and international reports. Internally, the reports from the Basic Education Certificate Examinations (B.E.C.E) consistently highlight the generally poor performance of students in mathematics, emphasizing the need to address this issue and cultivate a change in students' attitudes towards the subject (Chief Examiner's Report, 2011). Internationally, Anamuah-Mensah, Mereku, and Asabere-Ameyaw (2005) analyzed

Ghanaian pupils' performance in the Trends in International Mathematics and Science Study (TIMSS) and found that they scored significantly lower, with an average mean score of 276 compared to the international average mean score of 467. Out of the 46 countries participating in the 2003 TIMSS test, Ghana was ranked second to last. In the Effutu Municipality, Bentil (2020) reported on the academic attainment among Junior High School pupils, particularly in the Basic Education Certificate Examinations (BECE), as presented in Table 1.1.

Table 1.1: Academic achievement of pupils in Basic Education Certificate Examination (2013-2018)

Year	Pass rate (%)	Failure rate (%)
2013	42.5	57.5
2014	44.0	56.0
2015	44.8	55.2
2016	54.7	45.3
2017	70.2	29.8
2018	69.5	30.6

Source: Effutu Municipal Examination Unit of Ghana Education Service, 2022

The analysis of BECE results for the municipality between 2013 and 2018 revealed an average academic performance of 54.2%. In 2013, the pass rate was 42.5%, while the failure rate stood at 57.5% (Bentil, 2020). Subsequently, there was a slight improvement in performance in 2014, with 44.0% of pupils passing and 56.0% failing. The following year, 2015, saw a modest increase in performance compared to the previous year, with a pass rate of 44.8% and a failure rate of 55.2%. The academic year of 2016 witnessed a further improvement, with a pass rate of 54.7% and a failure rate of 45.3%. In 2017, the academic performance of pupils in the municipality showed significant improvement, with a pass rate of 70.2% and a failure rate of 29.8%. However, in 2018, there was a decline in performance, as 69.5% of pupils passed while 30.5% failed. These results indicate that in recent times, nearly half of the pupils in the municipality were unable to pass and gain admission to second cycle institutions (Bentil, 2020).

A study conducted by Mills and Mereku (2016) focused on assessing the performance of basic 8 (JHS 2) students in Effutu with regards to the National Minimum Standards (NMS) outlined in the 2012 Mathematics syllabus. The NMS represents the specific minimum objectives that students should achieve by the end of their basic education in order to fulfill the general aims of the mathematics curriculum. The findings revealed that 42% of the students found eight out of the nineteen content standards to be challenging. Only about 30% of the students achieved a proficiency mean score of at least 65%, while approximately 10% performed below the minimum competency level. Consequently, it was observed that nearly half of the students were operating at the minimum competency level, falling short of the NMS.

The poor performance in mathematics education in Ghana has raised concerns about the teaching strategies employed in classrooms. Fleisch, as cited in Owusu (2015), suggests that inappropriate teaching strategies could be one of the causes of poor mathematics learning. Simply focusing on faster calculations or completing activities regularly is not sufficient for improving mathematical competence. Instead, meaningful learning should be emphasized, where students build their own knowledge and apply it in their daily lives, starting from their existing knowledge (Bermejo et al., 2021).

This has led to a growing call for mathematics teachers to reflect on their instructional approaches. Educators recommend adopting innovative teaching strategies such as the constructivist approach. According to Bada and Olusegun (2015), constructivism is an approach to teaching and learning that views cognition as the result of "mental construction." It emphasizes that students learn by connecting new information with their existing knowledge. Therefore, teachers should provide opportunities for learners to build on their previous knowledge through scaffolding, as learning cannot occur in isolation.

Machaba (2017) asserts that constructivism is about how individuals learn, and it highlights the active construction of new ideas based on new or existing knowledge. The constructivist theory describes the construction of new knowledge through two processes: accommodation and assimilation (Bada & Olusegun, 2015). In essence, constructivism is a learner-centered educational theory that emphasizes the belief that knowledge cannot be simply transmitted by the teacher. Instead, students need to actively engage in activities such as group work, hands-on tasks, discussions, and projects. Teachers play the role of facilitators, creating a conducive learning environment and fostering positive relationships with students. They also serve as reflective practitioners who guide students in constructing their own meaning and understanding.

In the context of mathematics, a constructivist teacher stimulates learners' thinking and learning through experiments and the application of real-world problems that promote critical thinking (Bada & Olusegun, 2015). Setiawan and Koimah (2019) point out that learners often come to school with correct or incorrect prior knowledge, and during the process of learning, this new information may be distorted or completely rejected. According to Cobb, as cited in Bermejo et al. (2021), constructivism can be an alternative to traditional methodologies for two fundamental reasons. Firstly, students are capable of solving a wide range of mathematical problems because they develop more complex and abstract structures. Secondly, through the construction of their own knowledge, students change their perspective and become capable of creating and controlling mathematics, leading to increased motivation (Bermejo et al., 2021).

The constructivist approach in teaching mathematics has been widely recognized for its numerous benefits. Dagnew (2017) suggests that an effective alternative to traditional teacher-dominated instruction is to shift the focus of classroom instruction towards a student-centered approach using constructivism. Given the potential of this approach, it becomes crucial to investigate the implementation of the constructivist approach by Upper Primary School Teachers in the teaching of mathematics in the Effutu Municipality.

1.2 Statement of the Problem

Educators worldwide are recognizing the need for a transformation in mathematics instruction. In Ghana's public schools, the 2007 and 2012 mathematics curricula were designed to shift the focus of instruction from a teacher-centered approach to a learner-focused and hands-on method, aiming to address issues related to students' performance (MoE, 2012). Currently, the educational philosophy embraced in Ghanaian basic schools emphasizes the creation of an environment where learners can expand, change, enhance, and modify their worldview (Ministry of Education, 2019, p. vi). Consequently, constructivist-based teaching approaches are highly valued, with teachers utilizing the knowledge that children bring to Ghanaian schools (Ministry of Education, 2019). Teachers are expected to establish a learning environment that taps into the diverse knowledge of the students, employing constructivist teaching methods such as guided discovery, problem-solving, and inquiry-based approaches. The current educational philosophy emphasizes constructivist principles, requiring Upper Primary School Teachers to facilitate quality mathematics education through;

> "*active contextualized process of constructing knowledge based on learners' experiences rather than acquiring it. Learners are information constructors who operate as researchers. Teachers serve as facilitators by providing the enabling environment that promotes the construction of learners' own knowledge, based on their previous experiences" (*Ministry of Education, 2019, pg vi)

The constructivist approach holds significant importance for mathematics teachers, as it provides a framework for effective instruction. This educational philosophy serves as the foundation for various active learning pedagogies, including discovery-based, project-based, inquiry-based, problem-based, and case-based approaches (Cattaneo, 2017). Constructivism, being one of the prominent approaches in teaching and learning, emphasizes the active role of students in constructing their own knowledge through interactions with their peers and building upon their prior experiences. Unlike traditional teacher-centered methods, the constructivist approach places students at the center of the learning process, with the teacher taking on the role of a facilitator. In this approach, learners are seen as builders and creators, actively engaged in the learning process (Sharma, 2014). The constructivist approach considers students' interests, abilities, attitudes, achievements, aspirations, and motivations, ensuring that instruction is personalized and relevant to their needs. This approach offers flexibility, motivation, adaptation, creativity, and versatility for both teachers and students. It encourages students to learn through personal experiences, leveraging support from their peers and utilizing appropriate learning materials.

However, despite the recognized benefits of the constructivist approach, empirical studies indicate that many teachers struggle to go beyond traditional methods of imparting mathematical knowledge and skills to their students. This is evident in the context of primary school teaching in western worlds like Ethiopia, where it was found that teachers were not effectively utilizing the constructivist approach in the teaching-learning process (Dagnew, 2017). A similar situation can be observed in Ghana, particularly in mathematics education. According to Fredua-Kwarteng as cited in Dotse (2017), mathematics teaching in Ghana is often characterized by the use of transmission and command models. In these classrooms, students are not encouraged to ask questions or engage in hands-on and problem-solving activities that promote both conceptual and procedural understanding (Sarfo et al., 2014). Instead, the teacher is seen as the expert who simply imparts knowledge to passive students, who are expected to passively receive and memorize information (Bada & Olusegun, 2015). Consequently, many basic school pupils in Ghana lack the necessary conceptual understanding of mathematics and its underlying concepts (Baffoe & Mereku, 2010). In the case of Effutu, while Dotse (2017) reports positive perceptions of constructivism among junior high school mathematics teachers, the same cannot be said for upper primary mathematics teachers.

Recognizing the crucial role of constructivism in mathematics learning and education, the government of Ghana has implemented several initiatives to improve the approach to mathematics instruction. A significant step in this direction has been the revision of the mathematics curriculum to align it with constructivist principles (Addae & Agyei, 2018). The Ministry of Education, in collaboration with the National Council for Curriculum and Assessment (NaCCA), has mandated the integration of constructivism as a teaching and learning philosophy, emphasizing learner-centered pedagogies, differentiation, scaffolding, problem-solving, and the integration of Information and Communication Technology (ICT) (Ministry of Education, 2019; 2020). Furthermore, Ghana has introduced STEM (Science, Technology, Engineering, and Mathematics) education to empower learners to apply mathematical and scientific concepts in addressing real-life challenges and promoting innovation in society. STEM education encourages interdisciplinary knowledge and skills, fostering critical thinking, creativity, and problem-solving abilities among students.

In the Effutu municipality, specific efforts have been made to support the implementation of the constructivist-based mathematics curriculum. The Municipal Education Directorate has been organizing training sessions for teachers, aiming to equip them with the necessary skills and knowledge to effectively employ the constructivist approach in the classroom. These sessions are designed to enhance teachers' ability to prepare students for the practical application of mathematical concepts in solving real-life problems.

By incorporating constructivism into the curriculum, promoting STEM education, and providing training opportunities for teachers, the country aims to enhance mathematics instruction and cultivate students' ability to apply mathematical knowledge in practical contexts. The adoption of a constructivist approach empowers teachers to actively engage students in their learning process, facilitating meaningful connections between prior knowledge, new information, and the learning experience itself. Failing to adhere to constructivist principles in instruction can result in a lack of conceptual understanding of mathematical concepts among students (Baffoe & Mereku, 2010). It also hinders students' ability to relate mathematics to real-world contexts, leading to a loss of interest in the subject (Ministry of Education, 2019; Ampadu & Anokye-Poku, 2022).

The Ministry of Education emphasizes that the constructivist approach makes learning more relevant to learners and fosters the development of critical thinking and problem-solving skills (Ministry of Education, 2019; 2020). Additionally, Bada and Olusegun (2015) assert that constructivism promotes social and communication skills by creating a classroom environment that encourages collaboration and the exchange of ideas. Bhattacharjee (2015) supports this notion, stating that using the constructivist approach in lessons fosters inductive learning, starting from examples and facilitating effective learning experiences. In constructivist learning, the concepts emerge from the students' actions rather than being presented beforehand. The activity drives the acquisition of concepts, rather than the other way around. As a result, traditional classroom procedures are reversed, with a focus on student engagement in activities that develop skills and foster the acquisition of concepts (Bhattacharjee, 2015).

Although constructivism has gained global recognition as an effective approach to mathematics instruction, the majority of research studies conducted in this area have been conducted outside of Ghana, focusing on various aspects such as problem-solving in the American context (Gyan et al., 2021; Çetin et al., 2012), teaching financial accounting (Oguguo & Francis, 2016), general mathematics performance (Bermejo et al., 2021; Aydisheh & Gharibi, 2015), teacher interpretation of constructivism in teaching (Alsharif, 2014), constructivist approaches to mathematics professional development among school leaders (Bugg, 2020), challenges of implementing social constructivist learning approaches (Moskal et al., 2016; Dagnew, 2017), historical and personal perspectives of constructivism (Faulkenberry & Faulkenberry, 2014), explorations of constructivist tools in mathematics in Sweden (Aljundi, 2021), and teacher training, beliefs, and use of constructivism (Mercer, 2020).

However, within the Ghanaian context, studies specifically focusing on constructivism in mathematics instruction are rare. Existing studies have predominantly explored constructivism in subjects other than mathematics, and have often been conducted in colleges of education and secondary schools. For example, Qarareh (2016) examined the effect of using the constructivist learning model in teaching science, and Owusu (2015) investigated the application of constructivist principles in teaching algebra in secondary schools. Similarly, Assuah et al. (2016) explored the ideas, beliefs, and practices of Ghanaian primary school mathematics teachers regarding constructivist instructional strategies.

In Effutu, the perception and use of constructivism among JHS mathematics teachers have been explored by Dotse (2017) using a mixed-method approach and based on Piaget's theory of cognitive development. The study identified the need for further research to verify and assess the impact of the constructivist approach on students' performance. However, several gaps were left in this study in terms of methodology, theoretical framework, participants, and scope that needs to be addressed. For instance, with regards to participants, Dotse focused on only JHS teachers. In terms of scope, only perception and use of constructivism was been examined. Similarly, Dotse employed only interview and questionnaire without any form of observation to align teachers' responses with their actual classroom practices. Lastly, Dotse's study was underpinned by Piaget's theory of cognitive development while this current study was anchored on the Vygotsky's social constructivist theory.

In essence, while Dotse (2017) reported a regular use of constructivism among the JHS mathematics teachers, how the Upper Primary mathematics teachers also implement the approach is still unknown. Again, Dotse failed to explore related challenges and support needed. Importantly, no form of classroom observation was also conducted whereas the Upper Primary School Teachers were excluded from the study.

Considering the limited number of studies conducted on the use of constructivist approach in teaching Mathematics in the Ghanaian context, as well as the absence of studies specifically focusing on Upper Primary School Teachers in the Effutu Municipality, this study aims to fill that gap. It employs a quantitative approach, grounded in Vygotsky's constructivist theory, to investigate the use of the constructivist approach by Upper Primary School Teachers in teaching mathematics.

1.3 Purpose of the Study

The purpose of the study was to investigate the use of constructivist approach in teaching Mathematics by Upper Primary Mathematics teachers in the Effutu Municipality.

1.4 Objectives of the Study

This study sought to;

1. find out the perception of Upper Primary Mathematics teachers regarding the principles of constructivism in teaching mathematics in the Effutu Municipality.
2. assess the extent to which Upper Mathematics teachers practice constructivist approach in teaching mathematics in the Effutu Municipality.
3. investigate the challenges Upper Primary mathematics teachers in the Effutu Municipality face in the use of constructivism in their mathematics lessons.
4. find out the strategies that can be employed to enhance the use of constructivist approach in teaching mathematics by upper primary mathematics teachers in Effutu.

1.5 Research Questions

The present study was guided by the following research questions;

1. What are Upper Primary Mathematics teachers' perception of the principles of constructivism in teaching mathematics in the Effutu Municipality?
2. To what extent do Upper Primary mathematics teachers in the Effutu Municipality practice constructivist approach in their mathematics lessons?
3. What challenges do Upper Primary mathematics teachers in Effutu face in the use of constructivism in their mathematics lessons?
4. What strategies can be employed to enhance the use of constructivist approach in teaching mathematics by upper primary mathematics teachers in Effutu?

1.6 Significance of the Study

The findings of this research work have significant implications for practice, policy, and theory in the following ways:

Firstly, for teacher guidance and reflection: The study will provide valuable insights to mathematics teachers regarding their implementation of the constructivist-based mathematics curriculum. The findings will serve as advice to mathematics teachers, enabling them to reflect on their own practice and make informed adjustments to improve their instructional strategies. By understanding the effectiveness of their current approach, mathematics teachers can identify areas for improvement and enhance their teaching methods accordingly. Again, for continuous professional development: The research findings will emphasize the importance of continuous professional development for teachers. Teachers will recognize the need to stay updated with evolving trends in education and engage in ongoing training to enhance their pedagogical skills and understanding of constructivist approaches. This will foster a culture of lifelong learning among teachers, ensuring they are equipped with the knowledge and skills necessary to effectively implement modern methods of lesson delivery.

Also, for policy formation and implementation: the study's findings will inform policymakers, curriculum developers, and education stakeholders in making informed decisions regarding mathematics instruction. Policymakers can utilize the information to shape policies and guidelines that promote the effective implementation of the constructivist approach in mathematics teaching. Furthermore, the findings can guide the development of training sessions and support mechanisms to enhance teachers' pedagogical content knowledge and improve the learning of mathematics in schools.

Lastly, for advancing educational knowledge: this research work will contribute to the existing body of knowledge on the constructivist approach to instruction, particularly at the basic school level. By providing empirical evidence and insights into the use of constructivism in mathematics teaching, the findings will enrich the theoretical understanding of how this approach can be applied in the Ghanaian context. Other researchers can use these findings as a reference for further investigations into the constructivist approach to teaching and learning, thereby expanding the knowledge base in this area.

1.7 Delimitation

This study was conducted specifically in the Effutu Municipality of the Central Region, which may limit the direct applicability of the findings to teachers in other districts. The decision to focus on only that Municipality was based on factors such as familiarity, convenience, and accessibility, as the researcher is an in-service teacher within the Municipality. Therefore, it is important to acknowledge that the findings may have contextual nuances that are specific to the Effutu Municipality.

Additionally, the research targeted only Upper Primary School Teachers handling mathematics in public basic schools within the Municipality, which means that not all basic school teachers were included in the study. This limited scope was determined by practical considerations such as time and financial constraints.

Furthermore, this research primarily focused on teachers' knowledge of constructivist principles, their current practices, challenges encountered, and strategies for improving the implementation of constructivism in mathematics lessons. The study did not extensively explore other aspects. This focus was driven by the specific objectives and resources available for the research.

1.8 Organization of the Study

This study is structured under five main chapters. Each of the chapters also comprises of its own sub-headings. Chapter One discusses the introduction which involve the overview, background to the study, statement of the problem, purpose of the study, objectives of the study, the research questions, significance, delimitation, and the organisation of the study. Chapter Two deals with literature review, that is, the review of relevant literature related to the study. Literature is reviewed under three thematic areas as theoretical framework, conceptual and empirical review with a chapter summary. Chapter Three details with the methodology employed in the study. This covers the research design highlighting the approach, paradigm and design, study area, population, sampling, instruments, data collection procedure, method of data analysis and ethical considerations. Chapter Four focuses on data presentation and analysis where data collected were analyzed based on responses provided for each research questions as well as discussion of the findings. The final chapter, five, provides a summary of findings, conclusion and recommendations based on the findings of the study.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.0 Overview

This chapter explores the expository and analytical opinions of people knowledgeable in the problem area showing the importance of this study. The review is carried out in three main folds; theoretical, conceptual and empirical.

2.1 Theoretical Framework

This study in anchored on the Social Constructivism Theory of Learning by Lev Vygotsky. This theory is what has been endorsed for use in the Ghanaian standards-based curriculum. Bada (2015) defined constructivism as a learning theory based on the idea that learning is constructed by piecing new information together with what a person already knows (Bada, 2015). This theory was developed by first introduced by Jean Piaget (Da-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 students are allowed to construct their own knowledge" (Bada, 2015, p.23).

According to Driscoll (2005), "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, 2005). Driscoll 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, p.17). 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 student-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 (Ministry of Education, 2019, 2020).

2.2 Conceptual Review

2.2.1 Theories of learning

The term "theories of learning" encompasses the two words, "learning" and "stheories." Although learning is a frequently used term, there is no universally accepted definition for it. According to Shuell (1986) as cited by Schunk (2012), different experts in the field of education hold varying perspectives on learning, which may contribute to the lack of a universally accepted definition. The most commonly accepted definition of learning is that it involves any activity resulting in a permanent change in behaviour (Shunk, 2012). Shunk further explains that learning involves gaining and modifying knowledge, skills, strategies, beliefs, attitudes, and behaviours through practice or other forms of experience.

Cherry (2016) also defines learning as a relatively lasting change in behaviour resulting from experience. However, Cherry warns against the temptation to limit learning to formal education that occurs during childhood and early adulthood, as learning is an ongoing process that takes place throughout an individual's life. De Houwer, Barnes-Holmes, and Moors (2013) define learning as the changes that occur in an organism's behaviour due to consistencies in the environment. Lachman (2010) defines learning as a moderately sustainable or permanent change in behaviour resulting from a practical or experimental process of understanding new phenomena. In this sense, learning aims to model the learner's behaviour and is achieved through practical experience.

Pear (2016) emphasizes that the science of learning overlaps with behaviour analysis but is not identical to it. To assess the effectiveness of the learning process, it is necessary to understand the learner's behaviour before and after learning. Webb and Roberts (2017) add that learning involves the progressive comprehension of new concepts, allowing learners to respond to interactions and problems with an understanding of the phenomenon. They stress that learning is a progressive process, requiring breaking down into smaller units that are progressively added to the learner's knowledge. In conclusion, learning involves a moderately sustainable or permanent change in behaviour resulting from progressive comprehension of new concepts and responding to interactions and problems with an understanding of the phenomenon. It is an ongoing process that takes place throughout an individual's life, with practical experience as a critical element.

This perspective is shared by Pear (2016), who believes that the science of learning overlaps with behaviour analysis but is not identical to it. Understanding the learner's behaviour before and after learning is necessary to assess the effectiveness of the learning process. However, Webb and Roberts (2017) emphasize that learning involves a progressive comprehension of new concepts, and the ability to apply that understanding in addressing or responding to related problems or phenomena. Importantly, learning is a process that occurs incrementally, with smaller units building upon one another to create a foundation of knowledge for the learner. Ultimately, learning results in a moderately sustainable or permanent change in behaviour or action. As individuals explore their environment, they gradually become more familiar with it and learn from it. Therefore, it can be concluded that learning involves a progressive acquisition of knowledge and skills, which is demonstrated by an individual's ability to apply that knowledge in addressing related problems or phenomena.

On the definition of a theory, Darling-Hammond, Rosso, Austin, Orcutt, and Martin (2001) define a theory as "an idea that explains a set of relationships that can be tested (p.9)." They argue that theories are developed through a combination of research, practical experience, and systematic observation, and are continuously modified over time based on the insights of practitioners and researchers. Furthermore, they stress that theories are interconnected and help to explain more complex phenomena. Sunday (2015) offers three additional definitions of theory: as a model or framework for observation and understanding; as a generalized statement that asserts a connection between two or more types of phenomena; and as a system of interconnected abstractions or ideas that organizes knowledge about the world. From these definitions, it can be concluded that a theory is a framework that enables researchers to study and analyze the truth or falsity of a phenomenon. According to Neuman (2006) as cited by Sunday (2015), a good theory should provide basic concepts, suggest ways to make sense of research data, enable connections to be made between studies, provide a wider view of the issue or event being studied, and increase awareness of the interconnections and broader significance of data. According to Neuman (1997) as cited by Sunday (2015), a good theory should: Therefore, theories serve as a foundation for understanding and projecting the occurrence of events, as they contain explanations within themselves. When studying any issue or event, theories provide a basis upon which one can develop understanding and make informed predictions.

Combining the two definitions give what a learning theory is. From the above definitions for both the terms 'learning' and 'theory', we can define learning theories as ideas, frameworks or models that explain how knowledge is acquired or constructed by an organism. As Dunn (as cited in Gbeze, 2014) notes, learning theories help us to understand the process of learning, providing us with a basis for analysis, discussion, and research in the field of learning and practice. Learning theories can summarize a vast amount of information about the rules of learning in a small space, making them an essential tool for educators. Davis (2013) sees learning theories as theories that explain, predict, and influence behaviour related to knowledge acquisition. According to Ertmer and Newby (2013), learning theories provide verified instructional strategies and techniques for facilitating learning and a foundation for intelligent strategy selection. Furthermore, Encyclopedia of Children's Health (2017) notes that learning theory focuses on environmental factors that shape children's intelligence, including how certain behaviours are encouraged and others discouraged.

To further support the statement that a good learning theory should provide practical applications for educators, Ertmer and Newby (2013) explain that learning theories provide instructional designers with verified instructional strategies and techniques for facilitating learning. Moreover, a learning theory that aligns with the teacher's view of learning can lead to better instructional practices and better outcomes for learners (Davis, 2013).In addition, Lefrancois (1988) as cited by Davis (2013) provides two models that represent most psychologists' perception of human beings: the Mechanistic Model and the Organismic Model. The Mechanistic Model views humans as predictable and highly responsive to environmental influences, resembling machines. On the other hand, the Organismic Model considers humans to be dynamic, active, exploring organisms. Understanding these models can help educators in designing instructional strategies that cater to the diverse learning needs of students.

The mechanistic and organismic models proposed by Lefrancois (1988) as cited by Davis (2013) have given rise to three main learning theories that have influenced the nature of teaching and learning throughout history. These theories are the behaviourist theory of learning, which stems from the mechanistic model, and the cognitivist and constructivist theories of learning, which emerge from the organismic model. While Ertmer and Newby (2013) acknowledge the division of learning theories into two main categories - behavioural and cognitive - they also recognize the addition of a third category, the constructivist theory, due to its unique instructional design. According to Chen (2010), constructivism is an improvement of cognitive science. Ertmer and Newby (2013) emphasize that while these theories may appear to overlap, they are "distinctive enough to be treated as separate approaches to understanding and describing learning" (p.46). It is important to note that behaviourism, cognitivism, and constructivism are not the only learning theories that have shaped teaching and learning. Rather, they form the foundation from which other learning theories have emerged.

Overall, a good learning theory should not only provide a clear understanding of the learning process but also offer practical applications for educators, align with their views of learning, and cater to the diverse learning needs of students.

2.2.2 Constructivist theory of learning

The constructivist theory of learning has been widely discussed and applied in the field of education. Cooper (1993) notes that there has been a shift from behaviourism to cognitivism and now to constructivism in designing instruction. According to Johri (2015), Vygotsky's social constructivist and Piaget's radical constructivist approaches are preferred by many modern pedagogical theories and practices around the world due to their numerous benefits.

Constructivism is a student-centered approach in which students construct their own knowledge through interactions with others based on their previous experiences (Sharma, 2014). Learners are seen as builders and creators in the learning process, while teachers act as facilitators. The constructivist approach relies on the interests, talents, attitudes, achievements, aspirations, and motivations of students, providing flexibility, motivation, adaptation, and flexibility for both teachers and students (Ahmad et al., 2021). This approach encourages students to learn through personal experiences, with the help of others and appropriate learning material.

Vygotsky (1978) proposed that learning can promote the development of critical thinking skills, which refers to the conscious evaluation of a problem or situation to arrive at a logical decision or conclusion (Davis & Kazlauskas, 2004). The constructivist theory emphasizes the interconnectedness of learning and development.

Jean Piaget's epistemological theory is one of the leading constructivist theories, which posits that individuals create knowledge by building upon their existing schemas when they encounter new information (Hmelo-Silver et al., as cited in Ahmad et al., 2021).

Jerome Bruner, another influential constructivist theorist, argues that learning is an active process that involves linking new information to prior knowledge. Constructivism focuses on the development of deep learning strategies that lay a foundation for knowledge acquisition and growth, rather than just acquiring information (Galindo, 2014; Vogel-Walcutt et al., 2011). In terms of instructional design, Bruner advocates for the use of discovery-based learning, where the instructor facilitates student learning through active dialogue and strategies such as Socratic questioning (Smith, 2009).

According to Bruner's constructivist learning theory, learners construct knowledge for themselves through experience and reflection (Bruner, 1966). They use their existing knowledge and cognitive structures to select and transform information, construct hypotheses, and make decisions. This process helps learners expand their critical thinking skills, leading to future knowledge acquisition (Smith, 2009).

Bruner's theory emphasizes the importance of three modes of representation for children's learning: enactive (action-based), iconic (image-based), and symbolic (language-based) (Bruner, 1966). These modes of representation can be facilitated by instructional technology (Prensky, 2007).

Constructivism argues that knowledge is dependent upon both meaning and experience (Mascolol & Fischer, 2005). According to McLeod (2019), cognitive growth involves an interaction between basic human capabilities and culturally-invented technologies that serve as amplifiers of these capabilities. In the classroom setting, learners construct their understanding and knowledge of the world through experiencing things and reflecting on those experiences (Sherman, Richardson & Yard 2013). They reconcile new experiences with previous ideas and experiences, changing or discarding information as necessary.

As active creators of their knowledge, learners are encouraged to ask questions, explore, and assess what they already know about a phenomenon (Askew, 2013). The diagram below illustrates the constructivist learning theory.

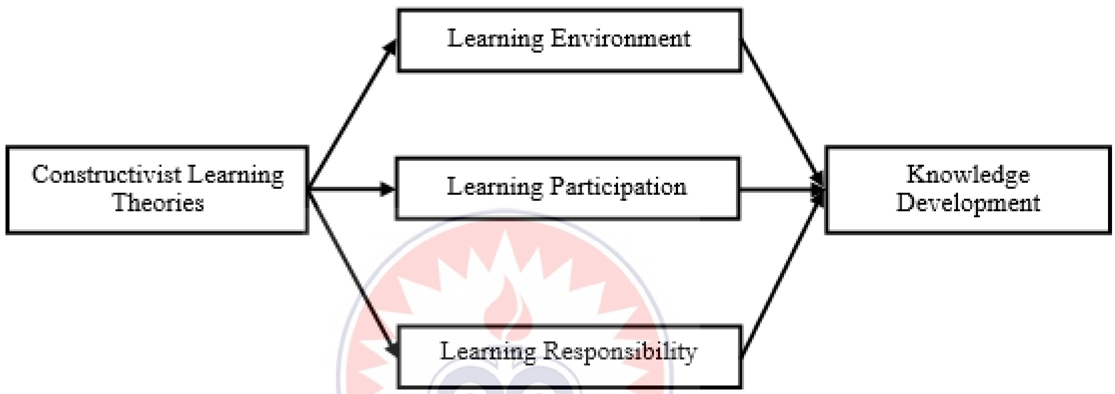

Figure 1: Constructivist learning theory

Source: Nugroho and Wulandari (2017, P.413)

The figure shows that knowledge development is a function of three factors:

The Figure illustrates that knowledge development is influenced by three key factors: learning environment, learning participation, and learning responsibility. Firstly, the learning environment plays a critical role in shaping the learning experience. According to Fouze and Amit (2018), an environment that aligns with learners' ethnocultural values can enhance their learning by linking it to their pre-existing knowledge. For instance, in the context of learning geometry, learners may benefit from experiencing shapes physically through demonstration and experimentation. Secondly, learning participation is essential for meaningful learning. As Nugroho and Wulandari (2017) suggest, learners should engage in activities that involve integrating learning into their environment, solving real-life problems, and teaching others. These activities can foster a sense of community among learners of different levels of understanding and promote their active involvement in the learning process. Finally, learning responsibility involves giving learners control over their learning activities, which helps them better understand their roles as learners in the learning process (Nugroho & Wulandari, 2017).

In addition to the three factors in Figure 1, Piaget's theory of constructivism provides insights into how learners internalize knowledge through the mechanisms of accommodation and assimilation. According to Piaget, people construct new knowledge from their experiences through these processes. Assimilation involves integrating new information into an existing framework without changing that framework, while accommodation involves reshaping one's perceptions of the world to fit new experiences (Piaget, 1972).

Constructivist teaching emphasizes the importance of meaning-making and active engagement in the learning process. Learners are not passive recipients of knowledge but are actively involved in constructing their own understanding. This approach fosters motivation, encourages creativity, and promotes critical thinking skills, leading to independent and self-directed learners (Bhattacharjee, 2015).

Based on these opinions, it can be concluded that constructivism has emerged as the dominant approach to education in recent years (Krahenbuhl, 2016), and has deeply influenced the teaching and learning process (Basturk, 2016). The use of constructivism in various disciplines and interdisciplinary fields has been increasing significantly (Jaleel & Verghis, 2015). For instance, teachers have begun to prepare lesson plans that include problem-solving, which is a core element of constructivism (Basturk, 2016). The constructivist theory emphasizes the active participation of learners in the teaching and learning processes and recognizes the culturally and socially rooted knowledge of learners (Fernando & Marikar, 2017). According to von Glaserfeld (1989), the theory of constructivism has two principles: firstly, the acquisition of knowledge is not a passive activity, and learners are actively involved in the learning process. Secondly, cognition has an adaptive function and works to organize the experiential world.

Therefore, teachers should acknowledge that learners are active participants in the teaching and learning environment. They should also focus on the point that the theory of constructivism can be connected to the practice of teaching. In summary, constructivism can be viewed as a teaching approach that encourages learners to create knowledge, fosters critical and creative thinking, and promotes independent learning.

2.3 Types of Constructivism in Education

Powell and Kalina's (2011) work highlight the two main types of constructivist practices in the classroom: cognitive or individual constructivism based on Piaget's theory, and social constructivism based on Vygotsky's theory. Piaget's cognitive development theory posits that a child builds a mental picture of the world through a process of biological maturation and interaction with the environment, with three key aspects: schemas, adaptation processes, and stages of cognitive development (McLeod, 2019).

In cognitive constructivist theory, Powell and Kalina suggest that individuals construct ideas through personal action, whereas social constructivism suggests that ideas are constructed through communication and social interaction in the classroom (Derry as cited in Dolma, 2016). This approach emphasizes the importance of culture and context in understanding and constructing knowledge, and is closely linked with contemporary developmental theories such as those of Vygotsky, Bruner, and Bandura's social cognitive theory (Schunk, 2000).

Through this constructive process of learning, students construct intended knowledge rather than simply rehearsing information for examinations and then forgetting it (Brooks & Brooks as cited in Dolma, 2016). Furthermore, Von Glaserfeld's work, cited in Dolma (2016), suggests that learning is dependent upon the learner's existing knowledge, which has been constructed through earlier experiences.

According to Sharma and Gupta (2015), Vygotsky developed the theory of social constructivism, which emphasizes that people learn through communication, social activities, and cultural apparatus. This theory asserts that knowledge is present in the social surroundings and people internalize it through communication and collaboration. In this process, the teacher plays the role of a guide and collaborator to facilitate learning. Jerome Bruner's theory of discovery learning emphasizes the importance of inquiry-based education. This theory asserts that it is beneficial for students to discover truth and relationships for themselves. Bruner's theory also explains language development, including the acquisition of intentions in communication, the growth of linguistic representation, early childhood interactions, and the role of parents in providing input and scaffolding to acquire linguistic structures. Shared meaning, according to Bruner's theory, is created through the active involvement of individuals in a social group and the meaningful use of language. This shared meaning involves collaborative, intersubjective, and interpersonal processes (Aljohani, 2017).

Similarly, David Ausubel was a prominent psychologist who contributed to the field of education with his theory of meaningful learning. According to Ausubel, learning is most effective when new knowledge is linked to pre-existing knowledge and when the learner finds the new information meaningful and interesting. Therefore, the role of the teacher is to create a supportive learning environment that helps learners make these connections and develop their understanding. In this theory, learning is not just the acquisition of isolated facts, but rather the integration of new knowledge into a meaningful context. Ausubel assumes that new knowledge must be acquired from a material that is interesting and meaningful to the learner and supported on their prior knowledge. According to this theory, teaching means creating situations that foster meaningful learning. Meaningful learning implies assigning meanings to new knowledge with personal components present in the cognitive system of each subject (Sousa et al., 2015). On the other hand, Chris Argyris is known for his theory of double-loop learning, which is a process of reflection and inquiry that challenges an individual's assumptions and beliefs about a problem or situation. Unlike single-loop learning, which focuses on improving efficiency within a fixed set of goals and assumptions, double-loop learning aims to change the underlying assumptions themselves, leading to more significant shifts in thinking and problem-solving (Ahmad, 2021).

Despite their differences, these theories share commonalities with constructivist approaches to teaching, which emphasize student-centered and inquiry-based learning. Students construct their understanding through contextual and meaningful experiences that build on their prior knowledge. These constructivist principles align with current trends in mathematics education reform, which focus on using real-life contexts and problem-solving to engage learners and deepen their understanding (Powell & Kalina, 2011).

Lowrie and Logan (2006) conducted a study on the use of realistic contexts to foster mathematical thinking, investigating the influence of genuine artefacts on students' spatial reasoning. The researchers found that students were more likely to utilize a range of spatial skills to complete mathematics tasks when they were deeply engaged in an activity. This finding supports constructivist views of learning, which suggest that mathematics should be learned through active involvement of students (Hurst, 2011). In this view, the teacher's role is to facilitate students' learning by providing authentic learning activities that are expected to arouse and motivate learners through the provision of materials related to real-life situations (Bickmore-Brand as cited in Dolma, 2016). A key goal of curricula based upon the social constructivist view is to achieve learning that is engaging, thoughtful, and meaningful to students. This means that students are encouraged to use prior knowledge to create or construct new knowledge in response to further experience.

One of the benefits of constructivist approaches is their inductive nature, which starts from examples that help students learn effectively. According to constructivist learning, ideas follow the action instead of preceding it. The activity leads to the ideas, rather than the concepts leading to the activity. In essence, constructive learning turns the traditional classroom procedure upside down. There are no lectures, demonstrations, or displays. From the outset, students engage in activities through which they develop skills and acquire new ideas (Bhattacharjee, 2015).

2.4 Constructivist Teaching and Learning Approaches in Mathematics Education

Constructivist theory has the potential to influence the role of the mathematics teacher and students as well as the pedagogical approaches used in the classroom. As pointed out by Brown and Coles (2012), in their classroom-based studies of how expert teachers reflect on their teaching, all learning is doing and all doing is learning and ultimately learning is equivalent to action. Teachers are no longer considered the only authority for learning in the classroom. Rather, students are encouraged to construct their own mathematical knowledge rather than receiving it in fixed form from the teacher or a textbook (Perry, Geoghegan, Owens, & Howe, 1995). According to Brooks and Brooks (1999), a constructivist approach is the key to building a deep understanding of mathematics in students.

According to constructivists, relational understanding of mathematics is considered to occur through active engagement of students in both cognitive and physical aspects. In support of this proposition, Hadi (2002), in a study of teacher professional learning activities relating to the introduction of a new approach in Indonesia (based upon RME), presented findings which revealed that doing mathematics was rated as the best approach by participants. The result of Hadi's study implied that learning takes place only when the learners are involved in doing something on their own in a relevant context and using authentic learning tools. It is through learning by doing that learners are engaged both cognitively and physically, and are expected to make sense of the concept, ultimately leading towards deeper understanding of mathematics.

Further, Goldsmith and Mark as cited in Dolma (2016), in their discussion about the purpose of standards-based mathematics curriculum in the United States, have referred to the term constructivism as "students being actively involved in building their own understanding" (p. 40). Aligning with this definition, these authors supported the argument that curriculum must enable students to make sense of mathematics and at the same time recognise and value their own mathematical thinking. Students are expected to derive knowledge through collaborative investigations and hands-on explorations using various representations and discussion (Goldsmith & Mark, as cited in Dolma, 2016). Hence, social constructivism serves as a basis for many current reforms, including those in mathematics education such as NCTM (connection to students' daily experience) and RME (horizontal connection).

Moreover, teachers and administrators are expected to be in a position to support students by providing learning materials that will promote a rigorous and constructivist based mathematical environment for them to develop both skills and deep understanding. Extending this point, teachers' deep and flexible understanding of mathematical concepts could help in providing richer learning opportunities for students. The implication is that mathematics learning requires the learning experience to engage students actively with appropriate resources supported by knowledgeable teachers. The focus of learning has shifted, as McLean and Hiddleston (2013) argue, from product to process. Constructivist environments are claimed to provide this opportunity since central to constructivist theory is the recognition of the influences of prior knowledge and experience upon learning. Thus, in mathematics education, the implication is that the content of mathematical activities should be based on children's life experiences so that they can find solving mathematical problems both easier and more enjoyable.

Ball and Bass (2000), in a literature review focused on the construction of mathematical knowledge in the elementary classroom, have argued that learners should be provided with situations in which they can construct relevant mathematics themselves. A similar point was made by Perry et al. as cited in Dolma (2016) in their report on cooperative learning and social constructivism in mathematics education: students attributed much of their success in their mathematical development to a supportive environment in which they cooperated. Therefore, as described by cited in Dolma (2016) citing Smith argued that it is important for teachers to choose learning problems and situations that will actively involve students and stimulate student interest in how mathematics is applied to real world situations.

Aligning with this point of providing a suitable situation for learning, there needs to be a shift in the role of the teacher from an explainer to a facilitator paying attention to all students, fulfilling the NCTM's equity principle (Lingefjard & Meier, 2010). Further, to help students reach a targeted learning level, teachers are expected to design an appropriate learning activity, from which students' ability levels could be identified (National Council of Teachers of Mathematics, 2015). In the process, a teacher's role could be best described as facilitator in guiding students to perform a learning activity. For instance, in a case study of two experienced teachers implementing the strategy of mathematical modelling as participants in the Comenius Network in Germany and Sweden, Lingefjard and Meier (2010) explored the role of the teacher as a manager of learning. In this role the teachers supported their students in the problem solving process without pushing them towards one specific solution. They posed diagnostic questions to stimulate student thinking and supported them to ultimately solve problems on their own. Hence, the preferred situation for learning should be one that requires learners to understand, explain, defend and evaluate (NCTM, 2015).

2.5 Instructional Pedagogies Derived from Constructivism

Instructional pedagogies derived from constructivism are based on the belief that learners actively construct their own knowledge and meaning through their experiences and interactions with the environment. According to Jones and Brader-Araje (2002), constructivism provides teachers with instructional methodologies which correlate with current research on learning. The different perspectives held by constructivist on learning have paved way to a number of teaching strategies in the classroom (Palmer, 2005). Some of these teaching strategies include problem-based learning, inquiry learning, and discovery method, cooperative learning, just to mention a few. Muhagir (2014) identified and discussed three of these methods namely: scaffolding, discovery learning, and cooperative learning. These three are further discussed below:

Scaffolding: According to Wood and Middleton as cited by Dotse (2017), the concept of scaffolding represents any kind of support for cognitive activity that is provided by an adult when the child and adult are performing the task together. Collins et al. as cited by Muhagir (2014) state that scaffolding can be seen as a teacher carries out "parts of the overall task that the student cannot yet manage. As such, it involves a kind of cooperative problem-solving effort by teacher and student in which the express intention is for the student to assume as much of the task on his own as possible, as soon as possible" (p.6). Scaffolding, in the view of Muhagir (2014), is the support the teacher or other colleagues of the learner provide to the learner. He adds that it can be seen in various forms of learning like problem-based learning, classroom discussion, cooperative learning, and brainstorming.

Discovery Learning: Hammer (1986) defined discovery learning as a form of curriculum in which learners are exposed to certain specific questions and experiences in order for them to discover for themselves the intended underlying concept. Discovery learning is based on the assumption that pupils are more likely to retain the knowledge they discover for themselves. "In this teaching/learning approach of learning students are given assignment to do scientific experiment or to investigate a problem in order to discover concepts by themselves" (Muhagir, 2014, p.7). The student's inquiry is usually guided by the teacher and the material. Spencer and Walker (2011) as cited by Muhagir (2014, p.7), purport that discovery learning "exploits the strategies of engagement, exploration, explanation, elaboration, and evaluation of learning experiences" as well as strict supervision of learning activities by the teacher to ensure learners stay on track. To Yakubu (2015), "the role of the teacher in discovery learning is to provide pupils with problems and provide feedback when necessary, without actually directing their efforts" (p.26).

Cooperative learning: According to Muhagir (2014), in cooperative learning, learners are put in groups to work collaboratively towards implementing a learning task. He adds that collaborative learning comes in different variations such as problem-solving, laboratory work, and in projects such as designing a prototype of a product or an object. Assignments given under co-operative learning should be clearly explained so as to ensure a correct division of task and to maximize learning

According to Yakubu (2015), constructivism has given rise to many different but related instructional approaches, some of which include problem-based learning, inquiry learning, cooperative learning, and others.

Case-based learning: According to Herreid (2012) as cited by Yakubu (2015), case-based learning uses real-life examples to enhance a learner's understanding by solving questions about specific cases, usually in small groups. Learners benefit from this approach as they are given an opportunity to make decisions and consider different perspectives. Through collaborative learning and group discussions, pupils are encouraged to take responsibility and respect different views, while developing critical thinking, creativity, self-learning, and communication skills.

Inquiry-based learning: ccording to Edelson, Gordin, and Pea cited by Yakubu (2015), inquiry-based learning places the responsibility for learning and understanding concepts on pupils, actively involving and leading them to understand concepts usually through questions that serve as a guide to instruction. Lee et al. (2004) as cited by Yakubu (2015) posits that this method helps pupils learn to formulate good questions, identify and collect appropriate evidence, present results systematically, analyze and interpret results, formulate conclusions, and evaluate the worth and importance of those conclusions.

Problem based learning: According to Tan (2021), problem-based learning teaches pupils to think critically, analyze problems, and use appropriate resources to solve real-life problems by presenting them with open-ended and authentic problems as they work in teams to find hints and develop solutions with teachers acting as facilitators. Throughout this process, the teacher plays the role of a facilitator, mainly providing guidance and advice, rather than directing and managing pupil’s work. At the end of the process, pupils demonstrate their newly acquired knowledge and are judged by how much they have learned and how well they communicate it.

Active learning: Yakubu (2015) describes the process of active learning as create an environment in which learners solve problems, answer questions, formulate questions of their own, discuss, explain, debate, or brainstorm during lessons. This, she adds, greatly encourages the learner as they are actively involved in the learning process. Active learning involves learners in two ways, thus, doing things while at the same time thinking about the things they are doing (Yakubu, 2015) under the guidance of the teacher.

In summary, therefore be concluded that the constructivist approach to teaching mathematics has given rise to several teaching and learning approaches, including scaffolding, discovery learning, cooperative learning, case-based learning, inquiry-based learning, problem-based learning, and active learning. These approaches promote learners' engagement in the learning process and provide opportunities for learners to construct knowledge through their experiences and interactions with the environment, peers, and teachers (Yakubu, 2015). By utilizing these approaches, teachers can create a conducive environment for learners to develop critical thinking, creativity, self-learning, communication, and problem-solving skills.

2.6 The Constructivist Approach to Education

Education is viewed as an important aspect of social life, much like nutrition and reproduction are essential to physiological life (Dewey, as cited in Gül, 2016). Dewey emphasized the importance of action and experience in education, as learners build their knowledge by manipulating materials and taking actions based on their experiences (Gül, 2016). This aligns with constructivist-based approaches to education, which prioritize the active engagement of learners in the learning process.

Traditional education systems that rely on prescription and fixed models are criticized for not allowing learners to perceive and explain ends or apply judgment in selecting and adapting means (Gül, 2016). In contrast, a more participative, creative, and constructive approach to education is vital, where learners are actively engaged in constructing their own knowledge. Gundogdu (2010) conducted a quasi-experimental design study in Turkey to explore the effectiveness of constructivist-based approaches to teaching. The study involved 85 prospective teachers in a public university who were taught a Human Rights course using either traditional or constructivist methods. The experimental group, which was taught using constructivist methods, demonstrated significant improvements in their application of constructivist principles. Gundogdu concluded that constructivist-based approaches that are learner-centered are more effective and have a longer-lasting impact on learners' attitudes.

In constructivism, the development of child psychology is essential, as learners construct their knowledge to understand the world around them. Teachers should consider the stages and steps of a child's cognitive development when designing learning materials and activities (Piaget, 1973). Piaget argued that children must pass through various stages that may initially involve forming incorrect ideas, but these ideas are essential to reaching a final, correct solution. It is crucial to take into account a student's motor and mental level when providing learning materials and activities, avoiding requirements that may be beyond their developmental stage. This gradual increase in knowledge and intellectual skills towards logical thinking is a central tenet of constructivism.

According to Cambourne (2010), children are active learners who constantly interact with their environment and should be provided with a classroom environment that encourages exploration and discovery of relationships and other phenomena that interest them. To foster the development of creativity and production skills, teachers should provide appropriate learning conditions. Cambourne identifies eight conditions of learning: immersion, demonstration, engagement, expectations, responsibility, approximations, employment, and response. In the immersion condition, students are surrounded by and immersed in what they are learning. When learners observe examples of actions and artifacts, the demonstration condition is applied. Engagement involves the learner attending to and participating in the learning activity. Expectations are messages that learners are able to and expected to do the learning activity. Responsibility provides opportunities for students to take ownership and make their own decisions about what they learn. The approximations condition allows learners to make gradual progress towards the correct level. Employment refers to opportunities for learners to apply and practice what they have learned. Finally, the response condition involves giving feedback or information to help learners see their improvement. These conditions of learning can help children become capable and creative learners by allowing them to discover and learn through exploration and hands-on experience. By providing a classroom environment that encourages active learning and exploration, children can develop their skills and become independent learners who are capable of solving complex problems and creating new ideas (Cambourne, 2010).

Constructivist theory emphasizes that children learn by actively constructing their own understanding of the world through interaction with their environment (Vygotsky, 1978). In order to fully comprehend scientific concepts, children must engage with them in a meaningful way that connects their prior knowledge with new information. Vygotsky (1978) argued that language plays a crucial role in this process, as it helps children to organize their thoughts and create new opportunities for learning. As children navigate the tension between their existing perceptions and new information, social interaction and context are essential components of their cognitive development. Vygotsky (1978) introduced the concept of the zone of proximal development (ZPD), which refers to the range of tasks that a child is able to perform with the assistance of others. The ZPD is the space between the child's current level of independent problem-solving ability and their potential level of development when provided with support or guidance from a more capable peer or adult. This concept highlights the importance of social interaction and collaboration in the learning process, as children can achieve greater levels of understanding when working with others who are more knowledgeable or experienced.

Moreover, Vygotsky (1978) stressed that the relationship between language and cognitive development is symbiotic. Language is both a tool for organizing and expressing thoughts, and a means of shaping and extending cognitive processes. Thus, the use of language within the ZPD can enhance children's learning experiences by providing them with a more comprehensive and nuanced understanding of the subject matter. In this way, constructivism highlights the importance of providing students with a rich and diverse language experience in the classroom, as this can contribute to their overall cognitive and intellectual development.

In addition to the points mentioned earlier, motivation plays a crucial role in constructivism. According to von Glasersfeld (1995), students are more likely to be motivated to learn when they understand the usefulness of what they are learning. However, traditional schooling often emphasizes rote memorization and exam preparation rather than intellectual growth and development. In radical constructivism, there is no fixed teaching procedure or "right" way to teach. Instead, constructivism provides a theory of knowledge, communication, and the learning process that encourages teachers to use their own creativity and imagination (von Glasersfeld, 1995). This means that constructivism cannot offer prescriptive guidelines for teachers, but it can help teachers to identify fruitless or counterproductive practices and suggest opportunities to promote meaningful learning.

Overall, constructivism diverges from positivist approaches in terms of epistemology and ontology (Goodman, 2005). Constructivists reject the idea that knowledge exists independently of the knower and argue that knowledge is constructed by the learner, not objective. This perspective emphasizes the complexity of education and the importance of taking students' individual needs and experiences into account. As Goodman (2005) notes, education cannot be reduced to a simple, linear process; rather, it is a complex and multifaceted issue that requires careful consideration of a range of factors.

2.7 Constructivist Approaches for The Teaching of Mathematics

1. *Concrete, semi-concrete, abstract, representational instruction.*

Approaches to teaching mathematics that follow the concrete, semi-concrete, abstract, and representational continuum align with social-constructivist theory as they allow students to construct their own meaning rather than simply memorizing a behavioural response (Baroody et al., 2013). While many students can easily connect concrete and abstract concepts in math, they may struggle with bridging the gap between concrete objects and their representations on paper (Baroody et al., 2013). An intervention that included representational problem-solving procedures showed more growth in word problem solving for low-achieving students than high-achieving students (Zhu, 2015). Therefore, teachers should provide mathematics instruction that scaffolds the relationship between concrete, representational, and abstract mathematics concepts, recognizing that some students may require more instruction to move along the continuum than others.

Explicit instruction using the concrete to representational continuum, as part of a social-constructivist approach, includes using an advance organizer, teacher modeling, guided practice, independent student practice, advanced application, and specific feedback (Agrawal & Morin, 2016). Such instruction can be used to support the acquisition of mathematics procedures or to guide students towards developing conceptual knowledge (Agrawal & Morin, 2016). In a study, third-grade students who received interventions using concrete materials or a combination of visual and verbal strategies showed significantly higher mathematics growth than those in the control group (Swanson et al., 2014).

Providing systematic instruction in using concrete, semi-concrete, and abstract representations in mathematics can help students make connections between concrete objects and representational symbols, leading to better problem-solving performance (Driver & Powell, 2015). In particular, explicit instruction using the concrete to representational continuum improved student performance in various math areas, such as number sense, area and volume concepts, solving word problems, computing with fractions, and understanding ratios, proportions, and fraction equivalency (Baroody et al., 2013; Hunt, 2014; Kingsdorf & Krawec, 2016; Morin et al., 2017; Sharp & Dennis, 2017; Swanson et al., 2013; Watt & Therrien, 2016). To ensure understanding of underlying concepts behind abstract procedures, teachers should teach abstract concepts along the concrete to semi-concrete continuum (Baroody et al., 2013).

2. *Technology-based instruction as a constructivist practice.*

One area of mathematics instruction that has gained significant attention in research is the use of technology-based instruction as a constructivist practice. Technology-based programmes are increasingly being used in schools to teach mathematics concepts and promote real-world connections for students learning advanced math concepts (Creech-Galloway et al., Collins, 2013). The effectiveness of technology-based instruction depends on how it is employed and the mathematical level of the students (Baroody et al., 2013; Bottge, Ma, Gassaway, Toland et al., 2014; Burton, Anderson, Prater, & Dyches, 2013).

By incorporating technology in instruction, students can actively participate in learning and develop a deep understanding of mathematical concepts through a constructivist-based approach. Technology-based instruction can be used in both non-constructivist practices, such as direct instruction and rote practice, and in constructivist practices, such as anchored instruction and self-modeling tools. Therefore, technology-based instruction can provide students with a variety of learning experiences that promote critical thinking, problem-solving, and real-world connections.

In conclusion, technology-based instruction has the potential to enhance mathematics instruction by promoting active student participation, real-world connections, and a constructivist-based approach. It is essential for educators to consider the mathematical level of the students and the appropriate use of technology-based programmes to ensure effective instruction and meaningful learning experiences.

3. Enhanced anchored instruction.

Enhanced anchored instruction (EAI) is a social-constructivist approach that promotes interactive and real-world experiences in mathematics to facilitate deeper understanding of underlying concepts. In EAI, teachers provide students with short contextual or situational videos that set up authentic learning situations, followed by real-world problems that allow students to apply the skills they have learned (Bottge et al., 2015). This approach not only enhances student motivation but also improves the maintenance of the concepts learned over time (Bottge, Ma, Gassaway, Toland et al., 2014; Bottge et al., 2015). EAI is particularly effective in providing applications for traditionally taught concepts within an engaging context, allowing students to develop real-world skills such as collaboration and problem solving that cannot be taught using traditional pencil and paper applications.

4. Problem solving strategy and skills instruction.

Developing strong problem-solving skills requires more than just a foundation in arithmetic concepts, numbers, and operations. Effective problem-solving instruction must also incorporate constructivist-based approaches that challenge students to process multiple layers of information and apply their number concepts and operations skills simultaneously (Hunt & Empson, 2014; Kong & Orosco, 2016). Effective problem-solving instruction also involves teaching students a variety of problem-solving strategies and skills that they can use to approach different types of problems. These strategies might include breaking problems down into smaller parts, visualizing the problem, identifying patterns or relationships, and using trial and error to test different solutions. By explicitly teaching these strategies and skills and providing opportunities for students to practice applying them, educators can help students become more confident and effective problem solvers. This can be particularly challenging for students who struggle with the cognitive demands of problem solving.

To address these challenges, educators can use a variety of instructional strategies that promote deeper understanding and engagement in problem solving. For example, educators can use problem-based learning, which encourages students to work collaboratively to solve complex, open-ended problems that require critical thinking and creative problem-solving skills. Additionally, educators can use metacognitive strategies such as self-reflection and self-evaluation, which help students develop a deeper understanding of their own thinking processes and problem-solving strategies.

In conclusion, effective problem-solving instruction requires more than just a foundation in arithmetic concepts, numbers, and operations. Educators must also use constructivist-based approaches, problem-based learning, and metacognitive strategies to help students develop the critical thinking and problem-solving skills needed to succeed in later grades and in real-world problem-solving situations.

2.8 Principles of Constructivism for Teaching Mathematics

Constructivism is an educational theory that emphasizes the importance of learners constructing their own knowledge and understanding of the world. The following is a review of the literature on the principles of constructivism in teaching.

1. Learning is an active process: In constructivism, learning is seen as an active process in which the learner is actively involved in constructing meaning from their experiences and interactions with the environment (Bruner, 1960; Vygotsky, 1978). Teachers who adopt a constructivist approach encourage students to engage in hands-on, real-world activities, and to question and challenge their own assumptions and those of others.

2. Learning is social: Constructivism emphasizes the social nature of learning, and the importance of social interactions in shaping students' knowledge and understanding (Vygotsky, 1978; Rogoff, 1990). Teachers who use a constructivist approach create opportunities for students to work collaboratively, share their ideas and experiences, and learn from each other.
3. Prior Knowledge: Constructivism emphasizes that learners' prior knowledge and experiences play a crucial role in the learning process. Teachers should build on their students' existing knowledge to help them construct new understanding (Brandsford et al., 2000)
4. Learning is contextual: Constructivism emphasizes the importance of context in shaping students' understanding of the world. Learning is not seen as a universal, objective process, but rather as a subjective process that is shaped by individual experiences and perspectives (Bruner, 1996; Dewey, 1938). Teachers who use a constructivist approach create learning environments that are relevant and meaningful to students' lives, and that encourage students to make connections between what they are learning and their own experiences.
5. Learning is reflective: In constructivism, learning is seen as a reflective process, in which students are encouraged to reflect on their own learning and to take ownership of their own learning process (Schon, 1983; Kolb, 1984). Teachers who use a constructivist approach encourage students to think about their own thinking, to reflect on their own learning process, and to take an active role in setting their own learning goals.
6. Learning is individual: In constructivism, learning is seen as an individual process, in which each student constructs their own knowledge and understanding in their own unique way (Piaget, 1970; Bruner, 1996). Teachers

> who use a constructivist approach recognize and value the diversity of students' experiences, perspectives, and learning styles, and create learning environments that support individual learning.

Similarly, Shandi and Purwarno (2018) viewed constructivism as a teaching theory that emphasizes learners' active participation in constructing their own knowledge and understanding. As such, the authors have identified several principles of constructivism, including creative and active classroom work, collaborative and action-based learning, task completion, and student autonomy. The theory also promotes awareness of learning, language, and culture in the classroom. In language classrooms, authentic, content-based, and multifaceted learning settings are crucial for comprehensive language understanding.

Recent research suggests that learners may develop their own comprehension, and teachers play a supportive role in the learning process (James et al., 2010). The importance of prior knowledge is also emphasized, as learners' existing comprehension provides a context for understanding new knowledge. Constructivist approaches consider cognition a two-way approach and emphasize collaborative learning and other discovery-based teaching techniques. Social aspects of learning are emphasized, and students are encouraged to exchange ideas, thoughts, and experiences with one another. This is achieved through discussions, peer coaching, and reflective activities like journal writing and drawing.

The constructivist classroom environment offers sufficient opportunities for discussion, dialogue, and reflection, with learners engaging with great notions and essential systematic values that can simplify practices and experiences (Fosnot, as cited in Ahmad, 2021). Overall, the principles of constructivism provide a valuable framework for effective teaching and learning in a variety of educational contexts.

Merve's (2019) discussion on the constructivist principles for effective learning highlights the following points:

a) The learning environment should be complex and relevant, and the assignments should be challenging enough to encourage problem-solving and critical thinking.

b) Social interaction is important for improving the cognitive process. Collaborative learning, where students interact with one another and share their perspectives, can be a valuable activity in the classroom.

c) Multiple perspectives and multiple modes of learning should be employed to provide learners with different ways of understanding the same content. Visual and auditory tools can be used to facilitate this.

d) Students should have ownership in their learning, including determining what they will learn and how they will learn it.

e) Self-awareness of knowledge construction is crucial for learners to understand their own learning process and monitor their progress.

These constructivist principles have been supported by other researchers as well. For example, Vygotsky's (1978) socio-cultural theory emphasizes the importance of social interaction in learning, while Dewey's (1933) experiential learning theory highlights the value of hands-on, active learning experiences. Additionally, Bruner's (1966) theory of discovery learning underscores the significance of learners actively engaging with the material and constructing their own knowledge. Overall, the principles of constructivism emphasize the need for active, collaborative, and reflective learning experiences that allow learners to construct their own understanding of the world around them.

The constructivist principles proposed by Ferguson (2001) have been endorsed by various authorities such as Jonassen (1991), Wilson and Cole (1991), Ernest (1995), and Honebein (1996). These principles must be accepted and applied to successfully use technology in a constructivist classroom. The principles include:

a) Creating "real-world" environments that make learning relevant
b) Focusing on solving real-world problems
c) Using instructors as guides
d) Providing learner control
e) Negotiating instructional goals with students
f) Using evaluation as a self-analysis tool
g) Providing the necessary conceptual tools to help learners interpret different perspectives
h) Ensuring that the learner is controlling and mediating learning internally
i) Providing multiple representations of reality
j) Focusing on knowledge construction, rather than reproduction (Ferguson, 2001).

These principles have significant implications for the use of technology in the classroom. According to Ferguson, a technology-integrated lesson plan that follows constructivist principles should be designed to bridge the transition between teacher-led instruction and self-directed learning by students (Ferguson, 2001).

According to Brunner, as cited in Gbeze (2014), there are several didactic instructional principles that can make constructivist teaching and learning even more effective. These principles include:

a) Instruction should be concerned with the experiences and context that make the student willing and able to learn.

b) Instruction should be structured so that it can easily be grasped by the students.

c) Instruction should be designed to facilitate extrapolation or fill in the gaps.

d) The instructor should encourage students to discover principles by themselves.

Since learners come from different social and ethnic backgrounds, they bring unique gifts, talents, and knowledge to the constructivist learning context (Southwest Educational Development Laboratory, as cited in Gbeze, 2014). To ensure that learners are not inhibited by their differences, learning situations must be firmly based on constructivist principles. This implies an ability on the part of learners to share without undue shame, shyness, or inhibition in team situations or when working with partners. It also implies that teachers are in agreement with the following constructivist ideas, premises, and principles, and are able to integrate them into their day-to-day practice:

Knowledge is constructed uniquely and individually, in multiple ways, through a variety of tools, resources, and contexts.

a) Learning is both an active and reflective process.

b) Learning is developmental.

c) We make sense of our world by assimilating, accommodating, or rejecting new information.

d) Social interaction introduces multiple perspectives on learning.

e) Learning is internally controlled and mediated by the students (Southwest Educational Development Laboratory, 1995).

Overall, the principles of constructivism emphasize the importance of active, social, contextual, reflective, and individual learning in the teaching and learning process. Teachers who adopt a constructivist approach create learning environments that support these principles, and that encourage students to take an active role in constructing their own knowledge and understanding of the world. By incorporating these principles, teachers can create an environment where learners are empowered to take control of their learning and construct their own knowledge

2.9 Effective Teaching and Learning in the Constructivist Classroom

According to the Australian Council for Educational Research (2015), there are three main functions that teachers must perform in a constructivist learning environment to facilitate student learning: modeling, coaching, and scaffolding.

Modeling is the most commonly used instructional strategy in a constructivist learning environment, as it helps learners understand how to perform specific tasks and activities. Modeling is a powerful instructional strategy because it provides students with clear examples of what they are expected to do and how they should go about doing it. Jonassen (1999) distinguishes two types of modeling: behavioural modeling, which involves demonstrating how to perform an activity, and cognitive modeling, which articulates the reasoning and cognitive processes that learners should use while engaged in the activity. In a constructivist learning environment, behavioural modeling is the most straightforward type of modeling, where the teacher demonstrates the desired behaviour or action that students should emulate. For example, in a science class, the teacher might model how to perform an experiment. On the other hand, cognitive modeling focuses on explaining the thought process or mental steps required to perform the task successfully. This type of modeling helps students understand not just what to do, but why and how they should do it.

Coaching is another critical function of the teacher in a constructivist learning environment. Coaching involves guiding and supporting students as they learn. According to Jonassen et al. (2008), an effective coach motivates learners, analyzes their performance, provides feedback and guidance on performance improvement and how to learn more effectively, and encourages reflection and articulation of what was learned. Teachers who take on the role of a coach in a constructivist classroom work to provide feedback, motivation, and support to students as they navigate complex tasks and concepts. Effective coaching involves helping students develop the skills they need to become independent learners, such as problem-solving, critical thinking, and metacognition. A good coach also helps students reflect on their learning, identify areas of strength and weakness, and set goals for future learning (Matthewman, Nowlan & Hyvönen, 2018).

Scaffolding is the provision of temporary frameworks to support learning and student performance beyond their current capacities. scaffolding is a technique used to help students' complete tasks that are beyond their current level of understanding or skill. The term "scaffolding" comes from the idea of providing temporary support structures, like scaffolds on a construction site, to help students reach their goals. In a constructivist classroom, scaffolding might involve breaking a complex task into smaller, more manageable steps, providing explicit instructions or guidance, or offering additional resources to support learning. The goal of scaffolding is to help students work independently by gradually reducing the level of support provided as their skills and understanding improve. When students are given tasks beyond their current level of understanding, scaffolding provides the necessary guidance to help them complete the task successfully. Scaffolding involves any type of support for cognitive activity that an adult provides when the child and adult perform the task together (Wood & Middleton, 1975, cited by Dotse, 2017).

In summary, three key instructional strategies used in a constructivist learning environment: modeling, coaching, and scaffolding. Modeling involves demonstrating desired behaviour or actions for students to emulate. Coaching involves providing guidance, feedback, and support to help students navigate complex tasks and concepts, while scaffolding helps students complete tasks beyond their current level of understanding or skill by providing temporary support structures. These strategies are essential for helping students become independent learners who can think critically, problem-solve, and reflect on their learning. In a constructivist classroom, teachers act as facilitators who support and guide students' learning, rather than simply delivering information. By effectively performing these functions, teachers can help create a constructivist learning environment that promotes active, reflective, and socially interactive learning, where learners construct knowledge through multiple tools, resources, and contexts.

2.10 Educational Benefits of Constructivism

Constructivism is a well-established learning theory that has been shown to have numerous educational benefits. According to Mayer (2006), constructivism helps learners develop higher cognitive levels by building on their existing knowledge. This means that learners are actively involved in constructing their own understanding of the world around them. In addition, Steakley (2008) notes that learners acquire knowledge through real-life experiences, which enables them to transfer their existing knowledge to new situations. This is particularly important in multidisciplinary learning environments, where learners can construct conceptual frameworks that are useful across a range of disciplines (Khuzzan, Goulding & Rahimian, 2015).

Constructivism has also been found to be an effective way of helping learners feel that they are part of the world and its history (Jaleel & Verghis, 2015). As Thompson (2015) points out, constructivism can facilitate learning by encouraging learners to take ownership of their learning process. This might involve allowing them to choose the background, tools, and methods they use to complete a task. In addition, constructivism promotes individualized learning by recognizing that learners have different interests and learning styles. For example, in a music class, a student who loves heavy metal may not be interested in playing the harp (Shively, 2015).

Another advantage of constructivism is that it promotes lifelong learning and self-directed learning. According to Gomleksiz and Elaldi (2011), learners who are involved in the learning process are better able to evaluate their own progress and make decisions about how they learn. This means that they are more likely to continue learning throughout their lives. Additionally, Marlow and McLain (2011) suggest that constructivism can lead to professional growth for teachers, as it encourages them to think critically about their own teaching practices.

Social constructivism, in particular, emphasizes the importance of the social context for learning. According to Qi (2019), learning is a social process, and learners benefit from interacting with others during the learning process. Mishra (2014) notes that social constructivism can be especially useful for helping learners construct knowledge in a social context.

Finally, content-rich lessons have been found to be particularly effective in helping learners acquire knowledge and understanding (Hendry et al., 2017). To promote critical thinking and reasoning skills, for example, mathematics instructors may use a variety of materials (Dewi & Harahap, 2016), while science instructors may focus on learning activities to measure learners' acquisition level (Hartle et al., 2012). This type of interdisciplinary learning can help learners develop the skills they need to deal with real-life problems (Kamphorst, 2018).

Overall, constructivism offers many benefits for learners and teachers alike. By promoting active participation in the learning process, individualized learning, and lifelong learning, constructivism can help learners develop the knowledge and skills they need to succeed in a rapidly changing world.

2.11 Criticism of Constructivism

Constructivism, a popular educational theory, has faced criticism from various angles. Fox (2006) and Terhart (2003) as cited by Owusu (2015) have leveled the following criticisms against constructivism:

First, constructivism is elitist. Critics argue that constructivism and other "progressive" educational theories have been most successful with children from privileged backgrounds who have access to quality teachers, supportive parents, and a conducive home environment. On the other hand, children from disadvantaged backgrounds may benefit more from explicit instruction rather than constructivist methods (Barton & Levstik, 2004).

Another critique is that social constructivism promotes group thinking, which can lead to a "tyranny of the majority." In such classrooms, a few learners' voices may dominate, while dissenting learners are forced to conform to the group's consensus (Burbules & Berk, 1999).

Critics also claim that there is little hard evidence to support the effectiveness of constructivist methods. They argue that constructivists reject testing and external evaluation, making themselves unaccountable for their learners' progress. Some studies, such as the 'Project Follow Through,' a long-term government initiative, found that learners in constructivist classrooms lag behind those in more traditional classrooms in basic skills (Brooks & Brooks, 1999).

Also, constructivism has faced criticism for its complexity, making it difficult for anyone to grasp the theory in its entirety. According to Gordon (2009), it can be challenging to create a consistent definition of constructivism and simplify it without a properly designed lesson. Additionally, constructivist teaching strategies require expert teachers in terms of pedagogy. However, not all teachers are adequately prepared for constructivist teaching, which requires them to be able to identify what their students need and make the required alterations to their teaching methods.

This issue is particularly acute in developing countries where there is often a lack of education for teachers to prepare them for the future. Instead of providing practical training, faculties often give nothing more than thick textbooks. To be an effective teacher, experience and creativity are essential, but newly graduated teachers may find themselves struggling to hold the attention of 20 pairs of eyes in a small classroom.

It is crucial for both teachers and the education system to be well-prepared to teach constructivism effectively. The relevance of these critical views of constructivism should not be underestimated. These criticisms can guide constructivist educators' perspectives when planning constructivist lessons, enable them to exercise caution and discretion when implementing constructivist-based instruction, and provide insight for constructivist-based educators not to see constructivist teaching approaches as the only pedagogical solution for all subjects.

In summary, while constructivism remains a popular theory in education, its implementation can be challenging, particularly in developing countries where teachers may lack adequate training. Teachers and education systems must be well-prepared to teach constructivism effectively. Criticisms of constructivism can serve as a useful guide for constructivist educators when planning lessons, ensuring that constructivist teaching approaches are implemented with care and insight.

2.12 Comparing and Contrasting of Constructivism to Other Learning Theories

Constructivism is a learning theory that has a unique approach to learning and has similarities and differences with other learning theories. For example, Bruner's constructivist learning theory emphasizes cognition, while Piaget's theory of cognitive development focuses on the different stages of mental growth. Both theories emphasize the role of the learner in constructing knowledge actively.

In contrast, Sweller's cognitive load theory emphasizes the role of prior knowledge and how it influences the acquisition of new knowledge. Similar to constructivism, Sweller's theory suggests that new knowledge can be altered based on previously-organized schemas. Therefore, these theories share a focus on the importance of prior knowledge in the learning process. In a study comparing objectivism, enactivism, and constructivism, Li, Clark, and Winchester (2010) argue that constructivism is not adequately supported by epistemological, ontological, metaphysical, and moral assumptions. Instead, they advocate for enactivism, which focuses on the inseparability of cognition and environment and the importance of both conscious and subconscious understanding in learning.

However, it is important to note that constructivism is a well-established learning theory with a strong empirical foundation and has been successfully applied in various educational contexts. The differences and similarities between constructivism and other learning theories highlight the complexity of the learning process and the importance of considering multiple perspectives when designing instructional approaches.

Li, Clark, and Winchester (2010) attempted to present a counter-argument to constructivism in the form of enactivism. However, the researchers appeared to pull pieces of constructionism, constructivism, and even behaviourism to form a new educational theory, which in many ways advocated for the same principles already established through constructivism. Thus, their criticisms fell short of opposing constructivism.

Bruner's constructivist learning theory, which is a cognition-based framework, has similarities with other well-respected leaders in education, such as Dewey, Vygotsky, and Montessori, who advocated for active learning from the very beginning (Bruner, 1957, 1966). According to Bruner, learning is active and must build on prior knowledge, and learners must be provided with the opportunity to grasp concepts and ideas for themselves. The effectiveness of active learning, coupled with the validity of meaningful and relevant learning experiences necessary for learning, supports the idea that today's generation of educators must modify their teaching styles to support the climate, culture, and community from which the students of today come to them from (Pulliam & Van Patten, 2007).

Richardson (2003) highlighted that there are significant differences between constructivist teaching and traditional teaching models. Marlowe and Page (2005) proposed four principles that distinguish constructivist learning from traditional learning. These principles include the active nature of learning, the emphasis on comprehension and application, the construction of knowledge by the learner, and the emphasis on thinking and analysis rather than memorization. According to constructivist theory, learners construct knowledge by interpreting their experiences and giving them meaning. Teachers play a facilitative role in this process, guiding students in constructing their own knowledge through interactive and problem-solving activities such as case studies, research projects, brainstorming, and collaborative learning.

Although the Ghanaian curriculum encourages the use of constructivist teaching approaches, there may still be teachers who hold beliefs in behaviourism and other teacher-centered approaches (Yarkwah, 2020). As such, there is a need to modify teacher preparation programmes to meet the changing needs of educators and learners. Pulliam and Van Patten (2007) argued that with the constant changes in curriculum, expectations, and student outcomes, teacher preparation programmes need restructuring to better equip teachers with the necessary skills and knowledge to meet the demands of modern education. This sentiment is echoed by Britland (2013) and Kearney (2016), who assert that teacher preparation programmes need to be updated and adapted to prepare teachers for the challenges of the modern classroom. Additionally, the rapid influx of technology in education has further emphasized the need for teacher preparation programmes to incorporate technology into their curriculum to adequately prepare future educators (Mustafa & Fatma, 2013).

Educational theorists have long emphasized the importance of creating interactive and engaging learning environments that are tailored to individual learners' cognitive abilities. According to Mustafa and Fatma (2013), a constructivist instructor's primary concern should be providing learners with environments that facilitate meaningful interactions, where they can construct knowledge based on their own experiences. As a result of the paradigm shift in society, education, and the workforce, the authors argue that a technology-supported constructivist approach and the creation of constructivist learning environments are essential to meet the needs of today's learners. Their research strongly supports the constructivist approach, which emphasizes activity and interaction, as a viable means of engaging learners and preparing them for a technology-rich world. Therefore, constructivist learning environments can help make education more meaningful and relevant, equipping students with the skills to become effective digital citizens.

Overall, the differences and similarities between constructivism and other learning theories highlight the complexity of the learning process and the importance of considering multiple perspectives when designing instructional approaches. By embracing the constructivist approach and creating engaging and interactive learning environments, educators can help make education more meaningful and relevant for their students.

2.13 Basic School Teachers Practice of Constructivism

Constructivism is a pedagogical approach that emphasizes learner-centered instruction and emphasizes the importance of the learner's experiences and knowledge in the learning process.

Dagnew's (2017) study examined how teachers in Dangilla district second cycle primary schools practice constructivism and the challenges they face in implementing it. The study identified five key roles that teachers should play in a constructivist classroom: Facilitating Role, Relationship Building Role, Scaffolding Role, Reflection Role, and Utilization of Dimension of Constructivist Teaching as Whole. The study found that teachers were not fully playing the facilitating role of student learning, which means that they were not providing enough opportunities for students to construct their own knowledge and understanding. However, teachers were found to be performing their relationship building role properly, which means they were building strong relationships with their students. Teachers were also found to be lacking in their knowledge of their students' interests, likes, and dislikes, as reported by principals. In terms of scaffolding, teachers were not providing enough support for students' learning, but they were good at structuring learning from mistakes. Moreover, the t-test result obtained from students and principals showed that teachers were not playing their reflection role properly in the classroom learning. Overall, the study found that teachers in Dangilla district were not fully implementing constructivism in their teaching, despite positive attitudes towards the approach.

Assuah et al.'s (2016) study found that primary school mathematics teachers generally had a positive perception towards constructivist instructional strategies. The study measured teachers' ideas, beliefs, and practices of constructivist instructional strategies using sub-scale mean scores, with scores above 3 considered positive and scores below 3 considered negative. The results showed that the sub-scale mean scores ranged between 2.35 and 3.71, indicating that teachers generally had a positive perception towards constructivist strategies. The study also found that a significant number of teachers used constructivist management strategies in their classrooms. Specifically, 31.7% of the teachers indicated that they frequently used constructivist management strategies, while 45.6% indicated that they sometimes used such strategies. However, 4% of the teachers indicated that they rarely used constructivist management strategies in their classrooms.

Overall, these findings suggest that while many primary school mathematics teachers have a positive perception towards constructivist instructional strategies, not all of them use such strategies frequently in their classrooms. This may be due to various factors, including lack of training or resources, and resistance to change. Teachers who are able to implement constructivist practices successfully tend to create learning environments that are student-centered, emphasize collaboration and active engagement, and provide opportunities for students to engage in authentic, real-world tasks. Therefore, it is essential for basic school teachers to receive appropriate training and support to improve their understanding and practice of constructivism in teaching.

2.14 Challenges of Using Constructivism In Teaching

While social constructivist learning approaches are seen as valuable in higher education, their implementation can be challenging. Studies have documented various real-world challenges faced when implementing social constructivist learning activities. For example, in the field of International Education, the implementation of learner-centred education (including social constructivist learning) in different countries is "riddled with stories of failure" (Schweisfurth, 2011, p. 425). In some cases, Chinese teachers, who are accustomed to more hierarchical cultures, expressed low support for social constructivist learning approaches compared with Flemish teachers (Zhu, Valcke & Schellens, 2010). In the field of Educational Technology, Lee, Huh, and Reigeluth (2015) reported instances of intragroup conflicts when implementing collaborative learning approaches. Loke et al. (2012) described challenges in balancing free exploration with fixed class times. Valtonen et al. (2013) highlighted issues with getting students to value collaborative learning processes. These challenges need to be addressed for effective implementation of social constructivist learning approaches in the classroom.

One of the challenges identified in implementing constructivism in teaching is inadequate prior knowledge of the learners. According to Moskal, Loke, and Hung (2016), teachers often face the challenge of engaging students in learning when they lack the necessary prior knowledge on which the teacher can build their lessons. This challenge poses a dilemma for teachers who want to implement social constructivist learning because such approaches inherently imply that students have incomplete prior knowledge. Sweller, (2006) found that novice learners in constructivist environments often lacked the necessary prior knowledge to integrate new information, while non-novice learners would benefit from such minimally guided activities. To address this challenge, Wass and Golding (2014) suggested that teachers design learning activities that better align with students' Zone of Proximal Development (ZPD), which should be beyond individual problem-solving but achievable via collective problem-solving. Hayden et al. (2016) recommended that teachers design case questions of varying difficulty and adjust difficulty as students progress to situate activity within students' ZPD, group students of differing abilities together and encourage them to help each other, and suggest ways for students to participate even when they are unsure. By addressing this challenge, teachers can better support students' learning and engagement in social constructivist learning activities.

Moskal, Loke, and Hung (2016) also identified a challenge with generating ideas from students, as they found that students were often uncomfortable exposing their incomplete understanding to their peers. This reluctance to engage with group annotation activities may hinder the effectiveness of social constructivist learning. Some students in the study suggested that anonymizing annotations could make them more willing to expose their incomplete understanding, but this is not recommended since ownership of the emerging body of knowledge is a crucial characteristic of social constructivist learning (Scardamalia & Bereiter, 2006). To create a safe learning environment where students feel more comfortable exposing their incomplete understanding, the authors recommended that teachers employ strategies for creating a safe environment for online learning. Palloff and Pratt (2007) provide useful strategies, such as the establishment of ground rules that respect a diversity of views, so students feel safe expressing themselves without fear of punishment. Teachers can position these learning environments as spaces where students can deliberately explore and articulate their incomplete understandings.

A study conducted by Dagnew (2017) aimed to identify the major challenges that hinder teachers' practice of constructivism in Dangilla district second cycle primary schools. The study collected data through a questionnaire that listed 12 challenges associated with the use of constructivism, and the responses were analyzed using percentage and mean value. The study identified that 59% of teachers and 63% of principals (59.2% of the total respondents) agreed that large class size was the most serious challenge. Additionally, the findings revealed that scarcity of learning resources (laboratory and pedagogical materials, textbooks, etc.) was not a major challenge, as confirmed by 59.7% of teachers and 63.6% of principals (59.8% of the total respondents). Furthermore, 59% of the teachers and 81.8% of principals revealed that curriculum materials (textbooks) were not prepared in a way that could facilitate a constructivist approach. The study also found that teachers' lack of dedication to implementing constructivist teaching, scarcity of allotted time to carry out active learning in greater depth, and teachers' lack of skill and knowledge to utilize constructivist teaching strategies were significant challenges. The study revealed that most teacher respondents (55.3%) did not consider lack of knowledge and skill to carry out constructivist teaching as a serious challenge, but 63.7% of school principals confirmed it as the most serious challenge. The study highlights the importance of addressing these challenges to effectively implement constructivist teaching in primary schools.

The study by Ahmad et al. (2021) aimed to identify the reasons why teachers in primary schools do not use a constructivist approach in teaching English grammar and the challenges hindering its implementation. The authors found that several challenges associated with constructivism in teaching English grammar, including overcrowded classrooms, limited time, untrained teachers, lack of teacher independence, heavy workload, deficiency of teachers, lack of facilities, lack of teacher preparation, lack of attention (from teachers, parents, and students), non-conducive learning environment, and lack of assessment. These findings are consistent with the challenges identified by other studies (Dagnew, 2017; Moskal, Loke, & Hung, 2016; Clark, 2006) and suggest that effective implementation of constructivist teaching requires addressing these challenges and providing support to teachers to enhance their skills and confidence in using this approach.

In conclusion, the challenges associated with implementing constructivist teaching approaches are varied and complex. These challenges include inadequate prior knowledge, discomfort with exposing inadequate understanding to peers, large class sizes, scarcity of allotted time for active learning, lack of teacher dedication and skill to implement constructivist teaching strategies, and scarcity of learning resources. These challenges may vary depending on the context and location of the implementation, as seen in the study by Dagnew (2017) which identified large class size as the most serious challenge in Dangilla district second cycle primary schools.

To overcome these challenges, teachers need to create safe learning environments, design learning activities that align with students' Zone of Proximal Development, and possess the necessary skills and knowledge to implement constructivist teaching strategies effectively. it is recommended that teachers design social constructivist activities of varying difficulty and adjust the difficulty as students' progress to situate activities within students' ZPD; group students of differing abilities together and encourage them to help each other; suggest ways for student participation even when they are unsure; create safe learning environments;

position activities as spaces for deliberately exploring and articulating incomplete understandings; design open-ended activities that genuinely allow multiple valid meanings to be made; and reassure students that correct answers will be given after (a) participation in the activity and (b) possible answers are discussed collectively. Addressing these challenges requires a collaborative effort from all stakeholders, including teachers, school leaders, and policymakers, to ensure that students receive quality education that prepares them for the demands of the 21st century.

2.15 Strategies to Enhance the Effective Use of Constructivist Approach In Teaching

Constructivist approaches to teaching have become increasingly popular in recent years, as educators recognize the importance of engaging students in active, participatory learning. However, despite the many benefits of this approach, teachers often face challenges when attempting to implement constructivist teaching methods in their classrooms. Several strategies have been identified for enhancing the use of constructivist teaching in classrooms.

One key strategy for enhancing the use of constructivist teaching is to create a safe learning environment. This can be achieved by establishing ground rules that respect a diversity of views and encourage students to express themselves without fear of punishment. Teachers can also position their classrooms as spaces where students can deliberately explore and articulate their incomplete understandings, creating an environment that encourages active participation and open communication (Parsons & Taylor, 2011).

Another important strategy is to provide students with adequate prior knowledge, so they are better prepared to engage in constructivist learning activities. To do this, teachers can design case questions of varying difficulty and adjust difficulty as students progress, group students of differing abilities together and encourage them to help each other, and suggest ways for students to participate even when they are unsure (Ahmad et al., 2021).

Teachers can also enhance the use of constructivist teaching by utilizing a variety of teaching strategies, such as cooperative learning, problem-based learning, and inquiry-based learning. These approaches can help students develop critical thinking skills, promote collaboration and communication, and encourage creativity and innovation (Anwer, 2019).

In addition, it is important for teachers to have the necessary knowledge and skills to effectively implement constructivist teaching. This includes knowledge of constructivist theory, an understanding of how to design and implement constructivist learning activities, and the ability to assess student learning in a constructivist context (Melesse & Jirata, 2015; Anagün, 2018).

Also, the use of technology can also be an effective strategy for enhancing the use of constructivist teaching. Technology can provide learners with access to a wealth of information and resources, and can facilitate collaboration and communication among learners (Gilakjani, Lai-Mei & Ismail, 2013). Technology can also be used to create interactive and engaging learning experiences that support the construction of knowledge.

Finally, it is important for schools and educational systems to provide the necessary support and resources to enable teachers to effectively use constructivist approaches in their teaching. This includes access to professional development opportunities, adequate time and resources for planning and implementing constructivist learning activities, and appropriate assessment tools and strategies (Alenezi, 2020).

In conclusion, the effective use of constructivist approaches in teaching requires a combination of strategies, including creating a safe learning environment, providing students with adequate prior knowledge, utilizing a variety of teaching strategies, developing teachers' knowledge and skills, and providing adequate support and resources. By implementing these strategies, teachers can enhance the effectiveness of constructivist teaching and help students develop the critical thinking skills and knowledge necessary for success in today's complex, ever-changing world.

2.16 Conceptual Framework of the Study

The conceptual framework of the study describes the relationship between the variables captured in the study; principles, practice, challenges and strategies of constructivism. The framework shows how the use of constructivist approach in teaching mathematics in the Effutu Municipality is influenced by three key factors relating to the teacher's knowledge of the principles of constructivism, the challenges encountered in its use as well as the knowledge of various instructional strategies to maximize the use of the approach. The principles of constructivism involve the teacher being a facilitator, the promotion of social interaction, use of instructional resources, active engagement of learners, building lessons on based on students' prior knowledge and the promotion of lifelong assessment. In the practice of constructivism, teacher make conscious effort to apply these principles such as encouraging active participation and engagement of students in mathematics lessons, provide opportunities for students to collaborate and discuss mathematical concepts among others. Yet this practice of constructivism cannot be without challenges. Among these challenges are the difficult identifying pupils' prior knowledge on which to build my new lessons, lack of instructional resources, large class size, and the teacher's knowledge and skill in using the approach compared to other traditional approaches. However, adopting appropriate strategies such as providing regular in-service and professional development training sessions on constructivist approaches to mathematics education for teachers and offering the necessary support systems in the form of instructional resources can help improve the use of constructivism in the mathematics classroom. Comprehensively, these factors influence each other in the use of constructivism by upper primary mathematics teachers in the Effutu municipality as illustrated on figure 1.

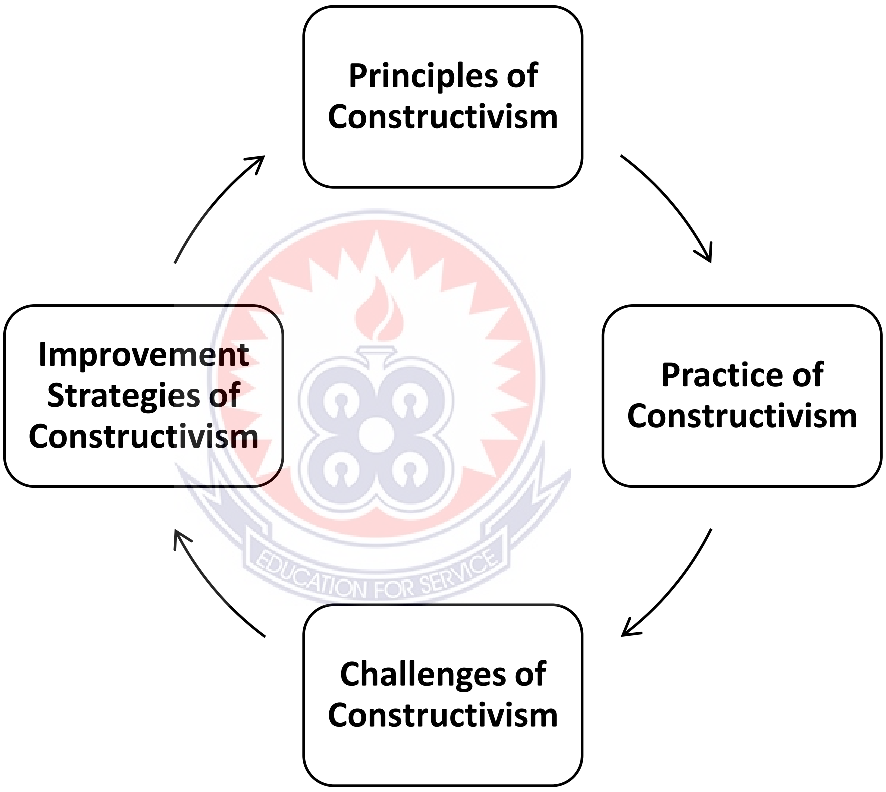

Figure 2: Conceptual framework showing the use of constructivist approach in teaching mathematics among Upper Primary School Teachers in the Effutu Municipality

Source: Researcher's own construct, (2023)

2.17 Empirical Evidence

Empirical evidence supporting constructivism in education has been well-documented in numerous studies. Qvortrup et al. (2016) assert that most contemporary learning theories, including Piaget's constructivist theory, emphasize the need for active engagement and dialogue to facilitate students' construction of knowledge and development of a personal academic identity. This view highlights the subjective nature of learning and the crucial role of the learner's cognitive construction in the process. Additionally, Amineh and Asl (2015) suggest that constructivism represents a synthesis of behaviourist and cognitive ideals, further emphasizing the importance of student-centered learning and the learner's active role in knowledge construction.

While constructivism has been widely endorsed as an approach to teaching mathematics globally, the available literature on this topic in Ghana is limited. Most of the existing research on constructivism has been conducted in other countries, such as studies on the effect of constructivism on problem solving in the United States (Ginga & Zakariya, 2020) and in teaching financial accounting (Oguguo & Francis, 2016), as well as research on general mathematics performance (Bermejo et al., 2021; Aydisheh & Gharibi, 2015), teacher interpretation of constructivism in teaching (Alsharif, 2014), and constructivist approaches to mathematics professional development among school leaders (Bugg, 2020). Other studies have explored the challenges of implementing social constructivist learning approaches (Moskal et al., 2016; Dagnew, 2017), the historical and personal perspectives of constructivism (Faulkenberry & Faulkenberry, 2014), the use of constructivist tools in mathematics education in Sweden (Aljundi, 2021), and teacher training, beliefs, and use of constructivism (Mercer, 2020). Therefore, there is a need for further research that investigates the use of constructivist approach in mathematics education specifically in the Ghanaian context.

Barman and Bhattacharyya (2015) for instance, conducted a study to ascertain the effectiveness of using the Constructivist Teaching Method on students' academic achievement in the study of Physical Science at the secondary level. The following were their findings after conducting the study: the constructivist teaching method is found to be significantly more effective and fruitful in teaching Physical Science as compared to traditional method of Teaching; the constructivist teaching method is found to be significantly more effective to enhance the performance of students in their academic achievement in the subject Physical Science as compared to traditional method of teaching; the constructivist teaching method makes teaching learning process less abstract and meaningful to the students; the constructivist teaching method is found to be significantly more fruitful in the formation of concept among the grade 8 school students as compared to traditional method of teaching and; that the constructivist teaching method motivates students better to their learning than the traditional method of teaching. They therefore concluded that constructivist teaching method is more effective and fruitful in teaching Physical Science than the traditional method of teaching.

Doğru, as cited by Yakubu (2015), studied the effect of traditional teacher-centred approaches to that of the child-centred constructivist methods. Initial test to assess learner performance after the lessons showed no significant difference between traditional and constructivist methods. "However, in the follow-up assessment 15 days later, learners who learned through constructivist methods showed better retention of knowledge than those who learned through traditional methods" (Yakubu, 2015, p.34).

Aydisheh and Gharibi (2015) study was also aimed at investigating the effect of constructivist teaching on students' academic achievement in mathematics. The study was an applied research with a quasi-experimental design and a control group. The statistical population consisted of 364 third grade girl students from high schools of Miandoab, Iran. To select the study sample, cluster random sampling was employed. In so doing, from among 6 schools with a total of 14 classes, one school was selected by a multistage method. Then, two classes of the selected school were randomly chosen; one as the experimental group and the other one as the control group. Instruments included a researcher-made questionnaire that was designed based on principles of academic achievement of Bloom's cognitive domain. The results indicated that constructivist teaching affects knowledge, understanding, application, analysis, combination, and evaluation. Based on the results of the study, it can be concluded that constructivist teaching can help with students' academic achievement.

Another study was conducted by Chowdhury (2016) to ascertain the effectiveness of the constructivist approach on student's achievement in mathematics, it was revealed that the orthodox methods of teaching and learning was not enough to develop critical thinking and risk taking attitude amongst students of today. Hence, the need for an urgent reform in our teaching practices in light of the NCF-2005 framework which views the child as a "discoverer" who can actively construct knowledge and build understanding through experimentation (National Council of Educational Research and Training, 2005). According to Chowdhury (2016), "the framework advocates the use of constructivism at every stages of Mathematics teaching" (p.40).

Mercer (2020) also studied teacher training, beliefs, and use of a constructivist learning environment supported by instructional technology. This study examined teacher training and beliefs in relation to the development of instructional technology-driven constructivist learning environments. The goal was to discover any existing gaps in theoretical beliefs and praxis, and develop recommendations that provide methods of merging theory into practice for both new and veteran teachers. Bruner's Constructivist Learning Theory was the theoretical framework

that was the basis for this study. Buttressing Bruner, Piaget, Vygotsky, and Montessori's influences on the development of constructivism as a theoretical lens were also used. The target sample of the intended study was sixth through twelfth grade teachers, both new (0-4 years of experience), and veteran (5 or more years of experience). Teacher participant data was collected via survey response. The findings were that there is not a statistically significant difference in training, belief, and implementation between new and veteran teachers.

In the Ghanaian context, such a study is rare. Primarily, studies on constructivism in Ghana have been skewed towards other subject other than mathematics. Again, it was contextualized in colleges of education and secondary schools. For instance, the study by Qarareh,(2016) examined the effect of using the constructivist learning model in teaching science (Qarareh, 2016) and in teaching an aspect of mathematics (algebra) in secondary schools (Owusu, 2015).

Quarreh (2016) also investigated the effect of using constructivist learning model in teaching science, especially in the subject of light: its nature, mirrors, lens, and properties, on the achievement of eighth-grade students and their scientific thinking. The study sample consisted of (136) male and female 8th graders were chosen from two basic schools in Tafila in the scholastic year 2015/2016. The four-class sample was divided into two groups (controlled & experimental). For achieving the study aims, the researcher prepared lesson plans using constructivist learning model, achievement test and scientific thinking test, which validity and reliability were checked. To answer the questions of the study, means, standard deviation, ANOVA and ANCOVA were used to determine the differences in means of the groups of the study. The results show that there is statistically significant difference at (α= 0.05) for the effect of the constructivist Learning model on the achievement and scientific thinking in favor of experimental group, and there is no statistically significant difference at (α= 0.05) for the constructivist Learning model on the achievement and scientific thinking attributed to gender, and there is no statistically significant difference at (α= 0.05) for the dual interaction between teaching method and gender on the achievement and scientific thinking. In the light of the study results, recommendations were made that extra attention should be given to employ constructivist learning model within science courses, and conducting further studies about the effect of the constructivist Learning model on various learning outcomes.

Owusu (2015) also examined the comparative effects of Constructivist Based Teaching Method (CBTM) and the Traditional Teaching Method (TTM) on Grade 11 Mathematics learners' errors in algebra. The constructivist learning theory (CLT) was used to frame this study. Mainly, CLT was used to influence the design of CBTI to hone participants' errors in algebra that militate against their performance in Mathematics. The study was conducted in the Mpumalanga Province of South Africa with a four-week intervention programme in each of the two participating secondary schools. Participants consisted of n=78 Grade 11 Mathematics learners and one Grade 11 Mathematics teacher. A non-equivalent control group design consisting of a pre-test and post-test measure was employed. The main aspects of CBTM entailed participants' construction of their own knowledge from the base of prior knowledge and through group learning approach and exploratory talk in which discussions included argumentation, verbalising explanations, justifications and reflections. The pre-test was used to determine participants' initial errors in algebra before the intervention. A post-test was given at the end of intervention to ascertain change in participants' errors in algebra over a four-week intervention period. Using descriptive and inferential statistical techniques, the study found that participants in experimental school significantly reduced their errors in algebra than those in control school. The study showed that CBTM was a more effective pedagogy that improved the errors Grade 11 learners commit in algebra than the

TTM.

In Effutu, teachers' perception and use of constructivism has been examined by Dotse (2017) among JHS mathematics teachers using the mixed method approach and underpinned by Piaget's theory of cognitive development.

In the study of Doste (2017), Junior High School mathematics teachers' perception and use of the principles of constructivism in the Effutu Municipality of the Central Region, Ghana were examined. This study used the descriptive survey research design and adopted a mixed method approach to data analysis and presentation. The purposive sampling technique was used to sample one hundred and thirty-eight (138) JHS mathematics teachers for the study. Instruments such as documents, a structured questionnaire and an interview guide served as tools for data collection. Data collected through these instruments were further analysed as follows: documents were analysed using content analysis; responses from the structured questionnaire were analysed using descriptive statistics such as mean, standard deviation and simple percentages; while responses from the interview were transcribed and analysed thematically. Also, the hypothesis for the study was tested using the Pearson product-moment correlation analysis. The study revealed that, contrary to the view that teachers in the basic school employ teacher centred methods of instruction, JHS mathematics teachers in the Effutu Municipality of the Central Region always employed the constructivist principles of learning in their classroom instructions which is a child centred approach and has been proven to maximize learning outcome. It again revealed JHS mathematics teachers' in the Effutu municipality had a positive perception about constructivism and that their perception of constructivism influenced their classroom instruction. The study also revealed that majority of the teachers had not attended any form of in-service training while others had not received any form of education on constructivism. It was thus recommended that the Ministry of Education (MoE) in collaboration with the Ghana Education Service (GES) establish clear policies to ensure and guide the professional development of teachers of mathematics so as to keep them abreast with modern theories of education, such as the constructivist theory of learning as well as effective methods of lesson delivery.

2.18 Summary of Review

The review has provided a comprehensive overview of constructivist theory and its application in education. The concept of constructivism in education has been widely discussed in the literature (Land & Jonassen, 2012; Vygotsky, 1978). Theories of learning, such as Piaget's constructivist theory of learning (Piaget, 1970), have provided a framework for understanding how students construct their own knowledge through active engagement with their environment. Other thematic areas covered included the concept of theories of learning, types of constructivism in education, constructivist teaching and learning approaches in mathematics education, instructional pedagogies derived from constructivism, principles of constructivism for use in teaching, effective teaching and learning in the constructivist classroom, educational benefits of constructivism, criticism of constructivism, basic school teachers' practice of constructivism, challenges of using constructivism in teaching, strategies to enhance the effective use of constructivist approaches in teaching, and comparisons of constructivism to other learning theories. The review confirms that in mathematics education, constructivist teaching and learning approaches have been shown to improve students' conceptual understanding and problem-solving skills (Cobb & Bauersfeld, 1995; Hiebert & Carpenter, 1992). Instructional pedagogies derived from constructivism, such as problem-based learning and inquiry-based learning, have been used to promote student engagement and understanding (Kirschner, Sweller, & Clark, 2006).

Despite the empirical evidence supporting the use of constructivist approaches in education, particularly in teaching mathematics, there is a lack of research specifically on the use of constructivist approaches in mathematics education in the Ghanaian context. This suggests a need for further research in this area to better understand the effectiveness of constructivist approaches in Ghanaian classrooms and to inform the development of effective teaching practices. Furthermore, the review highlighted a gap in the understanding and implementation of constructivist approaches among teachers. Many teachers in Ghana may not be familiar with constructivist theory and may lack the skills and knowledge to effectively implement constructivist teaching approaches in their classrooms. Therefore, professional development opportunities and support for teachers could be beneficial in improving their understanding and implementation of constructivist approaches.

In summary, while there is a strong theoretical and empirical basis for the use of constructivist approaches in mathematics education, there is a need for further research and professional development to enhance the effective use of these approaches in Ghanaian classrooms.

CHAPTER THREE

METHODOLOGY

3.0 Overview

This study focused on the use of constructivist approach in teaching Mathematics by Upper Primary Mathematics teachers in the Effutu Municipality. This chapter therefore discusses the various methods that were employed to generate and analyze the data used in the study. It gives insight into the research paradigm, approach and design, study area, population (target and accessible), sample and sampling technique, data collection instruments and procedure, validity and reliability of the research instrument, procedure for data collection, method of data analysis and ethical considerations of the study.

3.1 Research Paradigm

Research paradigm is the philosophical or motivation for undertaking a study (Cohen, Manion & Morrision, 2017). Hence, the approach that the researcher adopts in a study is underpinned by the paradigm they subscribe to base on a question to be answered. The positivist paradigm was adopted for this study. According to Saunders, Lewis & 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.

Moreover, Cooper and Schindler (2011) assert that the usage of measurable and gauging techniques in assertions of what is happening in a research phenomenon is found to enhance the interpretation of what is considered the objective reality of occurrences. Gauging techniques refer to the use of numerical measures (Sekaran 2016). 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).

Therefore, this study acknowledges constructivism as a social reality that can be objectively examined through the lens of the positivist paradigm. By employing quantitative methods and seeking numerical evidence, the researcher aims to provide a systematic and rigorous analysis of the phenomena under investigation. This approach aligns with the belief that objective knowledge about constructivism and its implementation can be obtained through empirical examination within a scientific framework.

3.2 Research Approach

The positivist paradigm aligns with a quantitative research approach, which involves quantifying assertions about a research phenomenon using numerical measurements (Hair et al., 2016). Quantitative research methods typically employ structured and close-ended inquiries, where the responses are subjected to measurement using numerical variables (Blumberg, Cooper & Schindler, 2016).

In the current study, a quantitative research approach was employed to investigate the teachers' perceptions and practices regarding constructivism. To collect data, a questionnaire was utilized, which consisted of structured and close-ended questions. This approach facilitated the standardization of data collection and allowed for the quantification of responses (Saunders, Lewis, & Thornhill, 2019). By assigning numerical values to the responses, the researchers were able to analyze the data statistically, identifying patterns, trends, and relationships (Blumberg et al., 2016).

Employing a quantitative approach in this study offered several advantages. It enabled the collection of large amounts of data from a relatively large sample size, enhancing the generalizability of the findings. The use of numerical data facilitated statistical analysis, allowing for the derivation of objective conclusions based on the data (Hair et al., 2019). Additionally, the standardized nature of the questionnaire ensured consistency in data collection, reducing potential biases and enhancing the reliability of the results.

3.3 Research Design

Research designs provide guidelines and instructions for conducting research (Creswell & Clark, 2018). The choice of research design depends on the purpose of the study (Cohen, Manion & Morrison, 2017). In this study, a descriptive cross-sectional survey design was deemed appropriate. This design aligns with the views of Allen (2017) and Ihudiebube-Splendor and Chikeme (2020), who suggest that cross-sectional surveys are employed to describe a population of interest at a specific point in time. It allows the researcher to study multiple variables simultaneously, which may not be feasible in laboratory or field experiments.

According to Creswell and Creswell (2017), survey designs provide quantitative or numeric descriptions of trends, attitudes, or opinions of a population by studying a sample of that population. From the sample results, the researcher can make generalizations or draw inferences about the population. The purpose of this survey was to generalize findings from a sample to a population, thereby making inferences about certain characteristics, attitudes, or behaviours (Creswell & Creswell, 2017). Surveys are known to reach a large sample size, enhancing the generalizability of the findings, and ensuring greater anonymity for respondents. They also provide consistent and uniform measures, and respondents are not influenced by the presence or attitudes of the researcher (Sarantakos, 2013).

Surveys have the capacity to provide descriptive, inferential, and explanatory information that can be used to determine correlations and relationships among survey items and themes (Cohen, Manion & Morrison, 2017). However, surveys also have limitations, such as the inability to ask probing questions or seek clarifications, difficulty in determining the contextual conditions under which respondents answered the questionnaire items, and the potential for a high non-response rate (Sarantakos, 2013).

The survey design was appropriate for this quantitative research as it helped address the research questions and achieve the objectives of the study. The survey design was chosen because its strengths outweighed its weaknesses, making it suitable for examining the opinions, ideas, and practices of constructivism among upper primary teachers. Additionally, the study aimed to capture the teachers' opinions at a specific point in time, further justifying the choice of the descriptive cross-sectional survey design

3.4 Study Area

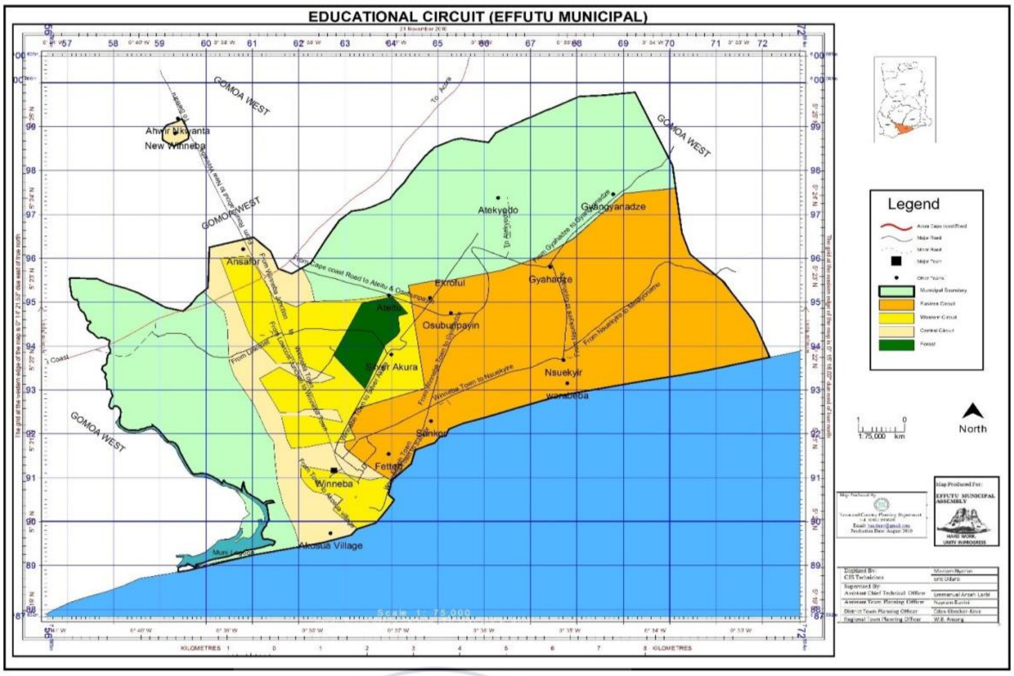

Figure 3: Map of Effutu Municipality

Source: Effutu Municipal Assembly Website

The research was conducted in the Effutu Municipality in the Central Region of Ghana, with Winneba as its administrative capital. The Effutu Municipality has a population of 107,798 according to the 2021 Population and Housing Census. Out of this population, 54,723 (50.76%) are males and 53,075 (49.24%) are females (Effutu Municipal Assembly, Composite Budget Report, 2023).

In terms of educational institutions, the municipality has a total of 247 schools, with 74 (30%) being public and 173 (70%) being private. These include 47 pre-schools (1 public and 46 private), 74 kindergartens (24 public and 50 private), 71 primary schools (26 public and 45 private), 47 junior high schools (22 public and 25 private), 8 senior high schools (1 public and 7 private), the University of Education, Winneba (which has its main campus in Winneba and other campuses at Ajumako), The Perez University (formerly the Pan African University, located in the Gomoa

East Municipality, Pomadze), a community health nurses training school, and a police staff and command college (Effutu Municipal Assembly, Composite Budget Report, 2023). The Effutu Municipality was chosen as the research site because teachers in the area were also required to use constructivism in their lessons. Again, no such study has been done for its upper primary teachers.

3.5 Population

Research population can be described as the totality of events, objects, or individuals that the research is concerned (Creswell, 2013). In this study, the population comprised of all Upper Primary School Teachers within the Effutu Municipality and was categorized under target and accessible population as follows;

3.5.1 Target population

According to Hair et al. (2016), a target population encompasses all potential cases that a study intends to include. The target population refers to the specific group or set of individuals that researchers want to study and draw conclusions about. In this study, the target population was composed of Upper Primary School Teachers who were involved in teaching mathematics in the 71 primary schools within the Effutu Municipality. This number was one hundred and forty-eight (148) based on data obtained from Effutu Municipal Education Office. This number consisted of teachers in both public and private schools in terms of their knowledge, practices and challenges regarding constructivism in mathematics education.

3.5.2 Accessible population

According to Explorable (2012), the accessible population, also referred to as the study population, is a specific segment of a larger population to which the researcher can apply their findings. The accessible population is obtained from the target population and can be considered as a subset of it. In the context of this study, data from the Effutu Municipal Education Office revealed that there were 26 public primary schools within the area. The accessible population therefore consisted of all upper primary mathematics teachers working in public basic schools within the Effutu Municipality. The municipality had eight-two (82) upper primary mathematics teachers at the time of this study. The researcher considered this category of teachers because they were those the researcher had easy access to through the official letter given by the Municipal Education Directorate.

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. In the present study, the sample was composed of all the eight-two (82) Upper Primary School Teachers responsible for teaching mathematics in public basic schools within the Effutu Municipality. This sample was chosen in order to generate findings that reflect the opinions of all the Upper Primary School Teachers within the public primary schools of the Municipality. Again, this sample helped to address the limitations of time and resources.

3.7 Sampling Technique

Sampling, as defined by Brynard et al. (2014), is a method employed to select a smaller group, known as the sample, with the aim of uncovering the characteristics of a larger group, referred to as the population. In this particular study, the census sampling technique was adopted, which involved selecting all the Upper Primary School Teachers responsible for teaching mathematics within public basic schools in the Effutu Municipality. The use of a census frame, where the entire population is included, is suitable when the study population is not extensive and the geographic area under study is not large.

One of the significant advantages of utilizing a census frame, as highlighted by Parker (2011), is that it provides every member of the population with an equal opportunity to participate in the study. Moreover, it has a higher potential to yield representative results. Since the number of Upper Primary School Teachers handling mathematics in the Municipality was limited, employing the census frame allowed for the inclusion of all teachers, enabling a comprehensive reflection of their opinions, ideas, and practices related to constructivism.

Nine of these teachers were purposively sampled for lesson observation. The choice of this number was influenced by several factors. First, upper primary levels in the Ghanaian education system comprised of three class: basic 4, 5 and 6. Hence, a teacher was selected from each of these levels. However, the municipality is spread across three circuits: Winneba East, West and Central. Hence, three teachers (representing the 3 Upper primary classes) were selected from each of the circuits based on their highest Mathematics teaching experience. By following this approach, the researcher aimed at ensuring that each of the upper primary classes and circuits within the Effutu municipality is represented in the study.

3.8 Data Collection Instruments

Annum (2017) defines research instrument as the tools for data collection. Thus, research instruments are tools designed to measure as well as obtain data on a given situation. They include, but are not limited to observations, questionnaires and interviews. According to Saunders et al. (2015), it is critical to choose research information gathering instruments carefully to adequately answer the research objectives. This study made use of a structured questionnaire and structured observation checklist.

3.8.1 Questionnaire

Annum (2017) states that a questionnaire is a data collection instrument normally used in surveys and defines it as a "systematically prepared form or document with a set of questions deliberately designed to elicit responses from respondents or research informants for the purpose of collecting data or information" (p.1). In the view of Yakubu (2015), a questionnaire is a written document in survey research that has a set of questions given to participants. Thus, questionnaires contain printed list of questions used to find out the views or opinions of people about an issue, product or service.

This study utilized a structured questionnaire (refer to Appendix A for a sample questionnaire). The questionnaire items were adapted from Dotse (2017), focusing on the principles and practices of constructivism. Additionally, items related to challenges and the support needed were similarly adapted from the study by Dagnew (2017). The questionnaire consisted of five sections (A-E) with forty-nine items in all. Section A consisted of seven (7) items collecting information with regards to respondents' biographical data. Personal information such as gender, age, highest qualification, years of teaching, class taught, years of teaching mathematics and the number of in-service trainings on mathematics attended. Section B consisted of twelve (12) items which sought to find teachers perception of the principles of constructivism in the mathematics. Section C consisted of fifteen (15) closed ended questions which sought to establish the degree to which mathematics teachers in the Effutu Municipality apply the constructivist approach in their classroom instruction. Section D, consisted of twelve (12) items which sought to find out the challenges faced by Upper primary mathematics teachers' in using constructivism in their mathematics lessons. Finally, Section E, which is the last part of the questionnaire, consisted of ten (10) items which sought to find out the strategies that can be adopted to enhance the use of constructivism in teaching mathematics.

Sections B and C were rated based on a five-point Likert scale, where 5 = Always, 4 = Often, 3 = Sometimes, 2 = Rarely and 1 = Never. Sections 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. 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.

3.8.2 Lesson observation checklist

According to Mulhall (2013), a lesson observation is an excellent instrument with which to gain a rich picture of any social phenomenon such as, the behaviour of learners in a classroom. Gay, Mills and Airasian (2011) supported this view when they stated that classroom behaviour, which constitutes the behaviour of the teacher, the behaviour of the student, and the interactions between teacher and student, can best be studied through naturalistic observation. In this study, a structured observation checklist was designed to monitor and describe the extent to which the teachers actually practice the constructivist approach in their lessons. The researcher used this to augment and confirm responses provided by the respondents on their practice of constructivism. Specifically, the observation checklist sought to gather classroom observational data on how Upper Mathematics teachers practice constructivist approach in teaching mathematics in the Effutu Municipality. Nine (9) lessons were observed and each observation lasted 40 minutes.

The observation checklist consisted of two sections A and B. section A collected data on teacher information such as school name, class, and the date on which the observation was made. Section B comprised on twelve (12) items grouped under six (6) subheadings, to reflect the key attributes of constructivist lessons. The subheadings were teachers serving as facilitators, encouraging social interaction, utilizing instructional resources, actively engaging pupils, building lessons on pupils' prior knowledge, and employing life-long assessment techniques. Each subheading contained a number of items reflecting the subheading in terms of constructivist approach in teaching mathematics. The first heading had one item, while headings two, three, five and six had two items each. Only heading four had three items. In the classroom, the researcher, for instance, observed whether or not the mathematics lesson teacher 1) serves as a guide to pupils during mathematics lessons 2) uses hands-on activities and manipulatives, 3) engages students actively in problem-solving activities 4) encourages multiple solution paths, and 5) uses assessment as ongoing; as part of the lesson.

The researcher used the symbols (√) and (×) to rate the use or disuse and its extent in the lesson observed where under practice observed, (√) means practice was present in that lesson while practice not observed (×) means practice was absent for that lesson.

3.9 Validity and Reliability of Instrument

3.9.1 Validity

Validity is defined as the ability of the research instrument to measure what it is intended to measure (Oluwatayo, 2012). To Zohrabi (2013), validity is concerned with "whether our research is believable and true and whether it is evaluating what it is supposed or purports to evaluate" (p.258). Validity is basically defined as the extent the extent to which a test or instrument measures what it is intended to measure. As Yakubu (2015) puts it, "validity of a measurement tool is the degree to which the tool measures what it claims to measure" (p.63).

Validity provides trust, usefulness and dependability to a research and therefore, it lies within the onus of the researcher to ensure validity in the different phases of his research, thus, from data collection through to data analysis and interpretation by ensuring the quality of research instruments used (Zohrabi, 2013). The author provided two forms of validity: content validity and internal validity. Content validity, according Zohrabi (2013), is a type of validity whereby an expert in the field of research reviews the different elements, skills and behaviours captured by an instrument in a research to ensure they are adequately and effectively measured. Zohrabi adds that, this helps to eliminate or revise unclear and obscure questions while rewording complex items.

In order to determine the content validity of the questionnaire, the researcher presented the drafts to his supervisors, who are Mathematics lecturers in the Department of Basic Education, University of Education, Winneba) to assess the questions. Also copies of the drafts were given to other lecturers to examine their content validity in terms of typographical mistakes, ambiguities, grammatical errors and these were incorporated in putting the instrument to shape before the actual data collection.

3.9.2 Reliability

Reliability refers to the likelihood of obtaining consistent or similar results when measuring the same variables multiple times using the same instrument or when different individuals measure the same variable (Noble & Smith, 2015). It encompasses factors such as consistency, dependability, and replicability of research findings, as emphasized by Zohrabi (2013).

Yakubu (2015) further defines reliability as a "measure of consistency of research instruments to obtain the same result with the same measure" (p. 63). The researchers recognized that ensuring reliability in quantitative research instruments, such as the questionnaire used in this study, is relatively easier and straightforward because the collected data are typically in numerical form, as noted by Zohrabi (2013).

In this study, a pilot study was conducted using 20 Upper Primary School Teachers in some public schools within the Gomoa Central District to assess the reliability of the research instruments. The Gomoa Central District shares close boarders with the Effutu Municipality and had similar characters such as hosting a university, the Perez University College, situated at Gomoa-Pomadze, along the Winneba-Swedru highway. The data from the pilot test was entered into SPSS And then the Cronbach's alpha was calculated. The following reliability coefficient were attained: RQ 1 (r=.769), RQ 2 (r=.815), RQ 3 (r=.741), and RQ 4 (r=.715). The overall scale yielded a reliability coefficient of 0.773, which indicated an acceptable level of consistency of the scale. This was in line with the recommendation by McMillan and Schumacher (2010) that a Cronbach's alpha coefficient of at least 0.70

indicates satisfactory internal consistency. To further enhance the reliability, the construction of the data collection instruments was carefully carried out, ensuring that they were well-structured and aligned with the research questions.

3.10 Data Collection Procedure

The researcher obtained an official letter of introduction (refer to Appendix E) from the Department of Basic Education, University of Education, Winneba, and submitted this letter to the Effutu Municipal Education Directorate to seek permission for conducting the study involving basic school teachers. Subsequently, the researcher visited the basic schools within the Effutu Municipality with an official letter of introduction (refer to Appendix E) from the Municipal Education Directorate to request permission from the school heads to conduct the study. Upon obtaining the necessary permissions, the researcher proceeded to organize the teachers for the study, familiarizing them with the study objectives and providing instructions on how to complete the questionnaires and participate in the lesson observations.

For data collection, a structured questionnaire consisting of closed-ended questions on a five-point Likert scale was utilized. Respondents were instructed to indicate their level of agreement with each question by ticking the appropriate response. The completed questionnaires were collected by the researcher for analysis. In addition, classroom observations of upper primary mathematics teachers in the Effutu Municipality were conducted using a structured observation checklist for nine of the teachers. This was done to validate the questionnaire responses by directly observing how teachers implement constructivist practices in their mathematics lessons.

Out of the 82 copies of the questionnaire that were distributed to the Upper Primary School Teachers within the Effutu Municipality, 82 were completed and returned, giving a response rate of 100%. Babbie (2020) opined that a response rate of at least 60% for a survey study is adequate for analysis and reporting. Babbie further stated that a response rate of 60% is good while 70% is very good. Throughout the process of administering the instruments, the researcher maintained open and honest communication with the participants. The purposes and uses of the collected data were clearly explained, and the participants were assured of the confidentiality of their responses. These measures were implemented to ensure that the research was conducted under standardized conditions and to instill trust and compliance among the participants.

3.11 Data Analysis Procedure

Data analysis describes that process through which data is organized and summarized using either descriptive statistics and/or inferential statistics (Yakubu, 2015). In this study, with the aid of Statistical Products for Service Solution (SPSS) software, descriptive statistics such as frequency counts, percentages and the mean and standard deviation was employed to analyse the questionnaire responses in answering the research questions as follows:

Table 3.1: Data analysis procedure

Research Questions	Construct	Instruments	Method of analysis
RQ1	Principles of constructivism used	Structured questionnaire (Closed ended)	Mean and standard deviations
RQ2	Practice of constructivism	Structured questionnaire & Structured observation checklist	Mean and standard deviations/ Simple frequency counts/percentages
RQ3	Challenges of using constructivism	Structured questionnaire and observation checklist	Mean and standard deviations/ Simple frequency counts/percentages
RQ4	Strategies to enhance constructivism use	Structured questionnaire (Close ended)	Mean and standard deviations

Source: Researcher's Own Construct (2023)

3.12 Ethical Considerations of the Study

In the current study, ethical considerations were carefully addressed, specifically regarding consent, confidentiality, and anonymity. The authorities of the schools from which the participants (teachers) were sampled received an introductory letter, providing them with information about the study. Following the approval granted by the authorities, the purpose and objectives of the study were explained to the Upper Primary School Teachers who were the participants. It was emphasized that participation was voluntary, and participants had the freedom to withdraw from the study if they felt uncomfortable at any point. To ensure confidentiality, the researcher guaranteed that the participants' personal information and responses would remain anonymous. By implementing these measures, the researcher aimed to protect the privacy and identities of the participants, as highlighted by Kusi (2012), emphasizing the importance of ethical considerations such as permission, confidentiality, and anonymity in the research process.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.0 Overview

This chapter presents the results and discussion of the findings. The chapter is presented under four sub-sections. The first section reports on the return rate of the questionnaire while the second presents the demographic characteristics of teachers. The third section is about the analysis of the data for each research question. In the analysis of the data, descriptive statistical tools including simple frequency tables and percentages were used to analyze the observational data while mean and standard deviation were used to analyze the responses of the questionnaire in answering the research questions. The final section of the chapter gives the discussion of results. For the purpose of the discussion, the responses for “Strongly Agree” (SA) and “Agree” (A) on the Likert-scale were combined and presented as one idea, and the responses for “Strongly Disagree” (SD) and “Disagree” (D) were also combined to mean the same idea. This was done to simplify the data and to make the discussion easier.

4.1.1 Demographic information of respondents

This section presents the results of the analysis of the demographic information collected from the respondents. The data included gender, age category, highest qualification, years of teaching experience, class handled, 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 information of Respondents

Variables	Category	Frequency	Percent
Gender of Participants	Male	21	25.6
	Female	61	74.4
	Total	**82**	**100.0**
Age Category of Participants	20-30 Years	18	22.0
	31-40 Years	50	61.0
	41-50 Years	14	17.0
	Total	**82**	**100.0**
Highest Academic Qualification of Participants	Diploma	18	22.0
	Bachelor's Degree	55	67.0
	Master's Degree	9	11.0
	Total	**82**	**100.0**
Years of Experience	1-5 years	22	26.8
	6-10 years	15	18.3
	11-15 years	30	36.6
	16-20 years	4	4.9
	21 years and above	11	13.4
	Total	**82**	**100.0**
Class Handled by Teachers	Basic 4	36	43.9
	Basic 5	21	25.6
	Basic 6	25	30.5
	Total	**82**	**100.0**
Number of Years in Teaching Mathematics	1-5 years	40	48.8
	6-10 years	16	19.5
	11-15 years	16	19.5
	16-20 years	9	11.0
	21 years ad above	1	1.2
	Total	**82**	**100.0**
Number of In-Service Training on Mathematics Attended	None	20	24.4
	1-2	31	37.8
	3-4	13	15.9
	5 and above	18	22.0
	Total	**82**	**100.0**

Source: Field Data (2023)

The data presented in Table 4.1 illustrates the demographic characteristics of Upper Primary Mathematics teachers involved in the study within the Effutu Municipality. In terms of gender distribution, the majority of teachers (61) were female, constituting 74.4% of the total sample, while males accounted for the remaining 21, representing 25.6% of the teachers surveyed. Concerning age categories, a significant proportion (50) of the teachers fell within the 31-40 years range, representing 61.0%, followed by those aged 20-30 years (22.0%) and 41-50 years (17.0%). The educational qualifications of the teachers revealed that the majority (55) held a Bachelor's Degree (67.0%), while a smaller percentage possessed a Master's Degree (11.0%), and 18 (22.0%) were diploma holders. The distribution of years of teaching experience showcases a diverse range, with the largest group having 11-15 years of experience (36.6%), followed by those with 1-5 years (26.8%), 6-10 years (18.3%), 21 years and above (13.4%), and 16-20 years (4.9%).

The data further revealed that 36 (43.9%) of the teachers were assigned to basic four, 21 (25.6%) were in basic five, with the remaining 25 (30.5%) handling basic six. This indicates that the majority of the teachers were assigned to basic four. Concerning the number of years dedicated to teaching mathematics, it was highlighted how diverse the teachers are, with 40 (48.8%) having 1-5 years, 16 (19.5%) with 6-10 years of experience, 16 (19.5%) with 11-15 years, 9 (11.0%) with 16-20 years, and only 1 teacher, representing a smaller percentage of 1.2%, with 21 years and above. It can be inferred that the majority of the teachers had taught mathematics for 1-5 years. In terms of professional development, the majority (31) of the teachers had attended 1-2 in-service training sessions on mathematics (37.8%), followed by those who had not attended any (24.4%). Additionally, 13 (15.9%) of the teachers had attended 3-4 sessions of continuous professional development on mathematics, while 18 (22%) had attended 5 and above

It can be inferred from the data that the study involved a diverse group of Upper Primary Mathematics teachers in the Effutu Municipality in terms of gender, age, qualifications, teaching experience, class assignments, years dedicated to teaching mathematics, and professional development in mathematics.

Presentation and Analysis of Data Based on Research Questions

Four research questions guided the study. Data from the questionnaire responses were analyzed to answer each of the research questions as follows;

4.2 Research Question One

What are Upper Primary Mathematics teachers' perception of the principles of constructivism in teaching mathematics in the Effutu Municipality?

The answer this research question, twelve (12) set of statements on the principles of constructivism in teaching mathematics was presented to the Upper Mathematics teachers in the Effutu Municipality to rate their views on a scale of 1-5 using the indicators, 1-strongly disagree, 2-disagree, 3-uncertain, 4-agree and 5-strongly agree. The data were analyzed using frequencies, percentages, mean and standard deviation. For the purpose of the analysis, the responses 'Strongly Disagree' and 'Disagree' were combined and interpreted as denoting 'disagreement' while the responses, 'Strongly Agree' and 'Agree' were similarly joined as indicating 'agreement' to the statements. The response 'Undecided" was interpreted as a 'Neutral' to show the uncertainty of respondents on the given statements. A mean score of 3.0 shows a neutral response to the given item, a mean score of below 3.0 indicates disagreement to the given statement while a mean score of above 3.0 indicate an agreement to the statement. Similarly, a standard deviation of 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 4.2;

Table 4.2: Perceptions of the principles of constructivism in mathematics

		Frequency N (%)				
Statements	**N**	**A (%)**	**U (%)**	**D (%)**	**M**	**SD**
Serving as a guide during mathematics lesson.	82	74 (90)	8 (10)	0 (0)	4.24	0.52
Telling pupils everything they need to know.	82	24 (29)	5 (6)	52 (63)	1.49	0.69
Use of strategies that discourage interaction among pupils in mathematics.	82	3 (4)	3 (4)	76 (92)	2.20	0.43
Fostering a comfortable and non-threating mathematics classroom.	82	71 (87)	2 (2)	11 (13)	4.28	0.74
Use of teaching and learning materials for only some mathematics topics.	82	1 (1)	9 (11)	72 (88)	2.21	0.68
Integrating technology tools and resources to enhance mathematical understanding.	82	64 (78)	12 (15)	6 (7)	3.85	0.80
Use of hands-on mathematical activities.	82	74 (90)	6 (7)	2 (2)	4.20	0.73
Denying pupils the opportunity to explore multiple solution paths and approaches.	82	1 (1)	6 (7)	75 (91)	1.24	0.64
Use of textbook-based activities and examples in mathematics lessons.	82	0 (0)	9 (11)	73 (89)	1.76	0.46
Use of examples and tasks familiar to pupils.	82	71 (87)	5 (6)	6 (7)	4.41	0.68
Assessing pupils' mathematics learning at the end rather than throughout a lesson.	82	2 (2)	0 (0)	80 (98)	2.55	0.63
Structuring assessment tasks in a way that challenge pupils thinking always.	82	69 (84)	7 (8.5)	6 (7.3)	4.13	0.86

Key: Agree (A); Uncertain (U); Disagree (D); Mean (M); Stand. Dev (SD)

Source: Field Data (2023)

The data presented on Table 4.2 revealed that 4 (90%) of respondents agreed that serving as a guide during mathematics lessons is crucial, with 10% uncertain and none disagreeing. The mean score of 4.24 and a low standard deviation of 0.52 reflect agreement and consistency in opinions. In contrast, only 24 (29%) agreed with telling pupils everything they need to know, while 6% were uncertain and 52 (63%) disagreed. The mean score of 1.49 and a standard deviation of 0.69 indicate disagreement and a lack of consensus on this approach. Regarding strategies that discourage pupil interaction in mathematics, just 3 (4%) agreed, 4% were uncertain, and a significant 76 (92%) disagreed. The mean score of 2.20 and a low standard deviation of 0.43 suggest a consensus against such strategies.

Fostering a comfortable and non-threatening classroom environment was supported by 71 (87%), with 2% uncertain and 13% disagreeing. The mean score of 4.28 and a standard deviation of 0.74 show strong agreement and similarity in responses. The use of teaching and learning materials for only some mathematics topics was endorsed by just 1 (1%), with 11% uncertain and a large majority of 72 (88%) disagreeing. The mean score of 2.21 and a standard deviation of 0.68 reflect disagreement and a similarity in opinions. Integrating technology tools and resources to enhance mathematical understanding was supported by 64 (78%), with 15% uncertain and 7% disagreeing. The mean score of 3.85 and a standard deviation of 0.80 indicate general agreement and consensus.

The use of hands-on mathematical activities was agreed upon by 74 (90%), with 7% uncertain and 2% disagreeing. The mean score of 4.20 and a standard deviation of 0.73 reflect agreement and consistency in opinions. Also, denying pupils the opportunity to explore multiple solution paths was strongly disagreed with by 75 (91%), with only 1% agreeing and 7% uncertain. The mean score of 1.24 and a standard deviation of 0.64 indicate disagreement and uniformity in responses. Again, none of the respondents agreed with using textbook-based activities and examples in mathematics lessons, with 11% uncertain and a substantial 89% disagreeing. The mean score of 1.76 and a standard deviation of 0.46 reflect disagreement and varied opinions.

Using examples and tasks familiar to pupils was supported by 71 (87%), with 6% uncertain and 7% disagreeing. The mean score of 4.41 and a standard deviation of 0.68 suggest agreement and consistency in responses. Furthermore, assessing pupils' mathematics learning at the end of a lesson rather than throughout was supported by only 2% of respondents, with no one uncertain and 98% disagreeing. The mean score of 2.55 and a standard deviation of 0.63 indicate disagreement. Finally, structuring assessment tasks to always challenge pupils' thinking was agreed upon by 69 (84%), with 8.5% uncertain and 7.3% disagreeing. The mean score of 4.13 and a standard deviation of 0.86 reflect agreement and similar responses.

The data suggests that Upper Primary Mathematics teachers in the Effutu Municipality perceived the principles of constructivism in teaching Mathematics as using familiar examples and tasks (87%, M=4.41), fostering a comfortable classroom environment (87%, M=4.28), serving as a guide during lessons and using hands-on activities (90%, M=4.24 and M=4.20), integrating technology received (78%, M=3.85), and challenging assessment tasks (84%, M=4.13). In contrast, the use of teaching materials for some topics was endorsed by only 1% (M=2.21), and assessing at the end of lessons had 2% agreement (M=2.55). Denying exploration of multiple solutions had 1% support (M=1.24), and telling pupils everything they need to know received 29% agreement (M=1.49). The use of textbook-based activities was unanimously disagreed with, and strategies discouraging pupil interaction had 4% agreement (M=2.20). These were not perceived as principles of constructivism in teaching Mathematics.

Table 4.3: Key principles of constructivism for mathematics as perceived by teachers

Key Principles of Constructivism	No. of items	Mean	Std. Dev.	Rank (Highest Mean Score)
Teacher as a facilitator	2	3.87	0.61	1st principle
Encourages social interaction	2	3.24	0.59	4th principle
Use of instructional resources	2	3.03	0.74	6th principle
Active engagement of learners	2	3.72	0.69	2nd principle
Building lessons on Prior Knowledge	2	3.09	0.57	5th principle
Lifelong Assessment techniques	2	3.34	0.75	3rd principle

Source: Field Data (2023)

Data on Table 4.3 showed that mean scores obtained for each key principle of constructivism was above a mean of 3.0, indicating a general agreement with all these as key principles of constructivism. However, in terms of the highest mean score, teachers perceived the key principles of constructivism to include the teacher serving as a facilitator (M=2.87, SD=0.61), active engagement of pupils (M=2.72, SD=0.69), use of life-long assessment techniques (M=3.34, SD=0.75), encouraging social interaction (M=3.24, SD=0.59), building lessons on pupils' prior knowledge (M=3.09, SD=0.57), and final the use of instructional resources (M=3.03, SD=0.74).

Based on the data, it can be inferred that Upper Primary Mathematics teachers in the Effutu Municipality perceived the key principles of constructivism as the teacher serving as a facilitator, active engagement of pupils, use of life-long assessment techniques, encouraging social interaction, building lessons on pupils' prior knowledge, and finally the use of instructional resources. They express a general agreement on the necessity for mathematics lessons to embody all these key attributes to be classified as constructivist-based.

4.3 Research Question Two

To what extent do Upper Primary mathematics teachers in the Effutu Municipality practice constructivist approach in their mathematics lessons?

This research question sought to find out from the Upper Primary School Teachers the extent to which they practice of constructivist approach in teaching mathematics in the Effutu Municipality. Respondents were presented with fifteen (15) set of statements concerning the extent to which Upper Mathematics teachers practice constructivist approach in teaching mathematics. On a scale of 1-5, respondents were asked to rate their views on the statements using the indicators, 1-never, 2-rarely, 3-sometimes, 4-often and 5-always. The data were analyzed using mean and standard deviation. To determine the extent of usage, a mean score of below 3.0 indicated "Rarely Used", a mean score between 3.0 and 3.5 indicated "Sometimes Used" while a mean score above 3.5 indicated "Always Used". Similarly, a standard deviation of 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 4.4:

Table 4.4: Practice of constructivism in mathematics lessons

Statements	N	Mean	Std. Dev.	Extent of Usage
I encourage active participation and engagement of pupils in mathematics lessons.	82	4.68	0.61	Always Used
I provide opportunities for pupils to collaborate and discuss mathematical concepts.	82	4.07	0.90	Always Used
I incorporate real-life examples and applications in teaching mathematics.	82	4.51	1.91	Always Used
I value and build upon pupils' prior knowledge and experiences.	82	4.62	0.58	Always Used
I encourage pupils to explore and discover mathematical concepts on their own.	82	4.00	0.82	Always Used
I promote critical thinking and problem-solving skills in mathematics.	82	4.43	0.77	Always Used
I encourage reflection and metacognition in pupils' mathematical learning.	82	3.49	0.81	Sometimes Used
I provide opportunities for pupils to use different strategies and approaches to solve mathematical problems.	82	4.15	0.92	Always Used
I integrate technology tools and resources to support mathematical understanding.	82	3.56	0.97	Sometimes Used
I create a positive and inclusive learning environment that respects pupils' diverse views and perspectives.	82	4.35	0.76	Always Used
I use methods that encourage interaction and collaborative learning among pupils	82	4.43	0.77	Always Used
I serve as a guide to pupils during mathematics lessons	82	4.61	0.62	Always Used
I use a lot of teaching and learning materials during lessons	82	4.23	0.63	Always Used
I assess pupils learning throughout the mathematics lesson rather than at the end of the lesson	82	4.34	0.72	Always Used
I assess pupils learning by creating contexts for them to apply their mathematical knowledge.	82	3.40	0.79	Sometimes Used

Source: Field Data (2023)

The data presented in Table 4.4 unveils the varied extent to which Upper Primary mathematics teachers in the Effutu Municipality employ constructivist approaches in their mathematics lessons. Teachers overwhelmingly indicated that they "Always Used" the strategy of encouraging active participation and engagement of pupils in mathematics lessons (M=4.68, SD=0.61). The low standard deviation suggests a high level of consensus among the teachers, indicating a consistent application of this teaching approach in the classroom. Similarly, on the strategy of providing opportunities for pupils to collaborate and discuss mathematical concepts, teachers generally reported “Always Using” this strategy (M=4.07), but the slightly higher standard deviation (SD=0.90) implies some variability in opinions among teachers regarding the effectiveness of providing opportunities for pupils to collaborate and discuss mathematical concepts.

Despite generally reporting “Always Using” the strategy of incorporating real-life examples and applications in teaching mathematics (M=4.51), the relatively high standard deviation (SD=1.91) suggests notable variability in opinions among teachers. This variability indicates that, while the incorporation of real-life examples is prevalent, there might be differing views on its effectiveness. Teachers expressed a strong consensus in “Always Using” the strategy of valuing and building upon pupils’ prior knowledge and experiences (M=4.62, SD=0.58). The low standard deviation indicates a high level of agreement among teachers regarding the importance of incorporating pupils' prior knowledge into teaching practices. Teachers predominantly reported “Always” encouraging pupils to explore and discover mathematical concepts on their own (M=4.00), but the standard deviation (SD=0.82) suggests some variability in opinions, indicating that while the encouragement of pupil exploration is common, teachers might hold diverse views on its use.

The strategy of promoting critical thinking and problem-solving skills in mathematics was reported to be “Always Used” by teachers (M=4.43, SD=0.77), demonstrating a high level of consensus and consistent application in the classroom. On the other hand, teachers indicated that they “Sometimes Used” the strategy of encouraging reflection and metacognition in pupils’ mathematical learning (M=3.49, SD=0.81). The standard deviation suggests some variability in the implementation of this strategy, indicating differing views among the teachers. Teachers generally reported “Always Using” the strategy of providing opportunities for pupils to use different strategies and approaches to solve mathematical problems (M=4.15, SD=0.92). However, the standard deviation indicates some variability in opinions among teachers regarding the effectiveness of providing opportunities for pupils to use different strategies and approaches. However, the strategy of integrating technology tools and resources was reported to be "Sometimes Used" (M=3.56, SD=0.97), reflecting some variability in opinions among teachers regarding its effectiveness in supporting mathematical understanding. Teachers also reported "Always" creating a positive and inclusive learning environment that respects pupils' diverse views and perspectives (M=4.35, SD=0.76), demonstrating a high level of consensus among teachers in creating a positive and inclusive learning environment that respects pupils' diverse views and perspectives.

Teachers consistently reported "Always Using" methods that encourage interaction and collaborative learning among pupils (M=4.43, SD=0.77). The low standard deviation suggests a high level of consensus, indicating a widespread application of collaborative learning approaches in the classroom. The strategy of serving as a guide to pupils during mathematics lessons was strongly endorsed by teachers, as indicated by the "Always Used" response (M=4.61, SD=0.62). The low standard deviation suggests a high level of agreement among teachers regarding the importance of adopting a guiding role in mathematics instruction. Teachers again reported "Always Using" a lot of teaching and learning materials during lessons (M=4.23, SD=0.63). The low standard deviation indicates a high level of consensus among teachers, suggesting a common practice of utilizing diverse instructional materials in the classroom. The strategy of assessing pupils' learning throughout the mathematics lesson was consistently reported as "Always Used" by teachers (M=4.34, SD=0.72). The low standard deviation suggests a high level of consensus, indicating a widespread preference for ongoing assessment practices However, teachers reported "Sometimes Using" the strategy of assessing pupils' learning by creating contexts for them to apply their mathematical knowledge (M=3.40, SD=0.79). The standard deviation suggests some variability in opinions among teachers.

The data revealed that in teaching mathematics, Upper Primary School Teachers in the Effutu Municipality practice the constructivist approach to a higher extent, employing most of its strategies "Always." The teachers consistently employ strategies such as encouraging active participation, valuing pupils' prior knowledge, serving as a guide, incorporating real-life examples into mathematics lessons, creating positive learning environments, continuous assessment of learning, use of instructional resources, encouraging multiple solutions to mathematical problems, promoting critical thinking, encouraging interaction and collaborative learning, and encouraging pupils' discovery of mathematical concepts. On the other hand, strategies such as the integration of technology into mathematics lessons, encouraging reflection and metacognition in pupils' mathematical learning, and the use of context-based assessment were also utilized on an occasional (sometimes) basis by the teachers.

Lesson Observation Checklist for Teachers' Practice of Constructivism in Mathematics Lessons

To confirm the actual practice of constructivist approach in teaching mathematics as used by the Upper Mathematics teachers in the Effutu Municipality, the researcher conducted classroom lesson observations with nine (9) of these teachers. The nine teachers observed were selected based on their self-reported practice of constructivism as revealed in the questionnaire responses. Consequently, teachers who reported high as well as low practice of constructivism from each of the three circuits were contacted and after engaging these teachers, those who agreed for their lessons to be observed were used. Out of the number sampled, nine were finally observed using this observation checklist to look out for aspect of constructivism including the teachers' instructional strategies, pupils' engagement, classroom environment as well as assessment and feedback in the teacher's actual classroom practices. These aspects of constructivism utilized in the lesson observed were indicated using symbols (√) and (×), where (√) means the aspect was present in that lesson while (×) implies the absence of the specific aspect for that teacher. The results of the observation are presented in Table 4.5.

Table 4.5: Observation checklist for teachers' practice of constructivism in mathematics lessons

Observation Criteria	T1	T2	T3	T4	T5	T6	T7	T8	T9	N (%)
Teacher as a facilitator										
• Teacher serves as a guide to pupils	√	√	√	√	√	√	√	√	√	9 (100)
Encouraging social interaction										
• Pupils engage in group interactions.	√	√	√	√	√	√	√	√	√	9 (100)
• The mathematics classroom is comfortable and non-threatening.	×	√	×	√	√	×	√	√	√	6 (67)
Use of instructional resources										
• availability and use of instructional resources and materials.	√	×	√	√	×	√	√	√	×	6 (67)
• use of technological tools and resources.	√	×	×	×	×	√	×	√	×	3 (33)
Active engagement of learners										
• active involvement of pupils	√	√	√	√	√	√	√	√	√	9 (100)
• allowing pupils contribution	√	√	√	√	√	√	√	√	√	9 (100)
• Encouraging multiple solution path	√	√	√	√	√	√	√	√	√	9 (100)
Building lessons on pupil' prior knowledge										
• Use of familiar examples ad activities	√	√	×	√	√	√	√	√	√	8 (89)
Lifelong assessment procedures										
• assessment as ongoing; as part of the lesson.	√	√	√	√	√	√	√	√	√	9 (100)
• Pupils are challenged to apply knowledge from lesson	×	√	√	×	√	√	√	√	×	6 (67)
• Use of varied assessment procedures	√	√	√	√	√	√	√	√	√	9 (100)

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

Source: Field Data (2023)

This data presented in Table 4.5 shows the extent to which Upper Primary School Teachers incorporate constructivist practices in their mathematics lessons. The data revealed how teachers integrate various aspect of constructivist approach into their lessons. The aspects observed were organized into categories such as teachers serving as facilitators, encouraging social interaction, utilizing instructional resources, actively engaging pupils, building lessons on pupils' prior knowledge, and employing life-long assessment techniques. The numbers and percentages indicate the proportion of teachers who demonstrated the observed criteria under each of these aspects of constructivism. In examining the role of teachers as facilitators, it was observed that all nine teachers (100%) functioned as guides for pupils during their lessons. Regarding the promotion of social interaction, all nine teachers (100%) involved pupils in group tasks and interactions, while only 6 (67%) of them established a comfortable and non-threatening environment in their mathematics classrooms. In terms of instructional resources, it was noted that only 6 (67%) teachers made instructional materials available and used them in their lessons, and a smaller number, 3 (33%), incorporated technological tools and resources to complement their teaching. Evaluating pupils' active engagement in lessons, it was found that all observed teachers (100%) actively involved pupils, encouraged contributions, and endorsed multiple solution paths for mathematics tasks. Additionally, the researcher also found, based on how teachers build lessons on pupils' prior knowledge, that 8 (89%) of the teachers actually use examples and activities that pupils were familiar with. Finally, looking at the use of life-long assessment practices of the teachers, it was revealed that all teachers (100%) integrated assessment as an ongoing part of the lesson and employed various assessment strategies. However, only 6 (67%) teachers challenged pupils to apply the knowledge gained from the lessons to solve problems.

Based on the observation of the nine lessons, it can be concluded that there is a high level of adherence to constructivist practices among the observed teachers. In all observed lessons (100%), teachers employed constructivist strategies, including acting as guides, utilizing group tasks, ensuring active pupil engagement, exploring multiple solution paths, integrating ongoing assessment, and employing varied assessment procedures. Familiar examples and activities were used in 8 (89%) of the observed lessons, while 6 (67%) lessons involved the use of instructional resources, application of mathematics knowledge, and the establishment of a non-threatening classroom environment. Unfortunately, the use of technological tools and resources to support mathematics lessons was almost absent, with only 3 (33%) of the teachers incorporating them. These variations highlight areas where professional development or support could be beneficial for enhancing constructivist teaching practices among Upper Primary School Teachers in the Effutu Municipality.

4.4 Research Question Three

What challenges do Upper Primary mathematics teachers in Effutu Municipality face in the use of constructivism in their mathematics lessons?

The second research question consisted of twelve (12) statements on the challenges faced by Upper Primary mathematics teachers in employing constructivism in their mathematics lessons. Respondents were required to rate their views on a scale of 1-5, with labels 1- strongly disagree, 2-disagree, 3-undecided, 4-agree and 5-strongly agree. The data were analyzed using frequencies, percentages, mean and standard deviation. For the purpose of the analysis, the responses 'strongly disagree' and 'disagree' were combined and interpreted as denoting 'disagreement' while the responses, 'strongly agree' and 'agree' were similarly joined as indicating 'agreement' to the statements. The response 'undecided was interpreted as a 'neutral' to show the uncertainty of respondents on the given statements. A mean score of 3.0 shows a neutral response to the given item, a mean score of below 3.0 indicates disagreement to the given statement while a mean score of above 3.0 indicate an agreement to the statement. Similarly, a standard deviation of 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 4.6 as follows;

Table 4.6: Challenges of using constructivism in mathematics lessons

			Frequency N (%)			
Statements	**N**	**A (%)**	**U (%)**	**D (%)**	**M**	**SD**
Difficulty identifying pupils' prior knowledge	82	9 (11)	15 (18)	58 (71)	2.33	0.90
Pupils' feel uncomfortable and shy expressing their ideas in class.	82	10 (12)	7 (9)	65 (79)	2.02	1.05
Lack of skill and knowledge to utilize constructivist teaching strategies.	82	5 (6)	0 (0)	77 (94)	1.77	0.84
Large class size is too large and overcrowding.	82	25 (30)	7 (9)	50 (0)	2.77	1.29
Lack of instructional resources	82	68 (83)	5 (6)	9 (11)	3.50	1.38
Lack of access to technology tools and resources.	82	16 (20)	2 (2)	62 (76)	2.84	1.18
High expenses and cost.	82	21 (26)	10 (12)	51 (62)	2.98	1.26
Lack of education and training on the use of constructivist teaching strategies.	82	21 (26)	7 (9)	54 (66)	2.70	1.31
Creation of noisy class.	82	5(6)	8 (10)	69 (84)	2.60	1.27
Heavy workload and responsibilities as a teacher.	82	49 (60)	12 (15)	21 (26)	3.81	1.82
Pressure from superiors to cover content quickly.	82	21 (26)	10 (12)	51 (62)	2.55	1.24
Pupils not taking the lesson serious because the class becomes playful.	82	11 (13)	2 (2)	69 (84)	2.16	0.91

Key: Agree (A); Uncertain (U); Disagree (D); Mean (M); Stand. Dev (SD)

Source: Field Data (2023)

The data presented in Table 4.6 revealed only 9 (11%) of respondents agreed that they had difficulty identifying pupils' prior knowledge, while 15 (18%) were uncertain, and a significant 58 (71%) disagreed. The mean score was 2.33 (SD = 0.90), indicating general disagreement with this statement. Similarly, just 10 (12%) agreed that pupils felt uncomfortable and shy expressing their ideas in class, with 7 (9%) uncertain and a large majority of 65 (79%) disagreeing. The mean score was 2.02 (SD = 1.05), reflecting disagreement on this issue. Regarding the lack of skill and knowledge to utilize constructivist teaching strategies, only 5 (6%) agreed, and none were uncertain, while a substantial 77 (94%) disagreed. The mean score was 1.77 (SD = 0.84), indicating a general disagreement.

In terms of large class sizes and overcrowding, 25 (30%) agreed, 7 (9%) were uncertain, and 50 (61%) disagreed. The mean score was 2.77 (SD = 1.29), suggesting varied opinions though the majoirty disagreed. A majority of 68 (83%) agreed that there was a lack of instructional resources, with 5 (6%) uncertain and 9 (11%) disagreeing. The mean score was 3.50 (SD = 1.38), indicating strong agreement on this issue. On the lack of access to technology tools and resources, 16 (20%) agreed, 2 (2%) were uncertain, and 62 (76%) disagreed. The mean score was 2.84 (SD = 1.18), suggesting disagreement with variability in responses.

Regarding high expenses and costs, 21 (26%) agreed, 10 (12%) were uncertain, and 51 (62%) disagreed. The mean score was 2.98 (SD = 1.26), showing mixed opinions with a slight inclination towards disagreement. When asked about the lack of education and training on the use of constructivist teaching strategies, 21 (26%) agreed, 7 (9%) were uncertain, and 54 (66%) disagreed. The mean score was 2.70 (SD = 1.31), reflecting varied opinions in disagreement. The creation of noisy classrooms due to constructivist methods was agreed upon by only 5 (6%) of respondents, with 8 (10%) uncertain and a significant 69 (84%) in disagreement. The mean score was 2.60 (SD = 1.27), suggesting general disagreement.

A majority of 49 (60%) agreed that heavy workload and responsibilities as a teacher were a challenge, with 12 (15%) uncertain and 21 (26%) disagreeing. The mean score was 3.81 (SD = 1.82), indicating strong agreement with varied responses. For pressure from superiors to cover content quickly, 21 (26%) agreed, 10 (12%) were uncertain, and 51 (62%) disagreed. The mean score was 2.55 (SD = 1.24), suggesting disagreement with diversity in opinions. Lastly, the statement that pupils did not take the lesson seriously because the class became playful was agreed upon by 11 (13%) of respondents, with 2 (2%) uncertain and a majority of 69 (84%) disagreeing. The mean score was 2.16 (SD = 0.91), reflecting a general disagreement.

Based on the data, the challenges faced by Upper Primary mathematics teachers in employing constructivism in their mathematics lessons included a lack of instructional resources (83%, M=3.50), and heavy workload and responsibilities (60%, M=3.81). Collectively, teachers perceive these two factors as significant impediments hindering their ability to effectively incorporate constructivist teaching strategies into their mathematics lessons.

4.5 Research Question Four

What strategies can be employed to enhance the use of constructivist approach in teaching mathematics by upper primary mathematics teachers in Effutu?

The last research question aimed to ascertain the strategies that can be adopted to support Upper Primary mathematics teachers in the Effutu Municipality to effectively use the constructivist approach in teaching mathematics. To address this research question, respondents were provided with ten (10) items, anchored on a five-point Likert scale ranging from 1 (strongly disagree), 2 (disagree), 3 (uncertain, 4 (agree) to 5 (strongly agree). The data were analyzed using mean and standard deviation. To aid the analysis, the responses ‘strongly disagree’ and ‘disagree’ were combined and interpreted as denoting ‘disagreement’ while the responses, ‘strongly agree’ and ‘agree’ were similarly joined as indicating ‘agreement’ to the statements. The response ‘undecided’ was interpreted as a ‘neutral’ to show the uncertainty of respondents on the given statements. A mean score of 3.0 shows a neutral response to the given item, a mean score of below 3.0 indicates disagreement to the given statement while a mean score of above 3.0 indicate an agreement to the statement. Similarly, a standard deviation of 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 4.7.

Table 4.7: Strategies for improving constructivist use in teaching mathematics

		Frequency N (%)				
Statements	**N**	**A (%)**	**U (%)**	**D (%)**	**M**	**SD**
Providing regular in-service and CPD training sessions for teachers.	82	75 (92)	5 (6)	2 (2)	4.52	0.82
Collaborating with other teachers to share best practices and resources.	82	81 (99)	0 (0)	1 (1)	4.56	0.63
Offering ongoing mentoring and coaching to teachers.	82	78 (95)	3 (4)	1 (1)	4.99	1.63
Advocating for sufficient time allocation within the curriculum.	82	70 (85)	7 (9)	5 (6)	4.17	0.87
Create safe learning environment by setting rules and regulation on diversity of views.	82	81 (99)	0 (0)	1 (1)	4.54	0.63
Schools and education directorate should provide additional funding and support for resources.	82	80 (98))	1 (1)	1 (1)	4.57	0.65
Use of groups of differing abilities together.	82	75 (92)	1 (1)	6 (7)	4.35	0.73
Integrating technology tools and resources into lessons.	82	74 (90)	7 (9)	1 (1)	4.30	0.73
Use of open-ended activities that allow multiple valid meanings to be made.	82	75 (92)	5 (6)	2 (2)	4.13	0.68
Conducting regular assessments and providing timely feedback to pupils.	82	80 (98)	1 (1)	1 (1)	4.56	0.65

Key: Agree (A); Uncertain (U); Disagree (D); Mean (M); Stand. Dev (SD)

Source: Field Data (2023)

Based on the data in Table 4.6, 81 (99%) of respondents agree on the importance of collaborating with other teachers, with only 1% disagreeing, reflected in a mean score of 4.56. This consensus is reflected in the mean score of 4.56 and a low standard deviation of 0.63, indicating uniformity in opinions. Similarly, 81 (99%)

support creating a safe learning environment by setting rules on diversity, with 1% in disagreement (M = 4.54, SD = 0.63). The mean score coupled with a standard deviation further supports the agreement on this issue. Conducting regular assessments and providing timely feedback is favored by 80 (98%), with 1% uncertain and 1% disagreeing. The mean score of 4.56 and a standard deviation of 0.65 indicate that this practice is widely valued among the respondents.

The provision of additional funding and support for resources is endorsed by 80 (98%), with 1% uncertain and 1% in disagreement (M = 4.57, SD = 0.65). the mean score suggest that respondents generally agree on the importance of financial support for educational resources Offering ongoing mentoring and coaching to teachers is supported by 78 (95%), with 4% uncertain and 1% disagreeing (M = 4.99, SD = 1.63). Regular in-service and CPD training sessions for teachers receive 75 (92%) agreement, with 6% uncertain and 2% in disagreement (M = 4.52, SD = 0.82). The mean score and the standard deviation reflect broad support with similar opinions.

Using groups of differing abilities together is agreed upon by 75 (92%), with 1% uncertain and 7% disagreeing. The mean score of 4.35 and a standard deviation of 0.73 suggest general agreement with similarity in views. Also, open-ended activities allowing multiple valid meanings are supported by 75 (92%), with 6% uncertain and 2% disagreeing (M = 4.13, SD = 0.68). The mean and standard deviation indicate general agreement on this approach. Similarly, integrating technology into lessons is favored by 74 (90%), with 9% uncertain and 1% disagreeing (M = 4.30, SD = 0.73). Lastly, advocating for sufficient time allocation within the curriculum is agreed upon by 70 (85%), with 9% uncertain and 6% in disagreement (M = 4.17, SD = 0.87). The mean score of 4.17 and a standard deviation of 0.87 suggest broad support with a general consensus in opinions.

The data suggests that upper primary mathematics teachers in Effutu supported various strategies to enhance the use of constructivist approaches in teaching mathematics. The analysis reveals that the most valued practices were offering ongoing mentoring and coaching (95%, M=4.99), collaborating with other teachers (99%, M=4.56), providing regular in-service and CPD training sessions (92%, M=4.52), advocating for sufficient time allocation within the curriculum (85%, M=4.17), creating a safe learning environment through rules on diversity (99%, M=4.54) and additional funding for resources (98%, M=4.57). Using groups of differing abilities (92%, M=4.35) and integrating technology into lessons (90%, M=4.30) were favored, along with using open-ended activities (92%, M=4.13) and conducting regular assessments and feedback (98%, M=4.56).

4.6 Discussion of Findings

Research Question One: What are Upper Primary Mathematics teachers' perception of the principles of constructivism in teaching mathematics in the Effutu Municipality?

With regards to the research question that sought to find out the perception of Upper Primary Mathematics teachers regarding the principles of constructivism in teaching mathematics in the Effutu Municipality, the findings of the study indicated that the teachers perceived the principles of constructivism in teaching Mathematics to include the use of familiar examples, creating a positive mathematics classroom environment, having teachers act as guides, incorporating hands-on activities, promoting critical thinking, and integrating technology resources into mathematics lessons. However, they perceived the ideas of end-of-lesson assessment, occasional use of instructional materials, spoon-feeding pupils, discouraging pupil interactions, relying on textbook-based activities and tasks, as well as discouraging multiple solution paths as not principles of constructivism in teaching Mathematics. In terms of the key principles, the rated this as the teacher serving as a facilitator, active engagement of pupils, use of life-long assessment techniques, encouraging social interaction, building lessons on pupils' prior knowledge, and finally the use of instructional resources.

The findings, where teachers serve as facilitators, align with James et al.'s (2010) assertion that learners develop their comprehension with teachers playing a supportive role. Furthermore, the adoption of life-long assessment techniques corresponds to contemporary trends in mathematics education reform, emphasizing real-life contexts and problem-solving to engage learners and deepen their understanding (Powell & Kalina, 2011). Similarly, constructing lessons based on pupils' prior knowledge supports Vygotsky's (1978) argument that meaningful engagement connecting prior knowledge with new information is essential for comprehending scientific concepts. Active pupil engagement echoes Bruner's (1966) theory of discovery learning, emphasizing learners actively constructing their knowledge, in line with Shandi and Purwarno's (2018) view of constructivism. Encouraging social interaction aligns with Vygotsky's (1978) theory, emphasizing its importance in learning. The use of instructional resources resonates with Dewey's (1933) experiential learning theory, emphasizing hands-on, active learning experiences. Overall, these findings align with Merve's (2019) constructivist principles emphasizing a complex, relevant learning environment, social interaction, diverse learning modes, learner ownership, and self-awareness for effective learning. Similarly, Fosnot, as cited in Ahmad (2021), argues that the constructivist classroom environment provides ample opportunities for discussion, dialogue, and reflection, enabling learners to engage with significant ideas and essential systematic values that simplify practices and experiences.

Research Question Two: To what extent do Upper Primary mathematics teachers in the Effutu Municipality practice constructivist approach in their mathematics lessons?

Concerning research question two that aimed at assessing the extent to which Upper Mathematics teachers practice constructivist approach in teaching mathematics in the Effutu Municipality, it was again revealed that in teaching mathematics, Upper Primary School Teachers in the Effutu Municipality practice the constructivist approach to a higher extent, employing most of its strategies "Always." The teachers consistently employ strategies such as encouraging active participation, valuing pupils' prior knowledge, serving as a guide, incorporating real-life examples into mathematics lessons, creating positive learning environments, continuous assessment of learning, use of instructional resources, encouraging multiple solutions to mathematical problems, promoting critical thinking, encouraging interaction and collaborative learning, and encouraging pupils' discovery of mathematical concepts. On the other hand, strategies such as the integration of technology into mathematics lessons, encouraging reflection and metacognition in pupils' mathematical learning, and the use of context-based assessment were also utilized on an occasional (sometimes) basis by the teachers. In corroborating this finding, the lesson observation showed a high level of adherence to constructivist practices among the observed teachers, especially in aspect such as teacher acting as a guide, utilizing group tasks, ensuring active pupil engagement, exploring multiple solution paths, integrating ongoing assessment, and employing varied assessment procedures.

Similarly, the use of familiar examples and activities, instructional resources, application of mathematics knowledge, and the establishment of a non-threatening classroom environment were highly practiced. Unfortunately, the use of technological tools and resources to support mathematics lessons was almost absent, with only three of the teachers incorporating them.

These outcomes align with Dotse's (2017) findings that mathematics teachers in the Effutu Municipality of the Central Region always employed the constructivist principles of learning in their classroom instructions, employing a child-centered approach known to enhance learning outcomes. Additionally, the study unveils a positive perception of constructivism among Junior High School mathematics teachers in the Effutu municipality, influencing their instructional practices and significantly improving pupils' mathematics learning. Mayer (2006) supports this approach, stating that constructivism aids learners in reaching higher cognitive levels by building upon their existing knowledge, actively involving them in constructing their understanding of the world. Steakley (2008) emphasizes the importance of real-life experiences in knowledge acquisition, enabling learners to transfer their knowledge to new situations, particularly valuable in multidisciplinary learning environments. Constructivism is also identified as effective in fostering a sense of connection for learners with the world and its history (Jaleel & Verghis, 2015). Thompson (2015) highlights how constructivism encourages learners to take ownership of their learning process, and content-rich lessons, as supported by Hendry et al. (2017), are found to be particularly effective in facilitating knowledge and understanding acquisition. In subjects like mathematics and science, instructors can use various materials and learning activities tailored to promote critical thinking and reasoning skills, ultimately enhancing the learning experience for pupils (Dewi & Harahap, 2016; Hartle et al., 2012).

Research Question Three: What challenges do Upper Primary mathematics teachers in Effutu Municipality face in the use of constructivism in their mathematics lessons?

The findings from research question three, which sought to investigate the challenges faced by Upper Primary mathematics teachers in employing constructivism in their mathematics lessons, unveiled that the challenges faced by teachers in employing constructivism in their mathematics lessons included scarcity of instructional resources needed for hands-on and constructivist lessons, and a heavy workload. Collectively, teachers perceive these two factors as significant impediments hindering their ability to effectively incorporate constructivist teaching strategies into their mathematics lessons.

The challenge of a scarcity of instructional resources for hands-on and constructivist lessons contradicts the findings of Dagnew's (2017) study, which indicated that the scarcity of learning resources, including laboratories and pedagogical materials, textbooks, etc., was not a major concern. This was affirmed by 59.7% of teachers and 63.6% of principals (59.8% of the total respondents). Conversely, the challenge of teachers' heavy workload impeding their ability to employ the constructivist approach aligns with Ahmed's (2021) findings, which identified a heavy workload as a reason why primary school teachers might not use a constructivist approach, particularly in teaching English grammar.

In contrast to these findings, Moskal, Loke, and Hung (2016) discovered that teachers commonly encounter the challenge of engaging pupils in learning when pupils lack the necessary prior knowledge upon which the teacher can build their lessons. On a different note, Dagnew's (2017) study, focused on identifying major challenges hindering teachers' practice of constructivism in Dangilla district second-cycle primary schools, indicated that 59% of teachers and 63% of principals (59.2% of the total respondents) considered large class size as the most serious challenge. Additionally, 59% of teachers and 81.8% of principals expressed that curriculum materials, particularly textbooks, were not prepared in a manner conducive to a constructivist approach. The study also highlighted challenges such as teachers' lack of dedication to implementing constructivist teaching, a shortage of allocated time for in-depth active learning, and teachers' deficiencies in the necessary skills and knowledge for employing constructivist teaching strategies. Notably, while 55.3% of teacher respondents did not view the lack of knowledge and skill for constructivist teaching as a serious challenge, 63.7% of school principals confirmed it as the most serious challenge. Also, Ahmed's (2021) study identified various challenges associated with constructivism, such as overcrowded classrooms, limited time, untrained teachers, lack of teacher independence, heavy workload, teacher deficiency, lack of facilities, lack of teacher preparation, lack of attention from teachers, parents, and pupils, non-conducive learning environments, and lack of assessment.

Research Question Four: What strategies can be employed to enhance the use of constructivist approach in teaching mathematics by upper primary mathematics teachers in Effutu?

It was found based on research question four, which sought to find out the strategies that can be employed to enhance the use of constructivist approach in teaching mathematics by upper primary mathematics teachers in Effutu, that teachers highly support various strategies to enhance the use of constructivist approaches in teaching mathematics. The analysis reveals a consistent and high level of agreement among teachers on key strategies. Notably, the highest endorsement is seen for the importance of ongoing mentorship and coaching, closely followed by advocating for additional funds, teachers' collaboration, conducting regular assessments with timely feedback, creating a safe learning environment, and providing regular in-service and CPD trainings. Other supports systems which were less emphasized included integrating technology, utilizing mixed-ability groupings, advocating for sufficient time and finally using open-ended activities.

The findings align with previous research, such as the work of Gilakjani, Lai-Mei, and Ismail (2013), which emphasized the effectiveness of incorporating technology as a strategy to enhance constructivist teaching. Furthermore, Parsons and Taylor (2011) highlighted the role of teachers in shaping classrooms as spaces where pupils actively explore and express their evolving understandings, fostering an environment conducive to active participation and open communication. In a similar vein, Alenezi (2020) stressed the significance of schools and educational systems providing necessary support and resources to empower teachers in effectively utilizing constructivist approaches. Likewise, Anagün (2018) emphasized the importance of teachers undergoing regular in-service and continuing professional development (CPD) trainings to acquire the essential knowledge and skills for successful implementation of constructivist teaching. These scholarly insights resonate with the perspectives of Upper Primary School Teachers in Effutu, who perceive these recommendations as crucial for enhancing the application of constructivism in mathematics education.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 Overview

This chapter provides a comprehensive summary of the study's findings. The subsequent sections present conclusions drawn from these findings, recommendations for practice, and suggestions for further research.

5.1 Summary of the Study

This study investigated the use of constructivist approach in teaching Mathematics by Upper Primary Mathematics teachers in the Effutu Municipality. Guided by four research questions, the study employed a quantitative approach, conducting a survey involving 82 Upper Primary Mathematics teachers selected through a census frame. Data were collected using two main research instruments: an observation checklist and a structured questionnaire. Descriptive data analysis techniques, including simple frequency counts, percentages, mean, and standard deviation, were utilized to analyze the collected responses, addressing the following research questions:

1. What are Upper Primary Mathematics teachers' perception of the principles of constructivism in teaching mathematics in the Effutu Municipality?
2. To what extent do Upper Primary mathematics teachers in the Effutu Municipality practice constructivist approach in their mathematics lessons?
3. What challenges do Upper Primary mathematics teachers in Effutu Municipality face in the use of constructivism in their mathematics lessons?

4. What strategies can be employed to enhance the use of constructivist approach in teaching mathematics by upper primary mathematics teachers in Effutu?

5.2 Findings

Four key findings emerged from the study;

1. Firstly, the study found that Upper Primary Mathematics teachers in the Effutu Municipality perceived the principles of constructivism in teaching Mathematics as the use of familiar examples, creating a positive mathematics classroom environment, having teachers act as guides, incorporating hands-on activities, promoting critical thinking, and integrating technology resources into mathematics lessons.
2. Also, it was revealed that in teaching mathematics, Upper Primary School Teachers in the Effutu Municipality practice the constructivist approach to a higher extent, employing most of its strategies "Always." Consistent use was identified for strategies including encouraging active participation, valuing pupils' prior knowledge, serving as guides, incorporating real-life examples, creating positive learning environments, continuous assessment, and promoting critical thinking while strategies like technology integration, reflection, and context-based assessment are occasionally used.
3. Again, the findings of the study unveiled that the challenges faced by Upper Primary mathematics teachers in the Effutu Municipality while employing constructivism in their mathematics lessons included scarcity of instructional resources needed for hands-on and constructivist lessons, and a heavy workload. Collectively, teachers perceive these two factors as significant

impediments hindering their ability to effectively incorporate constructivist teaching strategies into their mathematics lessons.

4. Lastly, the study's findings indicated that upper primary mathematics teachers in Effutu highly support various strategies to enhance the use of constructivist approaches in teaching mathematics. Key strategies with high level of agreement included ongoing mentorship and coaching, closely followed by advocating for additional funds, teachers' collaboration, conducting regular assessments with timely feedback, creating a safe learning environment, and providing regular in-service and CPD trainings.

5.3 Conclusions

This study has shed a valuable insight on the implementation of the constructivist approach in teaching Mathematics by Upper Primary Mathematics teachers in the Effutu Municipality.

Insights from this study highlighted that Upper Primary Mathematics teachers in Effutu had a good perception of the constructivist principles, including use of familiar examples, creating a positive mathematics classroom environment, having teachers act as guides, incorporating hands-on activities, promoting critical thinking, and integrating technology resources into mathematics lessons.

Also, teachers actively align with constructivist strategies, employing most of its strategies consistently, showcasing dedication to dynamic and participatory learning.

However, challenges like resource scarcity and heavy workloads hinder full commitment to the approach.

Recognizing the challenges faced by teachers, especially regarding resource limitations and workload constraints, the teachers highly endorsed strategies such as ongoing mentorship and coaching, additional funds, teachers' collaboration, regular assessments with timely feedback, as well as regular in-service and CPD trainings to overcome the challenges and enhance the constructivist approach, aiming for sustained improvement in Mathematics education in the Effutu Municipality.

5.4 Recommendations

1. Given that teachers had a good perceptions of the constructivist principles, it is recommended that the Effutu branch of Ghana Education Service, in collaboration with the Effutu Municipal Education Directorate to continue to invest in professional development programmes for Upper Primary Mathematics teachers. These programmes should focus on deepening their understanding of constructivism, especially in areas such as facilitating reflective practices, utilizing various instructional resources, and integrating continuous assessments seamlessly into their teaching practices.
2. Since teachers consistently employed the constructivist strategies, it is recommended for the Upper Primary Mathematics teachers in Effutu Municipality to explore other avenues on technology access and integration in mathematics. The Effutu Municipal Education Directorate should provide periodic workshops or training sessions focused on incorporating occasional strategies like technology integration, reflection, and context-based assessments into daily teaching practices.
3. In addressing the challenges of instructional resource scarcity and heavy workloads, teachers, Heads of basic schools and School Improvement Support Officers (SISO) within the Effutu Municipality should consider establishing a

resource support system. This system could involve liaising with old students and Parent Association in order to raise funds and create resource centres, and exploring workload management strategies such as collaborative planning among teachers.

4. To support the strategies endorsed by teachers in enhancing the use of constructivism, Heads of basic schools and School Improvement Support Officers (SISO) should design and implement a comprehensive mentorship and coaching program. This program should not only focus on enhancing teaching methods but also provide guidance on creating safe learning environments, fostering democratic classrooms, effectively integrating technology, use of mixed-ability groupings and open-ended activities.

5.5 Suggestions for Further Research

Future researchers could replicate this study in other classes to provide a more comprehensive understanding of the implementation of the constructivist approach in teaching Mathematics in the Effutu Municipality. Also, studies on the barriers and facilitators of technology adoption within the constructivist approach can be conducted. Lastly, it is suggested for other researchers to delve into a comparative analysis of the effectiveness of various support strategies endorsed by teachers, such as ongoing mentorship, collaborative projects, and in-service training.

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APPENDICES

APPENDIX A

UNIVERSITY OF EDUCATION, WINNEBA
DEPARTMENT OF BASIC EDUCATION
QUESTIONNAIRE FOR TEACHERS

Dear Sir/Madam,

Thank you for accepting to be part of this research. Kindly spend a few minutes of your time to respond to the items on this questionnaire. The questionnaire seeks to solicit your opinion on the use of constructivist approach in teaching Mathematics by Upper Primary Mathematics teachers in the Effutu Municipality. This study does this by examining your knowledge of constructivist principles, practice, challenges and possible support needed to enhance the use of constructivist approach in teaching mathematics by upper primary mathematics in the Municipality. 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 [ ] Ph.D [ ]
4. **Years of Teaching Experience:** 1-5[ ] 6-10 [ ] 11-15 [ ] 16-20 20+ [ ]
5. **Which class do you teach in your school?** Bsc 4[ ] Bsc 5 [ ] Bsc 6 [ ]
6. **How long have you been teaching mathematics?** ………………… years
7. **How many in-service trainings on mathematics have you attended?**
   None [ ] 1 [ ] 2 [ ] 3 [ ]] 4 [ ] 5 and above [ ]

SECTION B

The following is a list of statements to find out how Upper Primary Mathematics teachers perceive the principles of constructivism in teaching mathematics in the Effutu Municipality. Carefully read each statement and answer it as accurately as possible. Circle (◌) a number that best describes your view on each of the items. **On a scale of 1-5, rate your views on each of the constructivist principles in teaching mathematics in your class.**

S/N	Principles of Constructivism used in Mathematics Lessons	Perceived frequency of use of teaching strategies and methods				
		Strongly Disagree	**Disagree**	**Undecided**	**Agree**	**Strongly Agree**
A	**Teacher as a facilitator**					
1	Teacher should serve as a guide during mathematical discussions and learning.	1	2	3	4	5
2	Mathematics lessons should be planned in ways that allow teachers telling pupils everything they need to know	1	2	3	4	5
B	**Encourages social interaction**					
3	Teacher should use of strategies that discourage interaction among pupils during of mathematics lessons	1	2	3	4	5
4	The mathematics classroom must be comfortable and non-threatening.	1	2	3	4	5
C	**Use of instructional resources**					
5	Teachers should use teaching and learning materials for only some mathematics topics.	1	2	3	4	5
6	Technology tools and resources should be used to enhance mathematical understanding.	1	2	3	4	5
D	**Active engagement of learners**					
7	Pupils should be encouraged to actively construct their mathematical knowledge through hands-on activities.	1	2	3	4	5
8	Pupils should be denied the opportunity to explore multiple solution paths and approaches in mathematics lessons.	1	2	3	4	5
E	**Building lessons on Prior Knowledge**					
9	The mathematics activities and examples teachers used should be those provided by their textbooks.	1	2	3	4	5
10	Teachers must use familiar examples and tasks based on pupils' prior knowledge and experiences.	1	2	3	4	5
F	**Lifelong assessment**					
11	Teachers should assess pupils' mathematics learning at the end of the lesson rather than throughout a lesson.	1	2	3	4	5
12	Assessment tasks must challenge pupils to apply knowledge acquired from a lesson to solve other problems.	1	2	3	4	5

SECTION C

The following statements seek to assess the extent to which Upper Mathematics teachers practice constructivist approach in teaching mathematics in the Effutu Municipality. Carefully read each statement and answer it as accurately as possible. Circle (◌) a number that best describes your view on each of the items. **On a scale of 1 to 5, please rate the extent to which you practice the constructivist approach in your mathematics lessons**

S/N	Practice of Constructivism in Mathematics Lessons	Please **CIRCLE** a number to rate EVERY option				
		Never	**Rarely**	**Sometimes**	**Often**	**Always**
13	I encourage active participation and engagement of pupils in mathematics lessons.	1	2	3	4	5
14	I provide opportunities for pupils to collaborate and discuss mathematical concepts.	1	2	3	4	5
15	I incorporate real-life examples and applications in teaching mathematics.	1	2	3	4	5
16	I value and build upon pupils' prior knowledge and experiences.	1	2	3	4	5
17	I encourage pupils to explore and discover mathematical concepts on their own.	1	2	3	4	5
18	I promote critical thinking and problem-solving skills in mathematics.	1	2	3	4	5
19	I encourage reflection and metacognition in pupils' mathematical learning.	1	2	3	4	5
20	I provide opportunities for pupils to use different strategies and approaches to solve mathematical problems.	1	2	3	4	5
21	I integrate technology tools and resources to support mathematical understanding.	1	2	3	4	5
22	I create a positive and inclusive learning environment that respects pupils' diverse views and perspectives.	1	2	3	4	5
23	I use methods that encourage interaction and collaborative learning among pupils	1	2	3	4	5
24	I serve as a guide to pupils during mathematics lessons	1	2	3	4	5
25	I use a lot of teaching and learning materials during lessons	1	2	3	4	5
26	I always assess pupils learning throughout the mathematics lesson rather than at the end of the lesson	1	2	3	4	5

S/N	Practice of Constructivism in Mathematics Lessons	Please **CIRCLE** a number to rate EVERY option				
		Never	**Rarely**	**Sometimes**	**Often**	**Always**
27	I assess pupils learning by creating contexts for them to apply their mathematical knowledge acquired from a lesson to solve other problems	1	2	3	4	5

SECTION D

This section of the questionnaire is for you to rate your view on the major challenges faced by Upper Primary mathematics teachers in employing constructivism in their mathematics lessons. Please, carefully read each statement and answer it as accurately as possible. Circle (◌) a number that best describes your view on each of the items. **On a scale of 1 to 5, please rate your views on the following statements**.

S/N	Challenges Faced in Using Constructivism in Mathematics Lessons	Please **TICK** a number to rate EVERY option				
		Strongly Disagree	**Disagree**	**Undecided**	**Agree**	**Strongly Agree**
28	I find it difficult identifying pupils' prior knowledge on which I would build my new lessons	1	2	3	4	5
29	My pupils feel uncomfortable and shy expressing their ideas in class in the midst of their peers	1	2	3	4	5
30	I do not have the skill and knowledge to utilize constructivist teaching strategies	1	2	3	4	5
31	My class size is too large and overcrowded for me to facilitate pupils-centered teaching strategies	1	2	3	4	5
32	The instructional resources needed for hands-on and inquiry-based constructivist lessons are scarce.	1	2	3	4	5
33	I do not have access to technology tools and resources for integrating technology in mathematics lessons.	1	2	3	4	5
34	Constructivist teaching strategies involve a lot of expenses and cost.	1	2	3	4	5
35	I have no received any form of education and training on the use of constructivist teaching strategies.	1	2	3	4	5
36	The use constructivist teaching strategies affect other classes because it makes my class noisy.	1	2	3	4	5
37	I cannot use the constructivist teaching strategies because of my heavy workload and responsibilities as a teacher.	1	2	3	4	5
38	My superiors pressure me to cover content quickly, leading to a focus on rote memorization.	1	2	3	4	5
39	Pupils do not take the lesson serious because the class becomes playful.	1	2	3	4	5

SECTION E

These following list of statements aims at identifying the strategies that can be employed to enhance the effective use of constructivist approach in teaching mathematics by upper primary mathematics teachers in Effutu. Please, carefully read each statement and answer it as accurately as possible. Circle (◌) a number that best describes your view on each of the items.

On a scale of 1 to 5, please rate your views on the following statements.

S/N	Strategies for improving Constructivist Use in Teaching Mathematics	Please **TICK** a number to rate EVERY option				
		Strongly Disagree	**Disagree**	**Undecided**	**Agree**	**Strongly Agree**
40	Providing regular in-service and professional development training sessions on constructivist approaches to mathematics education for teachers	1	2	3	4	5
41	Collaborating with other teachers to share best practices and resources related to constructivist teaching	1	2	3	4	5
42	Offering ongoing mentoring and coaching to teachers to build their confidence and skills in implementing constructivist approaches.	1	2	3	4	5
43	Advocating for sufficient time allocation within the curriculum for hands-on and inquiry-based learning.	1	2	3	4	5
44	Create safe learning environment by setting rules and regulation on diversity of views	1	2	3	4	5
45	Schools and education directorate should provide additional funding and support to acquire resources and materials for implementing constructivist approaches.	1	2	3	4	5
46	Use of groups of differing abilities together	1	2	3	4	5
47	Integrating technology tools and resources to enhance pupil engagement and support constructivist learning.	1	2	3	4	5
48	Use of open-ended activities that allow multiple valid meanings to be made	1	2	3	4	5
49	Conducting regular assessments and providing timely feedback to pupils.	1	2	3	4	5

THANK YOU

APPENDIX B

CLASSROOM OBSERVATION GUIDE: CONSTRUCTIVIST APPROACHES IN UPPER PRIMARY MATHEMATICS LESSONS

This observation checklist is meant to gather classroom observational data on how Upper Mathematics teachers practice constructivist approach in teaching mathematics in the Effutu Municipality.

SECTION A: Lesson Information:

School: ……………………………………………………………………………

Class: ………………………………………………………………………………

Date of Observation: ……………………………………………………………

SECTION B: Teacher Practice of Constructivism in Mathematics Lessons

	Observation Criteria	Please **TICK** to rate EVERY option. **Practice Observed (√)** **Practice NOT observed (×)**
A	**Teacher as a facilitator**	
1	Teacher serves as a guide to pupils during mathematics lessons.	
B	**Encourages social interaction**	
2	Pupils engage in interaction during of mathematics lessons	
3	The mathematics classroom is comfortable and non-threatening.	
C	**Use of instructional resources**	
4	Teacher uses teaching and learning materials in class.	
5	Teacher uses technology tools and resources in the lesson.	
D	**Active engagement of learners**	
6	Pupils actively construct their mathematical knowledge through hands-on activities.	
7	Every pupil is allowed to contribute to the lessons.	
8	Pupils are allowed to explore multiple solution paths and approaches in the lessons.	
E	**Building lessons on pupil' prior knowledge**	
9	Teachers uses familiar activities and examples teachers in lesson.	
F	**Lifelong assessment**	
10	Teachers assesses pupils' mathematics learning throughout the lesson rather than at the end.	
11	Teacher assesses pupils learning by creating contexts for them to apply their mathematical knowledge acquired from a lesson to solve other problems.	

12	Teacher varies assessment procedure for pupil (e.g., oral, written, observations, discussions, pupil work	
	Keys: (√)- observed practice **Present, (×)-** observed practice **Absent**	

[END OF OBSERVATION]

APPENDIX C

LETTER OF INTRODUCTION FROM EFUTU MUNICIPAL EDUCATION DIRECTORATE

GHANA EDUCATION SERVICE

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

REPUBLIC OF GHANA

MUNICIPAL EDUCATION OFFICE
POST OFFICE BOX 54.
WINNEBA
TEL: 03323 22075
Email.geseffutu@gmail.com

My Ref. NO:GES/CR/EMEDW/LC.80/VOL.7/60
Your Ref. No:

DATE: 12TH DECEMBER, 2023

THE HEAD OF DEPARTMENT
DEPARTMENT OF BASIC EDUCATION
UNIVERSITY OF EDUCATION
WINNEBA

MS. MARGARET MARY AMISSAH
DEPARTMENT OF BASIC EDUCATION
UNIVERSITY OF EDUCATION
WINNEBA

THE HEADTEACHERS
CONCERNED SCHOOLS
WINNEBA

LETTER OF INTRODUCTION

We acknowledge receipt of your letter dated 7th June, 2023 seeking permission for a student to conduct research in the municipality.

Permission has therefore been granted to Ms. Margaret Mary Amissah, an M.Phil. student of the Department of Basic Education, University of Education, Winneba to conduct a research in the Municipality from December, 2023 to March, 2024.

Ms. Margaret Mary Amissah is carrying out a research on the topic: "***The Use of Constructivist Approach in Teaching Mathematics by Upper Primary Teachers in Effutu Municipality.***

You are to ensure that your research would not disrupt teaching and learning in the school.

Headteachers are to assist the student gather relevant data for her work while ensuring that she abides by the ethics of the teaching profession.

DINAH ANDERSON (MS)
MUNICIPAL DIRECTOR OF EDUCATION
EFFUTU-WINNEBA

THE MUNICIPAL DIRECTOR
EFFUTU MUNICIPAL EDUCATION
WINNEBA

cc: All SISOs
Effutu Municipal
Winneba

YZN