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TEACHERS' USE OF ASANTE TWI IN TEACHING MATHEMATICS AT THE EARLY CHILDHOOD CENTRES IN THE EJISU MUNICIPALITY

GRACE ADUBEA AMANING

MASTER OF PHILOSOPHY

2025

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**A thesis in the Department of Early Childhood Education,
Faculty of Applied Behavioural Sciences in Education
submitted to the school of Graduate Studies in partial fulfilment
of the requirements for the award of the degree of
Master of Philosophy
(Early Childhood Education)
in the University of Education, Winneba**

JULY, 2025

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DECLARATION

Student's Declaration

I, Grace Adubea Amaning, declare that this thesis is a result of my original research except for references to other people's work which have been duly acknowledged and it has neither in whole nor in part been presented for another degree in this university or elsewhere.

Candidate's Signature: …….

Date: ……

Supervisor's Declaration

I hereby declare that the preparation and supervision of this research work were done in accordance with the guidelines for the supervision of research work as laid down by the School of Graduate Studies, University of Education, Winneba.

Name of Supervisor: Prof. Michael Subbey (PhD)

Supervisor's Signature: …….

Date: ……

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DEDICATION

To my daughter Nana Aba-Tua Aidoo, my sister Vida Owusuaa and my brother T. O. Amaning

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ACKNOWLEDGEMENT

I am grateful to my supervisor, Prof. Michael Subbey for his dedication, constructive criticism, advice and encouragement throughout the study. My gratitude again goes to all teachers and lecturers who taught me throughout my entire life. Special thanks also go to the workers at the department and all the early childhood education teachers who willingly provided information for the success of the study. Finally, my appreciation goes to the family, friends and all those who supported me to g through this academic endeavour.

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ABSTRACT

This study examined the effectiveness of using Asante Twi as a medium of instruction in teaching mathematics at early childhood centres in the Ejisu Municipality, Ashanti Region. Guided by an interpretivist paradigm and employing a qualitative exploratory case study design, data were collected from 25 purposively selected early grade teachers through semi-structured interviews. The findings revealed that teachers recognize the pedagogical benefits of using Twi, including enhanced learner engagement, improved conceptual understanding, increased confidence, and stronger peer collaboration. However, challenges such as limited standardized Twi instructional materials, inadequate mathematical vocabulary, parental preference for English, and insufficient institutional support were identified. The study recommends targeted teacher professional development, development of localized teaching resources, community sensitization, and stronger policy implementation to sustain and scale the benefits of native language instruction. Overall, the research highlights the transformative potential of Twi-mediated mathematics teaching in making learning culturally relevant and accessible, while underscoring the need for systemic reforms to ensure sustainability.

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CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

During the inception of formal education in Ghana and the subsequent use of English as the medium of instruction, the indigenous languages were seen as "inadequate" as teaching media for learners (Bamgbose, 2000). There are over 100 linguistic and ethnic groups identified in Ghana, with these groups maintaining a sense of ethnic identity (Akramov et al., 2009). According to Machaba (2013), Myers-Scotton (1978), and Mchazime (1995), teacher challenges in the teaching of mathematics at the foundation phase are also acknowledged. It is stated that language plays a vital role in the education of a child. As such, Children should develop the ability to use the language to listen, speak, question, explain and discuss. Due to the similarities in the various dialects and the increasing mobility of the population, a typical Ghanaian understands at least one of five major languages: Akan, Nzema, Dagbane, Ga, or Ewe, as well as English, which is the official language of the country.

In the precolonial period (1529-1925), the use of bilingual in education in Ghana started with the initiation of formal education in Ghana which began with the castle schools and was later pursued by the missionaries. The first legislation on the use of a Ghanaian language in education was propagated by McWilliam (1975); Graham (1971); (Gbedemah, 1975). Ghanaian language was used as the medium of instruction only at the lower primary level, with English used thereafter. The policy was reversed and became unstable when the administration of the country came under the jurisdiction of indigenous Ghanaians in 1957. Since then, the use of a Ghanaian language as the medium of instruction at the early grade level has had an inconsistent history. Ghana

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having been a strong advocate of Pan-Africanism since Nkrumah's era has over looked the importance of using indigenous language at the early grade schools to promote the agenda but other Francophone countries have pursued it. The promulgation of the use of English as the medium of instruction in education and the abandoning of the indigenous languages in education is therefore in opposition to this ideology. Unlike most Francophone countries which had French forced on them as medium of instruction through the Brazzaville Conference of 1944 and made the use of native languages in schools forbidden (Djite, 2000), Ghana had the British lay a solid foundation for the use of the indigenous languages as media of instruction at the lower primary level.

The usage of native language as a medium of instruction is globally recommended for pupils in lower primary schools (UNESCO, Education in a Multilingual World, 2003). Emphatically according to the Global campaign for education (2013) revelation, learners taught in foreign language perform poorly than those taught in native language. Math is abstract while young children are deemed to be concrete thinkers; cognitive developmental work done in the mid-twentieth century has been used to suggest that young children's mathematical ideas develop on their own timetable, independent of environmental factors like teaching (Piaget, 1959). But this construed has been rejected by many recent researchers stating learners develop their mathematical cognitive skills better during the use of native language.

Native language is the language a child learns first from the mother or the principal caregiver (Dialyn et al.,, 2014). It is one 's native language. As stipulated in the Millennium Development Goals (MDG2), that child education must be compulsory and free for all children and for holistic national development, public and private pre-schools must provide the same or similar experiences and opportunities for all children to fully explore their potentials.

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To add to the native language usage, most African countries are multilingual with different language policies as such it is very difficult to adopt one common language and Ghana is no exception because of the different ethnic and language groups scattered all over. This makes teaching and learning at the early childhood level using one native language very difficult, especially when the instructor is not conversant with the native language of the locality. An attempt to retain most of the indigenous Languages as languages of instruction is seen by linguists as a good initiative that should be appreciated internationally. This is because native language acquisition is an important ingredient in the development of the child's intellect and other aspects of his or her personality. Comparatively, in some Anglophone countries in Africa, education is given entirely in the medium of English language whereas in Tanzania, education is given entirely in the native language (Osafehinti & Nabie, 2001).

Assertively, Dialyn et al. (2014) in research on MTB-MLE implementation language and education, argued that the use of native language enables a child to express himself/herself easily, as there is no fear of making mistakes. This affirms the fact that using the native language in teaching improves the child's confidence and encourages getting involved in teaching discussion. Additionally, (Kimizi, 2012) added that children taught in native language have better learning comprehension than those taught in a foreign language. Brief, 2013 also reveals that learners taught in foreign languages perform poorly than those taught in native language. These propound literatures back the essence of using native language at the early childhood level to teach and learn mathematics better. Ashanti region is one of the landmark regions in Ghana with a population of over 4.7million people according to the 2010 census. It is the region with the Golden stool, rich culture and traditions. The traditional native language in the region is Twi.

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According to the reports on basic Education (Israel, & Thomas, 2013), statistics and planning parameters a total of 3,356,743 primary schools exist from p1 to 6 as at 2010. A total of 39,111 was the population of citizens from kindergarten to primary school level located in the Ejisu municipality as at 2010. The area has a total population of 143,762 which constitute 3 percent of the regional population. Teaching and learning mathematics in native language is regarded as the best to improve child confidence at the early childhood level. According to Israel and Thomas (2013), children understand mathematics better when they are taught using their native language as such it's imperative to adopt Twi in helping to teach and learn Mathematic in the Ejisu Municipality.

Many researchers have postulated that learning using native language also helps to develop mathematical vocabularies that could be easily used and remembered by learners. Further to this, Niss and Højgaard (2016) defined mathematical competence as the means and ability to understand, judge, apply, and use mathematics in a variety of intra- and extra mathematical contexts and situations in which mathematics plays or could play a role. In other words, students do not just need knowledge in mathematics, but must also be able to apply knowledge and conceptual understanding indifferent contexts, and to analyze, and reason to solve problems. The importance is given to children's native language which helps children to develop mentally and use the ideas learnt from culture to enhance their performance.

1.2 Statement of the Problem

Worldwide, there are 50 -75 million 'marginalised' children who are not enrolled in school. Children whose primary language is not the language of instruction in school are more likely to drop out of school or fail in early grades (Graphic Online, 2025). This is why this research is being conducted to measure the effectiveness of using the

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native language in mathematics instruction at the early childhood level. Research has shown that children's first language is the optimal language for literacy and learning throughout primary school (UNESCO, 2008a). In spite of growing evidence and parent demand, many educational systems around the world insist on exclusive use of one or sometimes several privileged languages. This means excluding other languages and with them the children who speak them (Arnold et al, 2006).

Parents not enrolling their children in school at all, children not able to engage successfully in learning tasks, teachers feeling overwhelmed by children's inability to participate, early experiences of school failure, and so on. Some children do succeed, perhaps through a language transition programme that helps them to acquire the language of instruction. But there is the risk of negative effects whereby children fail to become linguistically competent members of their families and communities and lose the ability to connect with their cultural heritage.

Teacher education programme must include attention to the mathematics component of early childhood programs, and continuing professional development opportunities should support high-quality mathematics education. Effective professional programmes weave together into mathematics content, pedagogy, and knowledge of child development and family relationships (Ball & Cohen, 1999). The development of institutional policies that promote teachers' mathematical learning, teamwork, and planning can provide necessary resources to overcome classroom, community, institutional, and system-wide barriers to young children's mathematical proficiency.

Weaknesses in mathematics skills, however, begin early and are evident by the time children enter kindergarten (Bernstein et al 2014). Unfortunately, children who enter kindergarten with weak math skills are likely to remain behind their peers in the later

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grades this was affirmed by Watts et al (2014) since education policy does not permit the exclusive use of native language at the early grade level. Emphatically, Duncan and Magnuson (2011) and Siegler et al (2012) affirmed this assertion. In addition, the children who are the least prepared in math when they enter kindergarten tend to be from minority and low-income families, or they are just learning to speak English. Watts et al (2014) and Mulligan et al (2012) further established that these factors suggest that improving the long-term outcomes for all children may depend on exposing them to more early math concepts before they enter school. Other research work also affirmed that Children who learn mathematics fundamentals in preschool and kindergarten have the best chance of later achievement in school but too often, children don't get the effective early math instruction that makes all the difference (Clements & Sarama, 2021).

Before exploration of what can happen in the classroom, examination of the teacher in general terms is needed. One of the challenges in working with Early grade learners is that teachers lack the confidence they need to serve the children with linguistically diverse needs (Renner, 2011). The basic solution for dealing with this particular challenge is to offer staff development to the teachers of young children. Training for teachers of young Early learners is limited in accessibility (Ball, 2010). When teachers of young early learners receive training in working with linguistically diverse students, they can increase their confidence as well as learn theory and practice that will support them in their work (Renner, 2011). Most Early learners (ELLs) are in the mainstream classrooms and unfortunately, the majority of the teachers are not trained to successfully work with this population (Cho, 2012). With this information in mind, the basic solution that is common in the literature is for teachers to receive professional development and training in working with young ELLs. The teacher has to understand

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the developmental process of acquiring a new language, the stages involved, the socio-cultural aspects of learning a second language, and the technical aspects of language and language development (Cummins, 1979,1980, 1981; Hakuta, 1990). The majority of the ELL research available suggests the need for teacher training. However, there is little research about the types of training the teacher needs. Cho (2011) suggests that teachers need to be trained in content specific to working with young ELLs.

This is actually not the case in Ghana's early childhood education, where English language which is not our native language is mostly used, and most of the children find it difficult in expressing themselves better in class. But where the child could express themselves, they could not understand most of the mathematical jargons used in teaching. This re-emphasized the need to measure the effectiveness native languages play in the teaching of learning of mathematics in Ghana.

For better understanding of mathematics activity at the early grade level, it is important that the language used in the teaching of mathematics should be understandable and be pitched at the level of the child. Some African countries have their native language as their national language as such childhood education in mathematics is easy. These countries include Kenya, Tanzania, and Uganda (Myers-Scotton, 1993). Invariably an alternative to using a native language as a national language has been to use a foreign language such as English, French or Portuguese (Mchazime, 1995). This has resulted in either the native language not being used in teaching or it being limited in usage.

In Ghana during the missionary education era, the use of native language was projected alongside English in early education. The Wesleyan Missionaries, who settled along the western coast of the Gold Coast, used English Language as a medium of instruction in schools while Ga, Ewe and Twi were used along the eastern coast and inland parts of the country by the Bremen and Basel Missionaries. These native languages were

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developed and effectively used by the missionaries. Appiah and Ardila, (2021) identifies that, “as far back as 1872 Arithmetic was taught wholly in Twi and Ewe and the Twi and Ewe Grammars and Dictionaries were among the best in the world of scholarship…” This improves children's interest in the study of Mathematics and English than it currently is.

According to (Hazik & Farik, 2016) active participation and understanding at the early childhood in mathematics is due to neglecting the use of children’s native language and materials from children’s cultural background (cultural tools). As a result of this aforementioned reason, learners do not find any linkage between learning mathematics and their everyday life and thus perform poorly in mathematics. As such instruction of early child class in mathematics is very low and where it is, Native language Matters: Native language as a Key to Effective Learning. The learners, cannot relates his studies with the everyday life. This might have a multiplier effect on the learner’s performance even at the Senior High school level.

Israel and Thomas (2013) opined that learner’s understand mathematics better when they are taught using their native language. Learning using native language also helps to develop mathematical vocabularies that could be easily used and remembered by students Mathematics is an indispensable tool in the formation of an individual. It broadens and sharpens one's intellectual capabilities, and helps the child to understand, interpret and to give accurate account of the physical phenomena observed in the environment.

Additionally, due to the advent of distance learning in the training of teachers and the lack of emphasis by churned education curriculum many schools have neglected the usage of native language. To emphasize on native language usage and its impact the research sought to re-echo the importance of using native language in the teaching of mathematics at early grade level to curriculum reviewers and researchers through the

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appropriate medium for better comprehension and adaption in future curriculum review. It is generally observed that when mathematics syllabus is structured in English and not in native language, it makes translation to native language for use difficult and inconsistent. In response to this, this study is being conducted to measure the effectiveness of using the native language in mathematics instruction at the early grade level. Also, because there are inadequate teaching materials, it becomes almost impossible to use the native language to teach unless the Education service directorate resourced the syllabus with the culture materials.

1.3 Purpose of the Study

This study sought to find out the effectiveness of using the native language as the medium of instruction in teaching mathematics at early childhood centres in the Ejisu Municipality.

1.4 Objectives of the Study

This study sought to:

1. Examine teachers' knowledge about the use of native language (Asante twi) in mathematics lessons in the Ejisu municipality.
2. Find out learners' participation in mathematics using native language (Asante twi) in the Ejisu municipality.
3. Identify learning resources available to teachers in teaching mathematics through the use of the native language (Asante twi) in the Ejisu municipality.
4. Find out strategies that teachers can adopt to enhance the use of the native language in mathematics teaching in the Ejisu Municipality.

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1.5 Research Questions

1. What is the knowledge of teachers about the use of the Native Language (Asante twi) in mathematics lessons in the Ejisu municipality?
2. What is the level of learners' participation in mathematics lessons using the native language (Asante twi) in the Ejisu municipality?
3. What teaching and learning resources are available to teachers to facilitate mathematics learning in the native language (Asante twi) in the Ejisu Municipality?
4. What strategies could be adopted to enhance the use of the native language (Asante twi) in mathematics instruction in Ejisu municipality?

1.6 Significance of the Study

This study will help improve students' understanding of the study and learning of mathematics in early childhood and increase student achievement in the Ejisu Municipality. The outcome of this study will help the Ghana Education Service to revise the early childhood mathematics curriculum by linking mathematical thinking to student achievement in mathematics in the Ejisu municipality. They will also help in formulating policies to adopt critical measures in the reform of early childhood education in Ghana. The findings of this study will help to reform the early childhood public school curriculum and improve future research in the Ejisu municipality. The findings of this study will help policymakers to develop comprehensive strategies to improve the use of native languages in early childhood centres in the Ejisu municipality.

1.7 Delimitations to the Study

This study was delimited to early childhood centres within the Ejisu Municipality in the Ashanti Region of Ghana, with a specific focus on the use of Asante Twi as the medium of instruction in mathematics lessons. Ejisu Municipality was selected because of its cultural homogeneity, accessibility, and the researcher's familiarity with the area,

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which allowed for an in depth exploration within a clearly defined context rather than broad generalisation across the region. The study focused only on early childhood teachers and learners in both public and private schools, excluding upper primary and secondary levels, since early childhood is a foundational stage where language strongly influences mathematical understanding. Twenty teachers were purposively sampled to capture diverse teaching experiences and levels of fluency in Asante Twi, which was considered adequate for qualitative analysis. Data were collected through semi structured interviews and analysed thematically.

1.8 Limitations of the study

Although this study provides valuable insights into the use of Asante Twi in mathematics instruction at the early childhood level, several limitations must be acknowledged. These limitations arose from factors beyond the researcher's control and may affect the generalisability of the findings:

Generalisability of Findings: The study was confined to early childhood centres in the Ejisu Municipality. While the findings highlight important trends, they may not be directly applicable to municipalities with more diverse linguistic contexts or different socio-cultural dynamics. As Simons (2014) notes, every study aims to generalise beyond its sample, but conclusions here remain context-specific.

Sample Size and Sampling Technique: The study relied on a purposive sample of 20 teachers. Although this provided rich qualitative data, the relatively small sample size limits statistical representativeness. Furthermore, purposive sampling reduces the ability to generalise findings to the wider population of teachers in Ghana.

Teacher Training and Pedagogical Preparation: Many teachers lacked formal training in native language pedagogy, particularly in mathematics instruction. This

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limitation may have influenced the depth and accuracy of their responses, as teachers often relied on improvisation rather than structured approaches.

Parental and Societal Attitudes: Some parents preferred English over Twi, believing it to be more prestigious and beneficial for their children's future. This attitude limited learners' exposure to Twi outside the classroom and may have affected their fluency and confidence in using the language during mathematics lessons.

Community and Peer Influences: Learners' fluency in Twi was shaped not only by classroom instruction but also by interactions with peers and community members. These external influences were not directly measured in the study, yet they may have contributed significantly to learners' mathematical understanding.

Resource Constraints: The lack of standardized instructional materials in Twi posed a challenge. Teachers often improvised, which may have affected the consistency of mathematics instruction across schools. This limitation highlights the systemic issue of inadequate support for native language education.

1.8 Operational Definition of Terms

Native Language (Native language): Refers to the first language a child learns from their primary caregiver, which in the context of this study is predominantly Twi in the Ejisu Municipality. It is the language spoken at home and within the community by the majority of the learners.

Early Childhood Centres: These are educational institutions catering to children in the foundational phase of education, typically from Kindergarten to Basic 1–3, where foundational numeracy and literacy skills are introduced.

Mathematics Instruction: The process of teaching mathematical concepts and skills such as counting, addition, subtraction, measurement, and problem-solving to young learners through formal educational activities.

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Teachers' Knowledge: The awareness, training, and familiarity that early childhood educators possess regarding the integration of native language in mathematics teaching.

Learner Participation: The active involvement and engagement of pupils in classroom activities during mathematics lessons, including asking questions, responding, and collaborating with peers.

Instructional Materials: These include all teaching aids and resources (e.g., charts, textbooks, counting tools) used by teachers to support the teaching of mathematics, particularly those available in the native language.

Early Grade Learners: Children enrolled in early childhood education classes, typically aged 4 to 8 years, who are in the formative stages of cognitive and academic development.

NALAP (National Literacy Acceleration Programme): A Ghanaian government initiative aimed at promoting the use of native languages in early grade literacy and numeracy instruction.

1.9 Organisation of the Study

This thesis is structured into five chapters, each building upon the other to provide a coherent account of the research. Chapter One introduces the study by presenting the background, statement of the problem, purpose, objectives, research questions, significance, delimitations, limitations, and operational definitions of key terms. Chapter Two reviews relevant literature and theoretical frameworks, examining previous studies on the use of native language in mathematics instruction and identifying the gaps that this research seeks to address. Chapter Three outlines the methodology, describing the research design, target population, sampling techniques, instruments, validation procedures, data analysis methods, and ethical considerations. Chapter Four presents and discusses the results, using tables and thematic analysis to

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highlight the findings and relate them to existing literature. Finally, Chapter Five provides a summary of the key findings, draws conclusions, and offers recommendations for policy, practice, and future research.

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CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter deals with the summary of the related literature based on the following sub-headings:

1. Theoretical Framework.
2. Conceptual Framework.
3. Early childhood teachers' knowledge about native language usage in teaching mathematics.
4. Learners' participation in mathematics lessons using native language
5. Teaching resources available for mathematics lessons through native language
6. Strategies that can be adopted in achieving the usage of native language in early childhood centres.

2.1 Theoretical Framework (Cummins 1979)

This study was informed and guided by models of bilingual education and second language teaching namely; additive bilingualism, subtractive bilingualism, transitional bilingualism and immersion bilingualism.

Learners who experience additive bilingualism are able to maintain their native language while acquiring a second language, thereby enriching their linguistic repertoire (ArabPsychology, n.d.).

Subtractive bilingualism on the other hand describes the situation where learners lose their native language in the process of acquiring a second language (Lambert, 1975). Such situations are common in societies where one language is considered to be socio-

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economically more prestigious than others. Usually when this happens, the child's native language is replaced by the second language, which may lead to linguistic and cultural conflicts rather than complimenting each other ((Robinson, 1996).

Lambert (1975) argues that, in societies where both native language and second language are considered important, children gain better levels of cognitive development (Lambert, 1975). It means that children will be acquiring a second language that is not at the expense of their first language; in other words, addictive bilingualism have not been known to negatively affect children's intellectual and linguistic development. (Genesee, 1977) suggested that additive bilingualism becomes more productive when a child's native language is nurtured and encouraged then later the second language is introduced gradually in the cultural context as is being presented by the NALAP program in 2009/2010 academic year.

Research has shown that there are cognitive benefits associated with additive bilingualism such as promoting greater mental flexibility (Cummins, 1980). In terms of second language teaching, the submersion model promotes the practice whereby the second language is used as the medium of instruction and the children's native language is only used when students fail to understand a concept. For example, a non-native English-speaking student being placed into a regular English-speaking classroom with a teacher who understands their native language (Ndamba, 2008). In this scenario, when the native language is not supported the learners may lose it, which may result in negative cognitive consequences for the future learning of the child. Submersion is considered as subtractive bilingualism.

Transitional bilingual model provides opportunity for children to learn subject contents in their native language. English is taught as a second language mostly in subjects that require less language such as arts and music. The transitional bilingual has an advantage of helping children understand content area of subjects, which enables them to enjoy

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activities and to remain in school. The transitional model therefore serves as a bridge for children in terms of helping them move from their mother tongue to a second language such as English (Krashen & Terrell, 1983). They are useful in terms of assisting the child gain better understanding of concept and as a way of compensating for inadequate proficiency in the second language. This process prepares the child for immersion into the second language (Lemlech, 1994). Generally transitional bilingual education is popular in communities where native language is dominant. Immersion is usually referred to as a Canadian model and was used primarily to support English speaking children who were learning French (Taylor, 1992). Immersion bilingual education model is considered pluralistic and tends to have additive characteristics. It helps learners to acquire two languages simultaneously. Some consider immersion programs as consisting of full or part time models. In this regard, full immersion happens when programs begin in the pre-school or kindergarten classroom and continues to the upper grades. Partial immersion on the other hand, refers to situations whereby the second language is delayed till upper elementary grades or high school. Many countries in Africa including Ghana, Kenya and Zimbabwe use immersion bilingualism (Cleghorn, 1992). Research shows that children who are supported to master the native language tend to encounter less problems with regard to speech, listening, reading and writing when it comes to learning a second language (Cummins, 1981).

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FIGURE 2.1: CONCEPTUAL FRAMEWORK

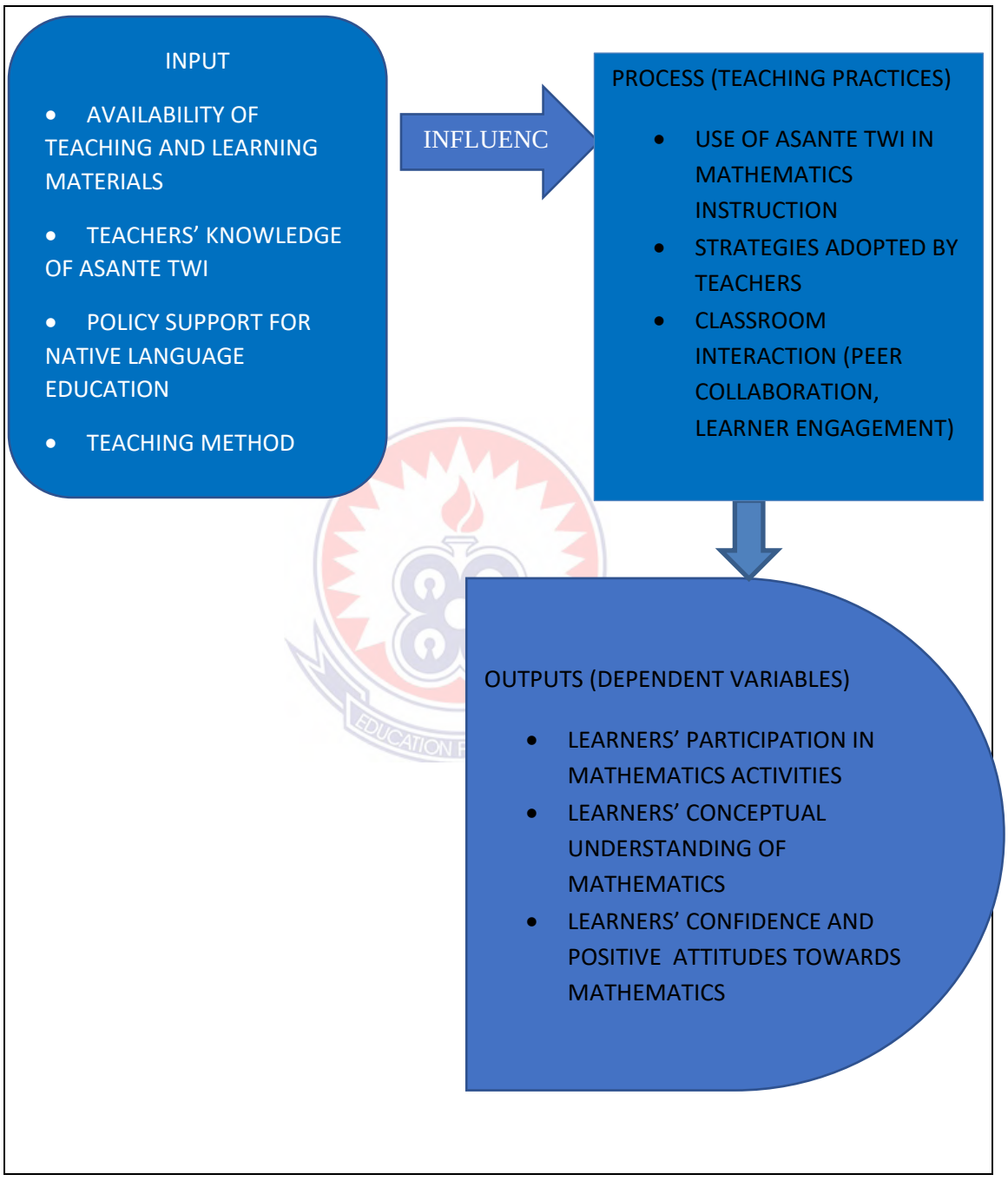

Figure 2.1: Developed conceptual framework (Author)

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2.2 CONCEPTUAL FRAMEWORK

Cummins (1979)

This study is guided by a conceptual framework that illustrates the relationship between contextual factors, teaching practices, learner outcomes, and long-term educational impact in the use of Asante Twi for mathematics instruction at the early childhood level. The framework is informed by Vygotsky's Sociocultural Theory, which emphasizes the role of language and social interaction in cognitive development (Vygotsky, 1978), and by empirical evidence supporting native language-based multilingual education (UNESCO, 2008a; Global Campaign for Education, 2013). The framework also draws on Piaget's constructivist theory, which highlights the importance of concrete experiences in early childhood learning (Piaget, 1959), and Cummins' linguistic interdependence hypothesis, which argues that proficiency in the first language supports learning in a second language (Cummins, 1979).

Together, these theories provide a strong foundation for understanding how the use of Asante Twi can enhance mathematics instruction by making abstract concepts more accessible, culturally relevant, and developmentally appropriate.

Narrative Explanation

Inputs (Independent Variables)

Inputs represent the contextual and institutional factors shaping mathematics instruction in Asante Twi. These include:

Teachers' knowledge of native language pedagogy: Teachers' understanding of how to integrate Asante Twi into mathematics lessons determines the quality

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of instruction. Lack of training often leads to improvisation rather than structured pedagogy (Renner, 2011; Cho, 2012).

Availability of teaching/learning resources in Asante Twi: The scarcity of standardized Twi mathematics materials limits effective teaching. Teachers often rely on oral explanations or improvised aids, which may not fully capture mathematical concepts (Israel & Thomas, 2013).

Teacher proficiency in Twi vs. English: Teachers' fluency influences their ability to translate abstract mathematical ideas into culturally relevant language (Hazik & Farik, 2016).

Societal and parental attitudes: Parents often prefer English, viewing it as a pathway to prestige and global opportunities. This attitude can undermine the use of Twi in classrooms (Arnold et al., 2006).

Policy support for native language education: Ghana's language-in-education policy has been inconsistent since independence, affecting implementation at the early childhood level (McWilliam, 1975; Gbedemah, 1975).

These inputs collectively shape the instructional environment and determine the feasibility and effectiveness of using Asante Twi in mathematics lessons.

Teaching Practices (Process)

This stage captures how teachers operationalize native language instruction. Practices include:

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Direct use of Asante Twi in mathematics instruction: Teachers explain concepts, give instructions, and facilitate discussions in Asante Twi, making abstract ideas more concrete (Kimizi, 2012).

Instructional strategies: These include translation, improvisation, play-based learning, and localized examples that reflect learners' cultural backgrounds (Clements & Sarama, 2021).

Classroom interaction: Twi enhances peer collaboration and learner engagement, as children feel more confident expressing themselves in their native language (Dialyn et al., 2014).

These practices embody Vygotsky's idea that language mediates learning and cognitive growth, while also reflecting Ghana's socio-cultural realities.

Outputs (Dependent Variables)

Outputs are the immediate effects of Twi-mediated instruction on learners:

Learners' participation in mathematics activities: Children engage more actively when taught in a familiar language (Brief, 2013).

Conceptual understanding of mathematics: Twi helps learners grasp mathematical ideas by linking them to everyday experiences (Israel & Thomas, 2013).

Development of mathematical vocabulary in Twi: Native language instruction supports the acquisition of terms that are easier to remember and apply (Niss & Højgaard, 2016).

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Learners' confidence and attitudes: Children taught in Twi exhibit greater confidence and positive attitudes toward mathematics (Hazik & Farik, 2016).

These outputs are critical indicators of instructional success and learner development.

Outcomes (Long-term Impact)

Finally, the framework highlights broader educational benefits:

Improved mathematics achievement: Early exposure to math in the native language lays a strong foundation for future academic success (Watts et al., 2014).

Stronger cultural identity and relevance: Twi instruction reinforces cultural values and helps learners connect classroom learning with their lived experiences (Appiah & Ardila, 2021).

Foundation for lifelong learning: Early mastery of mathematical concepts in a familiar language supports continued achievement across subjects and educational levels (Duncan & Magnuson, 2011).

Integration

The diagram and narrative together demonstrate how Inputs influence Teaching Practices, which in turn produce Outputs that lead to long-term Outcomes. This flow reflects the interpretivist paradigm of the study, focusing on teachers' lived experiences and contextual realities in Ejisu Municipality. It also aligns with the study's objectives and research questions, providing a coherent structure for analyzing the effectiveness of Asante Twi in mathematics instruction.

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By situating the study within both global frameworks (UNESCO, Global Campaign for Education) and local realities (Ghana's language policy, parental attitudes, and resource constraints), the conceptual framework underscores the transformative potential of native language instruction. It highlights that effective mathematics learning in early childhood is not only a pedagogical issue but also a socio-cultural and policy concern.

2.3 Early Childhood Teachers' Knowledge about Native Language Usage in Mathematic Instruction

Ntuli & Mudau (2024) highlight that teachers' linguistic background and proficiency strongly shape how effectively they use native languages in teaching. Although some teacher training institutions have all native languages studies as compulsory, not all trainees will be fluent in the use of the language after their studies. As such there is the need to emphasize on postings teachers with more fluency in a native language to teach at the lower primary level. Colleges in education should have language expert in the accepted native language areas so that teachers could choose according to the native language of the area to they are posted or work. This will help develop the capacity of the instructors better, for effective teaching in the local dialects.

According to Fakeye (2011), teachers in lower primary schools will certify that pupils' home language and school should have close experiences so that teaching and learning would be meaningful, value approaches and appreciated in classroom teaching. Edmonds-Wathen (2015) added that students do not make a lot of progress in mathematics when teachers use English or a foreign language. According to research carried out by UNICEF in 1999 on the use of native language, revealed that learners find it easier to read and acquire other academic skills when instruction is in the home language than when they are taught in a foreign language.

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As it happens in most African countries where early childhood educationist laid more emphasis on child learning foreign languages particularly English and French than the usage of home language. This is because most families believe that children learn languages faster at the early age so they encourage the use of foreign language in every instruction. One of the constraints to the effective teaching of mathematics at the lower grade level by the ministry of education in Ghana is Finding facilitators who have competence in demonstrating how mathematics should be taught by instructors to enable lower grade learners understanding may be problematic as there are not many mathematics educators in Ghana who are competent at explaining how to teach math to the students so that they can develop conceptual understanding and problem-solving skills.

Finally, Bernstein et al. (2014) found that, children who enter school and begin learning in a new language before they completely understand their first language, face much trouble or difficulty in confrontation of new ideas in the second language. In all these constraints to the use of foreign language in mathematics instructions at the lower grade level so it is expedient to measure its impact on student performance.

2.4 Learners Understand Mathematical Concepts Better in their Native Language

Chapman (1996) in Albert and Tafara (2011) revealed that, teachers who taught in second language have had a lot of constraints in mathematics experiences in schools, which resulted to the failure of the pupils in mathematics classes. This is because student find it difficult in relating mathematics as pictorial diagrams and practices taught to the environment which could have influence better understanding and appreciation of the subject is adopted.

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Although most learners are able to speak or communicate in English in Ghana, especially learners in private schools, they lack the understanding of the language and are not able to relate it to their environment properly. Most early grade learners are able to make deductive reasoning and contribute to discussion when teaching instruction is done in their native language. This is affirmed by Madzore, (2023), which revealed that, pupils who were taught in their native language comprehend better in mathematics classroom, such as understanding the mathematics vocabularies, concept, ideas and formulas. A former minister for education, Professor Naana Opoku Agyeman, has attributed Ghana's underdevelopment issues notably extreme poverty and income growth – to the use of English as the only medium of instruction in the lower primary schools. The argument is that this impedes learners' active participation in the teaching and learning process which, in turn, has negative repercussions on their future learning. (www.myjoyonlinenews.com/2015)

Some children do succeed, perhaps through a language transition program that helps them to acquire the language of instruction. But there is the risk of negative effects whereby children fail to become linguistically competent members of their families and communities and lose the ability to connect with their cultural heritage. While some children continue to develop proficiency in their first language while succeeding in school in a second language, this does not happen automatically.

Increasingly, it leads to an inability to communicate about more than mundane matters with parents and grandparents, and a rapid depletion of the world's repository of languages and dialects and the cultural knowledge that are carried through them. Teacher education programs must include attention to the mathematics component of early childhood programs, and continuing professional development opportunities should support high-quality mathematics education. Effective professional programs

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weave together mathematics content, pedagogy, and knowledge of child development and family relationships (Ball & Cohen, 1999). The development of institutional policies that promote teachers' mathematical learning, teamwork, and planning can provide necessary resources to overcome classroom, community, institutional, and system-wide barriers to young children's mathematical proficiency.

Weaknesses in math skills, however, begin early and are evident by the time children enter kindergarten (Bernstein et al, 2014). Unfortunately, children who enter kindergarten with weak math skills are likely to remain behind their peers in the later grades, and this was affirmed by Watts et al (2014). Emphatically, according to Duncan et al (2011) and Siegler et al (2012), they affirmed this assertion. In addition, the children who are the least prepared in mathematics when they enter kindergarten tend to be from minority and low-income families, or they are just learning to speak English. Watts et al (2014) and Mulligan et al (2012) further established that these factors suggest that improving the long-term outcomes for all children may depend on exposing them to earlier math concepts before they enter school.

Other research work also affirmed that Children who learn math fundamentals in preschool and kindergarten have the best chance of later achievement in school but too often, children don't get the effective early math instruction that makes all the difference.

2.5 Challenges for Teachers when Using the Native Language in Mathematics Lessons in Ejisu Municipality

According to the bedrock theory of this research, Vygotsky's (1978) Cultural Historic theory highlights that knowledge from children's culture and cultural background should form basis of teaching and learning process at the lower grade level. The

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importance is given to children's native language which helps children to develop mentally and use the ideas learnt from culture to enhance their performance. Niesche (2009), sees the need to embed children's culture in teaching mathematics. From his research in Western Australia, he found out that children performed better when the native language (Kriol) was used instead of English to teach mathematics to the children.

The implementation of the language policy at the early grade level has had some challenges and unavailable teaching and learning materials, which should have been designed and published in each of these 11 accepted Ghanaian languages. Parents were, however, not convinced that this had happened, or that the right teaching resources were in place. To buttress these points, poor training of teachers on the use of native language for mathematics instruction at various teacher training colleges also mitigated against the use of the native language in the teaching of Mathematics. The unprofessional status of some of the teachers in the advent of private schools which has been helping to reduce over overpopulation of learners cannot be overemphasised however, most of the teachers are not professional as such they lack the skills of effectively instructing in the native language.

Also, the lack of teaching and learning materials in the native language demands that there is ample teaching and learning materials for the exercise. Although some 11 native languages have been accepted for use under the Ghana education service, the practice of unavailable curriculum and textbooks transcribed in the native language affect the implementation of the language policy. Some teachers did not study the language of the locality. This usually occur when the teacher training institution could not offer good language tuition to the teacher trainee to ensure effective instruction in the native language. There are times that due to posting system teachers are posted to areas they

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are not fluent with the language. Disregard of teachers' linguistic competencies in native languages during teacher postings.

Teachers seem to be aware of the significance of the language policy on the mathematical development of children and try to practice it. They make effort to use the native language of the locality or a related language that children can understand for all aspects of mathematics instruction process. Before exploration of what can happen in the classroom, examination of the teacher in general terms is needed. One of the challenges in working with Early grade learners is that teachers lack the confidence they need to serve the children with linguistically diverse needs (Renner, 2011). The basic solution for dealing with this particular challenge is to offer staff development to the teachers of young children. Training for teachers of young Early learners is limited in accessibility (Ball, 2010). When teachers of young early learners receive training in working with linguistically diverse students, they can increase their confidence as well as learn theory and practice that will support them in their work (Renner, 2011). Most Early learners (ELLs) are in the mainstream classrooms and unfortunately, the majority of the teachers are not trained to successfully work with this population (Cho, 2012). With this information in mind, the basic solution that is common in the literature is for teachers to receive professional development and training in working with young ELLs. The teacher has to understand the developmental process of acquiring a new language, the stages involved, the socio-cultural aspects of learning a second language, and the technical aspects of language and language development (Cummins, 1979,1980, 1988; Hakuta, 1986). The majority of the ELL research available suggests the need for teacher training. However, there is little research about the types of training the teacher needs. Cho (2012) suggests that teachers need to be trained in content specific to working with young ELLs.

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2.5.1 Limited Instructional Resources for Teaching in Native Languages

One of the biggest challenges in the implementation of native language teaching in early education is the lack of adequate teaching resources and teaching aids (Karikari et al., 2022). In many cases, teaching materials such as textbooks, workbooks, visual aids and digital resources are predominantly developed in English, leaving the native language underrepresented (Saneka & de Witt, 2019). This scarcity leads to a gap in the delivery of quality education in a language that young learners understand fluently.

In Ghana, particularly in the Ejisu community, native language teaching materials for subjects such as mathematics are often unavailable or inadequate (Amaning, 2022). The process of translating existing or creating new materials in native languages such as Twi is complex and resource-intensive. Translators must ensure that mathematics terminology and concepts are accurately rendered in the native language while maintaining cultural relevance and linguistic clarity (Al-Tarawneh, 2024). However, limited resources and expertise in this area often delay such initiatives.

In addition, the lack of standardised orthographies and terminologies in many native languages further complicates the development of teaching materials (Mamo, 2016; Schroeder, 2016). For example, although Twi is widely spoken in the Ashanti region, the written form varies, leading to inconsistencies in teaching materials (Asuming, 2021). This inconsistency can confuse both teachers and students and undermine the effectiveness of teaching in the native language.

The lack of visual and digital teaching aids in the native languages also hinders engagement in early education (Moinian et al., 2016). Multimedia resources, which are increasingly being used to teach mathematics, are predominantly available in English. Without appropriate resources in native languages, educators cannot fully utilise these technologies to enhance learning (Galla, 2016). In addition, the scarcity of resources in

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rural areas exacerbates this challenge, as schools often lack the financial resources to develop or purchase customised teaching aids (Mncube et al., 2023).

To address these issues, education stakeholders need to prioritise the development of comprehensive teaching resources in native language (Cabansag, 2016). Collaboration between linguists, educators and policy makers can help standardise terminologies and create culturally relevant materials (Akintayo et al., 2024). Moreover, governments and non-governmental organisations (NGOs) can provide funding to support the creation of textbooks, teacher manuals and digital tools tailored to native language teaching (Kagendo, 2024; Kinoti, 2024). Such efforts are critical to overcoming resource constraints and ensuring that native language education is both effective and sustainable.

2.5.2 Teacher Proficiency in the Native language Compared to English.

Teacher proficiency in the native language compared to English is another critical challenge in the implementation of native language teaching (Karikari et al., 2022). While many teachers in Ghana are fluent in both their native language and English, their ability to teach effectively in the native language often varies (Osei-Boateng, 2022). This discrepancy is due to gaps in teacher training, the dominance of English in formal education and personal preferences for the use of English as a medium of instruction.

In the Ejisu community, where Twi is predominantly spoken, teachers' proficiency in Twi plays an important role in the success of teaching in the native language (Nyamekye, 2022). However, many teachers have completed most of their formal training in English, so they are less confident or able to teach complex subjects such as mathematics in their native language (Uchida & Sugimoto, 2020). This problem is

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particularly pronounced when teachers have to translate mathematical concepts into Twi, a language in which there are no universally recognised and standardised mathematical terminologies (Asuming, 2021; Moleko, 2021).

Moreover, teacher training in Ghana often uses English as the primary medium of instruction, with little emphasis on developing teaching skills in the native language (Boateng, 2019; Osei-Boateng, 2022). This can lead to teachers struggling to teach effectively in Twi, especially when it comes to explaining abstract mathematical concepts. This lack of confidence can lead to inconsistent teaching, with teachers switching between English and Twi at times, which can confuse students and diminish the benefits of native language teaching (Darko et al., 2016).

Another challenge is the varying levels of native language proficiency among the teachers themselves (Schüler-Meyer et al., 2019). Teachers from different regions or with different linguistic backgrounds may have different levels of proficiency in Twi, which further complicates the use of Twi as a medium of instruction. In culturally diverse classes where students speak different dialects or languages, it can be even more difficult for teachers to meet the linguistic needs of all learners.

To address these challenges, teacher training programmes must include solid components for native language teaching (Hood, 2020). Professional development workshops and in-service training can give teachers the skills and confidence they need to teach mathematics and other subjects effectively in their native language (Tonio & Ella, 2019). Educational institutions should also work towards standardising native language terminology and provide teachers with comprehensive resources and support (Parba, 2018). Improving teachers' native language skills can significantly improve the quality and consistency of teaching.

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2.5.3 Societal and Parental Contributions Toward Native Language Instruction

Social and parental attitudes play a decisive role in the implementation of mother-tongue teaching in early education (Khanyile, 2021). While educational research emphasises the advantages of teaching in a child's first language, societal and parental attitudes often tend to favour English as the preferred medium of instruction (Macaro et al., 2018). This preference stems from the socio-economic benefits associated with English language proficiency and leads to resistance to native language teaching in schools.

In Ghana, English is widely regarded as a symbol of upward mobility and global opportunity (Mathew, 2022). Many parents believe that early exposure to English gives their children a competitive advantage in higher education and the labour market. As a result, they may see mother-tongue education as a setback and fear that it will limit their children's ability to master English and compete in a globalised world (Saneka, 2019). This perception is particularly prevalent in urban areas where English is more commonly used in daily interactions and formal situations.

Societal attitudes further complicate the issue as native languages are sometimes stigmatised as less prestigious or academically challenging than English (Hyland, 2016). This stigma can discourage both parents and educators from advocating native language instruction, even when its effectiveness in improving academic achievement has been proven. Teachers may also face pressure from parents and school administrators to prioritise English, which undermines efforts to introduce mother-tongue instruction (Wint, 2024).

Additionally, the linguistic diversity in communities like Ejisu Municipality poses a challenge when it comes to gaining general support for native language education (Owusu-Kumih, 2017). While Asante Twi is predominantly spoken, other languages

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and dialects also exist, leading some parents to question the inclusivity and fairness of using a native language as a medium of instruction (Asuming, 2021). These concerns can lead to tension and resistance among stakeholders, further hindering implementation. To overcome these societal and parental barriers, awareness campaigns and community engagement initiatives are essential. Educating parents and communities about the cognitive and academic benefits of native language education can help change perceptions and gain support (Nishanthi, 2020). Highlighting research findings and success stories of schools that have implemented native language programmes can reinforce the value of this approach.

Furthermore, policy makers and educators need to ensure that native language education does not come at the expense of English language skills (Palviainen & Curdt-Christiansen, 2022). By adopting a bilingual education model that combines native language instruction with English language development, schools can address parents' concerns while preserving the benefits of native language instruction (Garrity et al., 2018). The support of society and parents is essential for the long-term success of mother-tongue teaching in early education.

2.6 The Role of Early Childhood Education in Cognitive and Mathematical Development

Early childhood education (ECE) plays a central role in laying the foundations for lifelong learning, including the development of cognitive, social and emotional skills (Solang et al., 2024). This stage, which typically spans the ages from birth to eight years, is considered a critical period in human development during which the brain undergoes rapid growth and exhibits high plasticity (Munsaka & Kalinde, 2017). During this time, the environment and the experiences that children have a major influence on their developmental trajectory (Lipscomb et al., 2021).

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One of the core aspects of ECE is basic learning, which includes literacy, numeracy and socio-emotional development (Laxman, 2024). These are the building blocks for more complex learning and problem-solving skills. In particular, numeracy, defined as the ability to understand and work with numbers, which is critical to a child's ability to understand mathematical concepts and apply them in everyday life (Chen, 2024).

The early years are characterised by significant brain development, particularly in the regions responsible for language acquisition, memory, attention and problem solving (Mustard, 2002). Cognitive skills such as pattern recognition, spatial reasoning and logical thinking develop during this period and are closely linked to early exposure to structured learning (Goswami, 2019). Basic education in daycare centres stimulates these cognitive skills through age-appropriate activities and encourages curiosity, creativity and critical thinking (Rumbidzai, 2023).

2.6.1 The Importance of Play-based Learning

Play-based learning is a hallmark of effective early childhood education (Bubikova-Moan et al., 2019). It allows children to explore mathematical concepts in a natural and engaging way (Murtagh et al., 2022). Activities such as counting objects, arranging shapes and playing board games teach basic numeracy skills while promoting motor skills and spatial awareness (Verdine et al., 2017). Building blocks, for example, can be used to learn geometry and measurement, while sorting games promote classification and pattern recognition (Clements et al., 2018).

Ensuring access to quality ECE is vital for addressing disparities in educational outcomes (Rao et al., 2023). Children from underprivileged backgrounds often enter formal schooling with a significant disadvantage due to a lack of early exposure to foundational learning (Law et al., 2017). Providing structured, inclusive early education

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can bridge this gap, ensuring that all children, regardless of socioeconomic status, have the opportunity to succeed academically (Uddin, 2023).

According to Von Suchodoletz et al. (2023), research consistently demonstrates that children who receive high-quality early childhood education are more likely to perform well academically, have higher rates of high school completion, and are better equipped for the workforce. Foundational learning also fosters resilience, adaptability, and a positive attitude toward learning, which are crucial for navigating the challenges of later education and life (Sciaraffa et al., 2018). Sophian (2008) postulated that fundamental learning in early childhood is essential for cognitive and mathematical development. By providing a stimulating environment and engaging activities, early childhood education lays the foundation for intellectual growth, academic success, and the ability to thrive in an increasingly complex world.

2.6.2 Relationship between Early Engagement with Mathematics and Later Academic Success

Mathematics is a fundamental discipline that underpins many aspects of everyday life and is essential for success in a variety of academic and professional fields (Lawson et al., 2020). Early exposure to mathematics is particularly important as it not only shapes a child's numeracy skills, but also influences their overall academic progression and problem-solving abilities (Harvey & Miller, 2017).

Exposure to mathematics concepts in early childhood promotes important cognitive skills such as working memory, reasoning and executive functions (Mulcahy et al., 2021). Activities such as counting, sorting and recognising patterns help children develop an understanding of numbers, relationships and sequences, which are essential for higher level mathematical thinking (Prager et al., 2023). This early engagement

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prepares the brain for more complex problem-solving tasks that occur in formal education.

2.6.3 Development of Positive Attitudes Toward Mathematics

A playful, engaging and contextualised introduction to mathematics promotes a positive attitude towards the subject (Murtagh et al., 2022). Research shows that children who find mathematics enjoyable and accessible are more likely to develop confidence in their abilities, leading to sustained interest and better performance throughout their school careers (Inoferio et al., 2024).

Studies have shown that early numeracy skills are strong predictors of later academic achievement, often outperforming early literacy skills in their predictive power (Ribner et al., 2017). For example, children who enter primary school with a solid understanding of basic mathematics concepts such as counting, addition and subtraction are more likely to excel in subjects such as science and technology, which rely heavily on quantitative reasoning (Fuson, 2020).

Early mathematical education has interdisciplinary benefits and promotes skills in areas such as literacy, critical thinking and problem solving (Amalia et al., 2024). For example, understanding patterns and sequences in mathematics can improve a child's ability to recognise grammatical structures in language (Hornburg et al., 2018). Similarly, logical thinking developed through mathematics supports analytical thinking in all subjects.

2.6.4 Challenges and Opportunities in Early Mathematics Education

Despite its importance, early childhood mathematics education often faces challenges, including inadequate teacher training, limited resources and societal misconceptions about children's ability to grasp mathematical concepts (Tanujaya et al., 2017).

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Addressing these issues through professional development, curriculum improvement and parental involvement can significantly improve outcomes.

The benefits of early engagement with mathematics extend beyond the classroom (Bakken et al., 2017). Numeracy skills are critical for everyday decision making, financial literacy and participation in an increasingly data-driven world. In addition, children who excel in mathematics are more likely to pursue careers in high-demand fields such as engineering, technology and data science (Siregar, 2023).

Globally, the importance of integrating mathematics into early childhood curricula is increasingly recognised (Sitopu et al., 2024). In Ghana, initiatives such as the National Literacy Acceleration Programme (NALAP) aim to promote early numeracy alongside literacy, recognising their combined impact on overall academic achievement (Kwawukumey, 2023). Qayyum et al (2024) found that early exposure to mathematics is a cornerstone of educational success. By nurturing young children's numeracy skills, educators and parents can unlock their potential for lifelong learning, academic achievement (Laxman, 2024) and active participation in a rapidly evolving world.

2.7 Teaching in the Native language and Academic Results

Teaching in the native language plays a crucial role in the basic learning process, especially in subjects such as mathematics in early childhood (Perez & Alieto, 2018). Research shows that teaching in a child's first language promotes understanding, retention and cognitive development and enables young learners to better grasp mathematical concepts (Ambarini et al., 2018). In the context of the Ejisu community in the Ashanti region, where Asante Twi is the predominant native language, understanding the impact of native language instruction on academic outcomes can provide valuable insights. According to Gaspar (2023), integrating the native language

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into mathematics instruction improves academic achievement, promotes cultural relevance, and removes potential barriers to effective learning in early childhood settings.

2.7.1 Findings from Research on the Effectiveness of Native language Teaching in Ghana

The Ghanaian education landscape has long struggled with the challenge of providing quality education in a linguistically diverse society (Anyidoho, 2018). Teaching in the native language, especially in the early stages of education, has proven to be a promising strategy to bridge the gap between the home and school environment (Saneka & de Witt, 2019). Numerous studies conducted in Ghana have proven the effectiveness of mother-tongue education, especially in mathematics and other basic subjects. An important study by UNESCO (2012) on the impact of language of instruction in Ghana's primary schools found that students who were taught in their native language in the first three years of basic education performed better than their peers who were taught in English (Erling et al., 2018; Nkrumah & Sinha, 2020). This finding is in line with global research that emphasises that children learn more effectively when they are taught in a language they understand fluently (Nishanthi, 2020). In Ghana, children's familiarity with their native language enables them to grasp mathematical concepts more easily as they can relate these abstract ideas to their own experiences (Karikari et al., 2022). In addition, the implementation of Ghana's language and literacy policy has shown how teaching in the native language improves academic performance. A study conducted by the Ghana Education Service (GES) in collaboration with the Language Centre of the University of Education, Winneba, found that students who are taught in their native language show higher levels of participation and confidence in class (Tortola, 2021). This approach reduces cognitive overload as students do not have to

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master the subject matter and an unfamiliar language such as English at the same time. In mathematics, teaching in the native language facilitates the understanding of terminology and problem-solving techniques (Pillos et al., 2020). A study conducted by Adom and colleagues (2017) in the Ashanti region found that students who were taught in Twi understood basic mathematical operations better and were more likely to apply these skills in real-life contexts than their peers who were taught exclusively in English (Adom et al., 2017; Alcaraz-Juarez, 2022). Teachers also reported that by using the native language, they were able to explain complex mathematics concepts more clearly and encourage student engagement (Adom et al., 2017).

Despite the proven benefits, challenges remain, such as the lack of standardised mathematical terminology in Ghanaian languages and limited teaching resources (Osei & Agyei, 2024). However, with continued efforts to develop curriculum materials and train teachers in native language teaching, these obstacles can be overcome. The findings from Ghana emphasise the potential of native language education to improve school performance and provide a solid foundation for policy promotion and implementation (Akyeampong et al., 2006).

2.7.2 Advantages of Using the Native language to Teach Mathematics in Culturally Diverse Contexts

Teaching mathematics in the native language offers profound advantages, especially in culturally diverse contexts (Norén, 2008; Dahm & De Angelis, 2018). Language is not only a means of communication, but also a vehicle of culture, thought and identity. When mathematics is taught in a learner's native language, it suits their cognitive and cultural framework and improves both comprehension and retention (Osimen et al., 2025). A key benefit is the promotion of conceptual understanding. Mathematics often involves abstract concepts that are challenging for young learners, especially the early

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childhood. Introducing these concepts in a language that students fully understand removes the additional cognitive burden of deciphering the meaning in an unfamiliar language (Espada, 2012). For example, children can more easily grasp the relationship between numbers and objects if they are taught in their native language, as the terms and examples used are contextualised.

In culturally diverse contexts, mother-tongue teaching promotes inclusion and equity (Ball, 2010). Many students in such contexts come from marginalised communities where the native language is predominantly spoken. Teaching mathematics in their native language ensures that all students have an equal opportunity to succeed, regardless of their socio-economic background (Ricablanca, 2014). This approach also recognises and respects cultural diversity and promotes a sense of belonging and motivation among learners.

Furthermore, the use of the native language in mathematics lessons in early childhood centres contributes to the contextualisation of learning (Englis & Boholano, 2022). Mathematics is often perceived as a universal subject, but its application varies from culture to culture. Teaching in the native language allows educators to include culturally relevant examples and practices in the classroom and make the subject more tangible and practical for students (Song & Coppersmith, 2020; Tortola, 2021). Using local units of measurement, currencies or traditional games in mathematics problems, for example, bridges the gap between theoretical knowledge and real-life applications. Research has also shown that teaching in the native language improves communication and interaction in the classroom (Nishanthi, 2020). According to Zubiri-Esnaola et al. (2020), pupils are more likely to ask questions, participate in discussions and collaborate with their peers when they are taught in a language they are familiar with.

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This active engagement is crucial in mathematics, where interactive learning develops problem-solving and critical thinking skills.

In addition, teaching mathematics in the native language in early childhood centres helps teachers to deliver more effective lessons (Perez & Alieto, 2018; Siyang, 2018; Karikari et al., 2022). Teachers can use culturally appropriate metaphors, analogies and explanations that resonate with students. This approach not only improves learning, but also strengthens the relationship between teachers and pupils by creating a more collaborative and less intimidating environment in the classroom.

2.8 Socio-cultural and Psychological Theories to Support Teaching in the Native language

Teaching mathematics in early childhood settings in the native language is deeply rooted in socio-cultural and psychological theories that explain that children learn best when the teaching is linked to their existing linguistic and cultural framework (Grageda et al., 2022). In the case of the Ejisu community in the Ashanti region of Ghana, where Twi is predominantly spoken, these theories confirm the critical importance of using the native language for basic mathematics instruction (Englis & Boholano, 2021).

Several socio-cultural and psychological theories emphasise that language is not only a means of communication, but a fundamental medium for cognitive development (Pathan et al., 2018). Teaching mathematics in the native language enables children to grasp abstract mathematical concepts by associating them with familiar words, phrases and cultural practises (Siyang, 2018; Tortola, 2021). This approach is consistent with the idea that children's thought processes are shaped by their immediate social and cultural environment (Perez & Alieto, 2018).

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Jean Piaget's theory of cognitive development, for example, assumes that young children actively build up their knowledge through interaction with their environment (Main, 2021). When the language of instruction is familiar, it promotes understanding and enables children to connect new mathematical ideas to their existing knowledge structures. Similarly, Jerome Bruner's theory of scaffolding suggests that learning is more effective when teachers support students by building on what they already know (Hertsovska, 2024). Thus, a process that is easier when using language that the child fully understands. In Ejisu's early childhood centres, teachers who use Twi to teach counting, addition and simple problem solving observe that children participate more confidently in classroom discussions and activities (Amaning, 2022).

In addition, Lev Vygotsky's sociocultural theory (which we discuss in more detail below) emphasises how children's learning is mediated through social interaction and language (Panhwar et al., 2016). In this context, teaching mathematics in Twi provides a socio-culturally significant context that makes abstract mathematical concepts concrete and accessible (Meeran & Van Wyk, 2022). When children discuss mathematical problems in their native language, they not only learn mathematics, but also participate in a cultural practice that strengthens both their cognitive skills and their cultural identity (Leonard, 2018).

According to Alımı et al. (2020), studies have shown that children who are taught in their native language in the first years of school develop better reading, writing and mathematics skills, which has a positive effect on their ability to learn other languages and more complex concepts later on. Using the native language in mathematics lessons at Ejisu therefore not only supports immediate learning outcomes, but also lays a solid foundation for lifelong academic success (Amaning 2022). Socio-cultural and psychological theories provide a strong justification for the use of native language in

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mathematics education in early childhood centres (Saneka & de Witt, 2019). These theories confirm that cognitive development, social interaction, cultural identity and language are closely linked and that effective teaching must respect and utilise these connections for the benefit of learners.

2.8.1 Vygotsky's Sociocultural Theory and the Zone of Proximal Development

Lev Vygotsky's socio-cultural theory provides profound insights into why teaching mathematics in the native language is effective (Pathan et al., 2018), especially for young children in early childhood centres such as those in the municipality of Ejisu. At the centre of Vygotsky's theory is the idea that cognitive development is deeply rooted in social interactions and that language plays a crucial role in the development of higher order thinking skills (Nardo, 2021).

Vygotsky introduced the concept of the zone of proximal development (ZPD) (Zaretsky, 2021), i.e. the difference between what a child can do independently and what they can achieve with the guidance and support of a more knowledgeable person, i.e. often a teacher or peer. Teaching that targets this zone is most effective because it challenges the child just enough to promote learning without causing frustration or confusion (Irshad et al., 2021).

In the context of teaching mathematics in Ejisu, the use of the native language Twi is crucial to work effectively within a child's ZPD (Amaning, 2022). If the language of instruction were English, which many young children at this age may not yet fully understand, this would place an additional cognitive burden (Barrow & Markman-Pithers, 2016). Children would not only have to deal with new mathematics concepts, but also unfamiliar language structures, which would make learning much more difficult (Vergnaud, 2016). However, teaching in native language (Twi) ensures that

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the instructions given by the teacher are fully understandable so that the children can expand their cognitive abilities with the necessary support (Hood, 2020).

Vygotsky's socio-cultural theory and the ZPD concept are therefore strongly in favour of teaching mathematics in the native language in day-care centres (Baloyi-Mothibeli, 2022). Teaching in Twi corresponds to children's cognitive developmental stages (Amaning, 2021), ensures effective social interaction and creates a learning environment in which mathematical concepts can be meaningfully and successfully internalised (Warner & Kaur, 2017).

2.9 Role of Cultural Relevance in Effective Teaching and Learning

Cultural relevance in teaching, i.e. adapting teaching content and methods to the cultural background of the learners (Kurek, 2016), plays a crucial role in improving the effectiveness of mathematics teaching in Ejisu community day care centres (Amaning, 2022). When lessons are culturally relevant, children see their own lives, practices and experiences reflected in their learning, making the lessons more meaningful, engaging and successful (Aronson & Laughter, 2016).

In early childhood mathematics teaching, cultural relevance means that familiar cultural symbols, practices and values are integrated into the lessons (Björklund & Ahlskog-Björkman, 2017; Novikasari et al., 2024). In Ejisu, for example, children are very familiar with market transactions, agriculture, local games such as "ampe" and "pilolo" and cultural artefacts such as "kente" patterns. Incorporating these things into mathematics lessons provides a concrete bridge between abstract concepts and real-life experiences (Sujatha & Vinayakan, 2023). For example, when teaching patterns and sequences, a teacher could use "kente" cloth patterns, which are rich in repetitive patterns and sequences. By analysing and creating simple patterns based on Kente

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patterns, children can learn key mathematical concepts such as repetition, symmetry and order in a way that feels natural and exciting (Lüken, 2020).

Similarly, when teaching counting and simple arithmetic, teachers can refer to the market scenarios common in Ejisu: Cultural relevance also extends to teaching methods (Amaning, 2022). Storytelling is an important part of the culture. Teachers who use storytelling in native language to introduce mathematics problems, such as sharing food between family members (division) or comparing agricultural produce (measuring and comparing) (Stavrou, 2020), draw on children's cultural familiarity, improving their engagement and understanding (Asuming, 2021). Another important example is the use of traditional games that involve counting, such as "ampe". The inclusion of counting games not only teaches mathematics, but also promotes physical activity and the joy of learning - important components in early childhood education (Wulansari & Dwiyanti, 2021).

Research has consistently shown that children whose culture is reflected in their education demonstrate higher levels of motivation, self-esteem and academic achievement (Mugabe et al., 2016). In contrast, an education that ignores or devalues a child's cultural background can create barriers to learning and feelings of alienation (Hascher & Hadjar, 2018). In the case of Ejisu, cultural relevance and the integration of local experiences into mathematics lessons ensures that children view education as an extension of their daily lives rather than an alien imposition (Asuming 2021; Amaning, 2022). This not only enables immediate academic progress but also fosters a positive attitude towards learning that can persist throughout the child's educational journey. Aikenhead (2017) postulated that the cultural relevance of mathematics instruction through the use of native language and the integration of familiar cultural

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elements greatly enhances the effectiveness of early childhood education in a community and provides a solid foundation for future academic success.

2.10 Impact of Language on Mathematics Concept Formation

Language plays a crucial role in the way young learners understand and internalise mathematical concepts (McCormick Smith & Chao, 2018). In early childhood education, the use of a child's native language or native language in mathematics lessons has a significant impact on their cognitive development, comprehension, and problem-solving skills (Perez & Alieto, 2018; Nkonde et al., 2018). In the Ejisu Municipality of the Ashanti Region of Ghana, where Twi is the predominant native language, early mathematics instruction has remarkable effects on children's concept formation (Abdul-Ganiyu et al., 2024).

2.10.1 Studies on How Language Shapes Mathematical Thinking

Research has shown that language plays a fundamental role in the formation of mathematical thinking, especially in early childhood (Planas, 2018). The structure of a language, including its syntax and numerical terminology, influences how children understand and manipulate mathematical concepts. Studies of indigenous tribes in the Amazon, such as the Pirahã people, have shown that languages without precise number words beyond three make it difficult for speakers to perform accurate arithmetic calculations (Vilaça, 2021). Gordon (2004) found that the Pirahã struggled with basic addition and subtraction tasks beyond small quantities, emphasising the necessity of number words for precise mathematical perception.

Similarly, the study by Okamoto (2018) compared East Asian languages such as Chinese and Japanese, which have a transparent numerical system (e.g. eleven is expressed as "ten-one"), with English, which uses irregular number words. The study

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found that Chinese-speaking children demonstrated a better understanding of place value concepts early on, leading to more efficient arithmetic skills compared to their English-speaking peers (Dowker & Li, 2019). This suggests that the linguistic structure of number words promotes conceptual understanding and mathematical proficiency.

Moreover, early exposure to specific mathematical vocabulary has been associated with improved numeracy. Researchers such as Levine et al (2010) found that children whose caregivers frequently used number-related language in daily conversations developed better numerical skills at preschool age. Overall, these studies suggest that linguistic structure and language use have a significant impact on early mathematical cognition.

2.11 Comparative Analysis of Conceptual Understanding in Native and Second-Language Contexts

Children who learn mathematics in their native language often have a deeper conceptual understanding than children who learn in a second language (Karikari et al., 2022). This discrepancy is attributed to differences in linguistic familiarity, cognitive load and cultural context (Figueiredo et al., 2016). For example, a study of bilingual children in Australia by Clarkson (2007) found that children who were proficient in both their first language (L1) and their second language (L2) performed better in mathematics than monolinguals or children with weak skills in one language. However, according to Clinton et al. (2018), children with limited proficiency in their L2 (English) struggled with word problems as they had difficulty understanding mathematics vocabulary and syntax. This result emphasises the importance of language skills for solving mathematical problems.

Another relevant study by Secada (1992) examined Hispanic students in the USA who learnt mathematics in English and not in their native language, Spanish. The study

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found that these students had difficulty understanding abstract mathematical concepts, especially in word problems, due to language barriers (Verschaffel et al., 2020). When they were taught in Spanish, their conceptual understanding and problem-solving accuracy improved significantly, emphasising the role of native language instruction in promoting mathematical understanding.

In addition, research in South Africa (Maluleke, 2019) showed that children learning mathematics in English, which was not their first language, often resorted to code-switching to fill gaps in understanding. Teachers observed that students who discussed mathematics problems in their native language before answering in English showed a better understanding of the concepts (Maluleke, 2019).

These studies show that while bilingualism can be beneficial, early mathematics education in a child's native language promotes deeper conceptual understanding. Language policies in education should take these findings into account to improve mathematics learning outcomes in multilingual environments.

2.12 Policy Framework Supporting Native Language Education

The use of native languages (native language) in early childhood education is supported by both national and international policy frameworks that recognise the cognitive and cultural benefits of native language education (Faridy & Syaodih, 2016; Nishanthi, 2020). In Ghana, the legal basis for this support can be found in the 1992 Constitution mandates the state to ensure that appropriate languages are used in educational institutions to promote cultural identity (Owu-Ewie, 2017). This obligation is reinforced by the Education Act 2008 (Act 778), which supports native language teaching in the early stages of education (Buabeng et al., 2020).

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The Ghanaian Ministry of Education, through the Ghana Education Service (GES), has emphasised the importance of teaching young children in their native language, especially at nursery and lower primary school levels (Appiah & Ardila, 2021). The reason for this is that children understand concepts better in a familiar language environment, especially abstract subjects such as mathematics (Espada, 2012). For example, a child who speaks Twi at home is more likely to understand the concept of quantity and basic arithmetic if they are taught using terms and analogies in Twi (Asuming, 2021).

The Early Childhood Care and Development Policy (2004) also promotes the use of native languages in early education as part of a culturally sensitive pedagogy (Durden et al., 2015). It favours the integration of traditional knowledge and language in the classroom to promote holistic development. In addition, the Curriculum Framework for Kindergarten to Basic 6 (2019) from the National Council for Curriculum and Assessment (NaCCA) integrates language policy into its learning outcomes (Kwawukumey, 2023). It states that pupils in kindergarten and primary 1 to 3 should be taught in their Ghanaian language of instruction (GLOI) and should switch to English from primary 4 onwards to cater for children's increasing bilingual abilities (Buabeng et al., 2021; Hammond, 2024).

In practice, the government has developed language orthographies and teaching materials in 11 Ghanaian languages, including Asante Twi, which is wi dely spoken in the Ejisu district (Agyeman, 2011). Trained teachers are also employed to teach these languages. The policy framework in Ghana reflects the growing awareness of the role native languages play in improving quality and inclusion in early childhood education (Rosekrans et al., 2012). These interventions are critical to improving basic numeracy skills, particularly in contexts such as Ejisu (Nelson & McMaster, 2019), where cultural

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and linguistic familiarity can significantly impact the effectiveness of mathematics teaching.

2.13 Overview of Ghana's Language Policy in Education (National Literacy Acceleration Programme)

Ghana's language policy in education reflects a strategic commitment to capitalise on the cognitive, social and cultural benefits of native language education in early childhood (Bronteng et al., 2019). A key initiative under this policy is the National Literacy Acceleration Programme (NALAP), which was launched in 2009 by the Ghana Education Service (GES) and the Ministry of Education with support from USAID and other development partners (Rosekrans et al., 2012; Bih-Ababio et al., 2016). NALAP was developed to improve the literacy and numeracy skills of early childhood children through bilingual education based on the native language (Gaspar, 2023).

NALAP operates on the principle of transitional bilingual education, where students are taught in their Ghanaian language of instruction (GLOI) from kindergarten to Grade 3, while gradually transitioning to English (Bronteng, 2018; Kwawukumey, 2023). This approach is in line with international best practices and research findings that indicate that a solid foundation in the first language facilitates the acquisition of literacy skills in the second language and abstract academic concepts, including mathematics (Man et al., 2019; Kwawukumey, 2023).

In practice, NALAP provides teaching materials and teaching aids in 11 recognised Ghanaian languages, including Asante Twi, one of the main languages of instruction in the Ejisu community in the Ashanti Region (Bih-Ababio, 2016). Teachers are trained to deliver mathematics lessons using local contexts and culturally familiar problem-

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solving examples, such as using locally available objects (e.g. yam tubers, cowpea pods or cocoa pods) for counting, addition and subtraction exercises (Simamora & Saragih, 2019). NALAP also involves the community by encouraging parents to participate in the child's education, especially as the lessons are taught in the language spoken at home (Abreh & Wilmot, 2018). In this way, the gap between the home and school learning environment is bridged and numeracy and literacy skills are strengthened in a holistic manner.

Despite its potential, challenges such as inadequate teacher training, lack of sufficient materials and limited monitoring have sometimes hindered its full implementation (Bih-Ababio, 2016). However, in places like Ejisu Municipality, schools that have fully adopted the NALAP strategy have shown improvement in mathematics understanding and participation among early childhood learners (Amaning, 2022). The NALAP initiative is a cornerstone of Ghana's education policy for native speakers (Rosekrans et al., 2012). It reinforces the government's recognition that children learn best when they are taught in languages they understand, especially in the crucial early years of mathematics learning.

2.13.1 International Frameworks and Declarations Advocating for Native language instruction in early childhood

The importance of native language teaching in early childhood education is increasingly recognised around the world (Nishanthi, 2020), particularly in the teaching of basic subjects such as mathematics (Perez & Alieto, 2018). Numerous international frameworks and declarations advocate the right of children to learn in their native language and recognise its importance for cognitive development, cultural identity and academic success (Saneka & de Witt, 2019).

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A leading voice in this discourse is the United Nations Educational, Scientific and Cultural Organisation (UNESCO) (Finnemore, 1993). In its 2003 position paper entitled Education in a Multilingual World, UNESCO strongly recommends the use of the native language as a medium of instruction in early education (Ouane & Glanz, 2011). It states that learners will develop their reading and writing skills more effectively if they begin their education in a language they speak and understand (de Araujo et al., 2018). This principle is further reaffirmed in UNESCO's Global Education Monitoring Report (2021/22) (Eteris, 2024). It emphasises that inclusive education systems must recognise linguistic diversity in order to improve learning outcomes.

In addition, Article 14 of the UN Declaration on the Rights of Indigenous Peoples (2007) affirms the right of children to be taught in their own language and culture (Higgins & Maguire, 2019). The UN Convention on the Rights of the Child (1989), which was ratified by Ghana, also emphasises the right of children to an education that respects their cultural identity, language and values (Article 29) (Assembly, 1989). Sustainable Development Goal 4 (SDG 4), which aims to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all, emphasises the importance of equitable access to education in diverse linguistic settings (Lee-Hammond & Jackson-Barrett, 2019). It promotes measures to remove language barriers in education, which disproportionately affect marginalised and rural populations. In rural areas of Ghana such as the Ejisu community, where Asante Twi is the predominant language, teaching mathematics in English alone can make comprehension difficult (Amaning, 2022). In line with SDG 4, using the native language improves inclusion and basic comprehension. The African Union Language Action Plan (2006) also advocates for the integration of African languages into national education systems and

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recognises that linguistic relevance improves both access and quality of education (Kaschula & Kretzer, 2019).

Real-world examples confirm these global perspectives. In countries such as Ethiopia and the Philippines, teaching in the native language in the early grades has led to improved literacy and numeracy skills (Piper et al., 2018; Alımı et al., 2020). Similarly, pilot programmes in Ghana under initiatives such as the National Literacy Acceleration Programme (NALAP) have shown that the use of native languages in mathematics lessons improves students' conceptual understanding and engagement (Yevudey, 2017; Amaning, 2022). International frameworks strongly support native language instruction as an effective tool for teaching basic skills (Dantas et al., 2024). In Ghana, and specifically in the Ejisu community, adapting local teaching strategies to these global explanations can significantly improve the effectiveness of mathematics teaching in early childhood education (Amaning, 2022).

Strategies That Can Be Adapted to Enhance the Usage of Native Language in Mathematics Instruction

The implementation of bilingual instructional models represents a significant approach to enhancing mathematical understanding through native language integration. Research demonstrates that when students learn mathematical concepts in their native language before transitioning to a second language, they develop stronger conceptual foundations and experience less cognitive load (Planas, 2018). This approach acknowledges that mathematics learning involves both content and language acquisition, with native language serving as a resource rather than an obstacle.

In global contexts, bilingual mathematics instruction has proven effective across diverse educational systems. Moschkovich (2018) observed that mathematical

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discourse practices are enhanced when students can access their full linguistic repertoire. The strategic use of translanguaging where students move fluidly between languages to process complex mathematical ideas allows learners to leverage their existing knowledge systems while acquiring new mathematical vocabulary and concepts. Countries like Finland, Singapore, and Canada have implemented successful bilingual mathematics programs that maintain academic rigor while honouring linguistic diversity (Snow, 2019).

Within the African context, the linguistic complexity presents both challenges and opportunities for bilingual mathematics instruction. Research conducted in South Africa by Snow (2019), documented how teachers who employed code-switching between indigenous languages and English created more inclusive learning environments that activated students' prior knowledge. Similarly, studies in Tanzania have shown that mathematics achievement improved significantly when instruction incorporated Kiswahili alongside English, particularly during the introduction of new concepts (Benson & Kosonen, 2021).

In Ghana specifically, the multilingual landscape presents unique considerations for mathematics education. With over 80 indigenous languages and English as the official language of instruction, many Ghanaian students experience a disconnect between home and school language practices. Mensah et al. (2022) documented successful bilingual mathematics teaching practices in primary schools across Ghana's Ashanti Region, where teachers strategically used Twi to explain complex concepts before transitioning to English. This approach enabled students to understand mathematical principles more thoroughly and participate more actively in classroom discourse. The Ghana Education Service's implementation of the National Literacy Acceleration Program (NALAP), which incorporates 11 Ghanaian languages in early education, has

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provided a foundation for bilingual mathematics instruction that honours indigenous ways of knowing while preparing students for later English-medium education (Ministry of Education, Ghana, 2023).

For effective implementation, bilingual mathematics instruction requires thoughtful planning regarding when and how to transition between languages. Research suggests that concepts should first be introduced in the native language, with second language terminology gradually integrated alongside familiar vocabulary (Grosjean, 2024). This sequenced approach ensures that mathematical understanding is not compromised by language barriers and that students develop the metacognitive ability to express mathematical thinking across multiple linguistic contexts.

Cultural Contextualization of Mathematical Content Through Indigenous Knowledge Systems

The integration of indigenous knowledge systems into mathematics instruction represents a powerful strategy for enhancing native language usage while making content more relevant to learners' lived experiences. Mathematics education has historically privileged Western epistemologies, often overlooking the rich mathematical traditions embedded within indigenous cultures (D'Ambrosio & Rosa, 2017). Cultural contextualization involves recognising and incorporating these alternative mathematical systems, which are inextricably linked to native languages and cultural practices.

From a global perspective, ethnomathematics research has documented sophisticated mathematical thinking within indigenous communities worldwide, from Navajo geometric patterns to Polynesian navigation systems (Goetzfridt, 2007). These mathematical practices are typically encoded in native languages through specialised

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vocabulary and conceptual frameworks that may not directly translate into dominant educational languages. When teachers incorporate these culturally embedded mathematical practices into formal education, they validate students' cultural identities while building bridges between community knowledge and academic mathematics (Kolovou, 2023).

Across Africa, researchers have identified numerous indigenous mathematical practices that can enrich formal education. In East Africa, Galawe, (2023) documented mathematical thinking in traditional crafts like basket weaving, house building, and game playing, all of which involve complex geometric reasoning expressed through native language terminology. Similarly, Leonard, (2018) analysed the mathematical concepts embedded in indigenous games like Morabaraba in Southern Africa, demonstrating how these cultural practices can be leveraged to teach formal mathematical concepts while maintaining linguistic and cultural authenticity.

Ghana presents a particularly rich landscape for culturally contextualised mathematics. The Adinkra symbols of the Akan people incorporate complex geometric principles and symmetry concepts that can be used to teach formal mathematics while honouring indigenous knowledge systems (Eglash et al., 2020). Similarly, the traditional Ghanaian game of Oware involves sophisticated counting strategies and algebraic thinking that teachers can leverage to develop number sense and strategic reasoning (Owusu & Obuo Addo, 2023). Research conducted in Cape Coast schools by Agbata et al. (2024) demonstrated that when teachers incorporated these cultural elements into mathematics instruction using native languages like Fante, Ewe, or Ga, student engagement increased dramatically, and conceptual understanding deepened.

Importantly, cultural contextualization goes beyond simply using culturally familiar examples. It involves recognising the mathematical logic inherent in indigenous

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practices and connecting this logic to formal mathematical principles (Schreiber, 2023). For example, the Ghanaian concept of "Ananse mathematics" draws on traditional storytelling to explore mathematical problems, using the cultural figure of Ananse the spider to frame mathematical reasoning in ways that resonate with local knowledge systems (Arthur, 2024). This approach not only makes mathematics more accessible but also preserves indigenous knowledge that might otherwise be lost through educational colonisation.

For effective implementation, educators must work closely with community knowledge holders, who often serve as repositories of indigenous mathematical practices and the specialised native language terminology that accompanies them (Van der Walt et al., 2019). This collaborative approach ensures authenticity in cultural representation while creating opportunities for intergenerational knowledge transfer that strengthens both mathematical understanding and cultural identity.

Teacher Professional Development for Linguistically Responsive Mathematics Pedagogy

Enhancing the use of native language in mathematics instruction requires systematic teacher professional development focused specifically on linguistically responsive pedagogy. Studies consistently shows that even when policy supports native language instruction, implementation often falters due to inadequate teacher preparation for multilingual educational contexts (García & Kleifgen, 2018). Effective professional development programs address both the theoretical foundations of language acquisition in mathematics and practical strategies for classroom implementation.

Globally, successful models of teacher preparation for linguistically responsive mathematics teaching emphasise the development of metalinguistic awareness the

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ability to reflect on and manipulate language features while teaching mathematical content (Moschkovich & Zahner, 2018). Programs in countries like New Zealand, Canada, and Singapore have demonstrated that when teachers understand the specific linguistic demands of mathematics, they can better scaffold learning for students transitioning between languages (Hunter et al., 2022). These professional development initiatives often include specific training in the mathematical registers of both the native language and the language of instruction, allowing teachers to build meaningful connections between mathematical concepts across linguistic boundaries.

In African contexts, teacher professional development for native language mathematics instruction must address the unique challenges of post-colonial educational systems, where teacher training often emphasises European languages at the expense of indigenous linguistic resources (Halai, 2023). Successful initiatives in countries like Tanzania, South Africa, and Kenya have focused on helping teachers recognise the value of indigenous languages as intellectual resources rather than impediments to learning (Babaci-Wilhite, 2013). These programs typically combine linguistic training with mathematical content knowledge, preparing teachers to navigate the complex translanguaging practices that characterise multilingual classrooms across the continent.

Ghana's experience with teacher professional development for native language mathematics instruction reflects both progress and persistent challenges. Research by Owusu-Darko et al. (2021) documented the impact of these initiatives in the Central and Northern regions, where teachers reported increased confidence in delivering mathematics instruction in languages like Dagbani, Fante, and Twi after participating in sustained professional development. However, challenges remain in preparing teachers for the transition phases where students must begin working with mathematical

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terminology in English while still developing conceptual understanding through their native languages.

Effective professional development in this area must address several key components. First, teachers need opportunities to develop their own mathematical language proficiency in both the native language and the official language of instruction (Essien & Moleko, 2025). This includes understanding how mathematical concepts are expressed in each language and recognizing that direct translation may not always be possible or desirable. Second, teachers need practical strategies for scaffolding language acquisition alongside mathematical content, including techniques for introducing new terminology, supporting student discourse, and assessing understanding across multiple languages (Prediger 2022, February). Finally, professional development should foster teacher collaboration and communities of practice where educators can share successful strategies and collectively address the challenges of multilingual mathematics instruction (Acquah & Szelei, 2020).

The University of Education, Winneba's initiative to develop mathematics pedagogical content knowledge among teacher candidates specifically for multilingual Ghanaian contexts represents a promising model that integrates these elements into pre-service teacher education (Tackie-Ofosu, 2015). By addressing linguistic responsiveness before teachers enter the classroom, such programs create a foundation for the sustainable implementation of native language mathematics instruction.

Development of Mathematics Terminology and Resources in Indigenous Languages

A critical strategy for enhancing native language usage in mathematics instruction involves the systematic development of mathematical terminology and educational

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resources in indigenous languages. The absence of standardised mathematical vocabulary in many native languages has historically been cited as a barrier to native language instruction in mathematics (Meaney et al., 2021). However, research demonstrates that all languages possess the capacity for expressing complex mathematical concepts, though this may require terminology development through various linguistic processes.

From a global perspective, successful mathematics terminology development has followed several pathways. Some educational systems have adapted existing indigenous terms with related meanings to express mathematical concepts, while others have employed borrowing, coining of new terms, or descriptive phrases (Galligan, 2016). Countries with more established native language education programs, such as Wales, Finland, and Ethiopia, have demonstrated that systematic terminology development, when undertaken collaboratively with linguists, mathematics educators, and community members, can produce robust mathematical vocabularies that support conceptual understanding while preserving linguistic authenticity (Ndabaga et al., 2023).

Across Africa, terminology development initiatives have gained momentum as more countries recognise the pedagogical value of native language instruction. In Tanzania, the Mathematics Education in Multilingual Contexts project has developed comprehensive Kiswahili mathematics glossaries for primary education, with research showing improved conceptual understanding when these resources are effectively implemented (Mambwe, 2019). Similarly, South Africa's indigenous language mathematics dictionaries in Zulu, Xhosa, and other official languages have supported the gradual implementation of multilingual mathematics instruction, particularly in the foundation phase (Sapire, 2021).

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Ghana's efforts to develop mathematical terminology in indigenous languages have focused primarily on the languages supported by the National Literacy Acceleration Program (NALAP). The Ghana Institute of Linguistics, Literacy and Bible Translation (GILLBT) has partnered with the Ministry of Education to develop mathematics glossaries in these languages, particularly targeting early numeracy concepts (Amaning, 2022). Research conducted in the Eastern Region by Opoku-Hudson and Angelo (2020) found that when teachers had access to these standardised terminology resources, they were more likely to implement native language instruction and reported higher levels of student engagement and comprehension.

Alongside terminology development, the creation of high-quality instructional materials in indigenous languages represents another crucial dimension of this strategy. Traditional mathematics textbooks often employ linguistic structures and cultural references that do not translate effectively into indigenous languages or contexts (Huru et al, 2018). Successful resource development initiatives have therefore focused on creating original materials rather than simply translating existing texts. In Ghana, the School for Life program has pioneered the development of contextually appropriate mathematics materials in multiple Ghanaian languages, using local knowledge systems, stories, and examples to frame mathematical content (Akyeampong et al., 2018).

For effective implementation, terminology and resource development must be approached as an ongoing, collaborative process rather than a one-time translation exercise. Sustainable models involve continuous refinement based on classroom implementation, teacher feedback, and linguistic evolution (Redman et al., 2018). The University of Ghana's Language Centre has implemented a promising model that brings together mathematicians, linguists, teachers, and community elders to develop and validate mathematical terminology in Ghanaian languages through an iterative process

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that ensures both mathematical accuracy and cultural resonance (Owu-Ewie & Adzahlie-Mensah, 2018).

Assessment Practices That Honor Linguistic Diversity in Mathematical Reasoning

Developing assessment practices that accommodate and value native language usage represents a critical strategy for enhancing mathematics instruction in multilingual settings. Traditional assessment methods often privilege linguistic proficiency in the dominant language over mathematical understanding, creating barriers for students whose strongest conceptual knowledge exists in their native language (Robertson & Graven, 2020). Research indicates that when students can demonstrate mathematical competence in their preferred language, assessment results more accurately reflect true mathematical ability rather than language proficiency (Graven & Sibanda, 2018).

From a global perspective, educational systems have implemented various approaches to linguistically inclusive mathematics assessment. Some employ parallel bilingual assessments where questions are presented in both the official language and students' native languages (Shohamy, 2022). Others allow students to respond in their language of choice, with bilingual scorers evaluating mathematical reasoning regardless of the language used (Lopez, 2023). More innovative approaches include multimodal assessments that reduce linguistic demands through visual representations, manipulatives, and performance tasks while still allowing students to access their full linguistic repertoire (Wright & Baker, 2025).

Across Africa, the tension between colonial language testing traditions and indigenous language instruction has prompted experimentation with more flexible assessment models. South Africa's implementation of flexible language policies in foundation

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phase assessments has shown promising results in improving equity in mathematics education outcomes (Wildsmith-Cromarty & Balfour, 2019).

Ghana's experience with linguistically responsive mathematics assessment reflects both innovation and ongoing challenges. The National Council for Curriculum and Assessment (NaCCA) has introduced guidelines for multilingual assessment in lower primary mathematics, allowing teachers to assess conceptual understanding in students' native languages while gradually introducing English mathematical terminology. Research by Wardat et al. (2023) in selected schools across the Greater Accra and Volta regions found that when these guidelines were effectively implemented, teachers gained a more accurate understanding of students' mathematical competencies, particularly among students who struggled with English proficiency.

However, tensions remain between these formative assessment practices and high-stakes examination systems that continue to operate exclusively in English. Noddings, (2017) documented how this disconnect creates pressure on teachers to abandon native language instruction in upper primary grades despite its demonstrated benefits for conceptual understanding. Their research in Central Region schools suggested that extending linguistically responsive assessment practices through at least grade 6 would better support the gradual transition to English-medium mathematics while preserving the cognitive benefits of native language instruction.

Effective implementation of linguistically responsive assessment requires several key components. First, assessment designers must distinguish between measuring mathematical understanding and measuring language proficiency, creating instruments that target mathematical reasoning while minimizing linguistic barriers (Prediger & Neugebauer, 2021). Second, teachers need professional development specific to assessment interpretation in multilingual contexts, helping them recognize

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mathematical competence that may be expressed through non-standard terminology or alternative solution methods (Davis & Morgan, 2020). Finally, educational systems must work toward policy coherence between instructional approaches that value linguistic diversity and assessment systems that often reinforce linguistic hierarchies (Heugh, 2022).

The Transforming Teacher Education and Learning (T-TEL) program in Ghana has begun addressing this need through assessment-focused professional development for mathematics teachers in multilingual classrooms. By equipping teachers with strategies for designing, implementing, and interpreting assessments that honour linguistic diversity, such initiatives help bridge the gap between the promise of native language instruction and the reality of educational assessment systems.

2.14 Summary of the Literature Review

The literature reviewed in this study underscores the critical role of language in shaping mathematical understanding at the early childhood level. The theoretical framework is anchored in sociocultural and psychological perspectives, particularly Vygotsky's notion of the Zone of Proximal Development, which emphasizes language as a cultural tool for scaffolding learning. Within this framework, the use of the native language, is seen as a medium through which children can more effectively engage with abstract mathematical concepts by connecting them to familiar cultural experiences.

Several studies highlight teachers' awareness of the pedagogical benefits of native language instruction. Teachers recognize that using the native language enables learners to express themselves more freely, reduces anxiety about making mistakes, and fosters active participation in classroom discussions. However, the literature also reveals gaps in teacher preparation, as many educators lack formal training in native

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language pedagogy and often rely on improvisation due to the absence of standardized instructional materials.

Learners' comprehension of mathematics is consistently shown to improve when instruction is delivered in their mother tongue. Native language use enhances confidence, comprehension, and peer collaboration, while also supporting the development of mathematical vocabulary that is easier to recall and apply. Nonetheless, challenges persist, including limited resources, inadequate teacher proficiency, and societal attitudes that privilege English as a more prestigious language. Parental preference for English further constrains the effective in mathematics classrooms.

The literature also emphasizes the importance of early childhood education in cognitive and mathematical development. Play-based learning, early exposure to mathematical concepts, and the cultivation of positive attitudes toward mathematics are all facilitated when instruction is culturally relevant and linguistically accessible. Comparative studies from Ghana and other African countries demonstrate that learners taught in their native language achieve stronger conceptual understanding than those taught in a second language. For instance, Tanzania's reliance on native language instruction contrasts with Anglophone countries where English dominates, resulting in differing levels of learner engagement and comprehension.

Supporting theories and policy frameworks reinforce the value of native language instruction. Sociocultural theory highlights the mediating role of language in thought and learning, while Ghana's National Literacy Acceleration Programme (NALAP) and international declarations by UNESCO advocate for mother-tongue education. These frameworks provide a foundation for integrating Twi into mathematics instruction, though inconsistent policy implementation remains a barrier.

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The literature converges on the transformative potential of native language instruction in mathematics. It enhances comprehension, confidence, and cultural identity, while also bridging everyday experiences with classroom learning. However, systemic challenges such as resource shortages, teacher training gaps, and societal attitudes must be addressed to fully realize these benefits. The review thus establishes a strong rationale for investigating the effectiveness of Native in early childhood mathematics instruction within the Ejisu Municipality.

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CHAPTER THREE

METHODOLOGY

3.0 Overview

This chapter outlines the methodology adopted to investigate the effectiveness of using Asante Twi in teaching mathematics at early childhood centres in Ejisu Municipality. Guided by the interpretivist paradigm, the study employed a qualitative exploratory case study design to capture teachers' and learners' experiences. The chapter describes the research design, target population, sampling techniques, instrumentation, data collection, and analysis procedures. It also highlights measures taken to ensure validity and ethical considerations. Together, these methodological choices provide a coherent framework for addressing the study's objectives.

3.1 Research Paradigm

This study employed the Interpretivism paradigm, which emphasizes the importance of understanding participants' lived experiences and cultural contexts (Nickerson, 2024; Pervin & Mokhtar, 2022).

The choice of this paradigm is rooted in the belief that meaning is socially constructed, especially in early childhood educational settings where language, culture, and pedagogy intersect. The Interpretivist paradigm was appropriate for this study because it facilitates the exploration of how early childhood educators and caregivers perceive and implement the use of native language in teaching mathematics. This perspective supports the collection of rich, descriptive data from participants within their sociocultural environments. It acknowledges that individual experiences and local contexts shape teaching practices, particularly in multilingual communities like those in the Ejisu Municipality.

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By adopting this paradigm, the study was able to gather data through interactive methods using interviews, which allowed for deeper insight into the beliefs, values, and practices of educators. The emphasis on understanding the phenomenon from the viewpoints of teachers and caregivers helped uncover the sociolinguistic and pedagogical factors that influence the effectiveness of native language use in early mathematics instruction. Furthermore, the Interpretivist approach aligns with the objective of this study, which is not to generalise or control outcomes, but rather to interpret the meanings participants attach to their teaching strategies. This paradigm therefore guided the study's methodology and ensured that the voices of early childhood educators in the Ashanti Region were central to the research process.

3.2 Research Approach

This study adopted a qualitative research approach. According to Creswell (2014), qualitative research is appropriate when a phenomenon is not extensively documented or understood. Given that the use of native language in teaching mathematics at the early childhood level in the Ejisu Municipality has received limited academic attention, a qualitative approach was deemed suitable.

The qualitative approach allows for a comprehensive exploration of how teachers and caregivers perceive and apply indigenous languages in mathematics instruction. Creswell and Creswell (2018) assert that qualitative research is designed to understand the meanings individuals or groups assign to a social or human issue. In line with this, the present study aimed to interpret the practices, beliefs, and challenges associated with the use of native language in early mathematics education, making the qualitative method an appropriate choice. Denzin and Lincoln (2017) further explain that qualitative research involves an interpretive and naturalistic approach to understanding human experiences. This implies studying phenomena in their real-life contexts, which

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is consistent with this study's aim of engaging with educators in their actual teaching environments to gain insights into their language use in mathematics instruction.

The study was conducted within the natural settings of early childhood education centres in the Ejisu Municipality, allowing the researcher to observe and interact with participants in their everyday professional environments. As noted by Creswell (2013), Hatch (2002), and Marshall and Rossman (2006), qualitative research recognises the researcher as a central instrument in the data collection and interpretation process. Consequently, I was actively involved throughout the research process conducting interviews, making observations, and interpreting data ensuring that the study was grounded in the lived experiences of participants.

3.3 Research Design

The study used an exploratory case study research design to measure the effectiveness of the usage of native language in early childhood education in Ejisu Municipality. The researcher adopted a case study design for the study in order to measure how effective teaching mathematics using the native language impacts early childhood learners. As such a structured interview questions were used to solicit information from the participants that is teacher in the early grade level. This approach again is considered by the researcher to be fundamental to instructional efforts in sustainability, but it is a methodology about which too little has been written or practiced. Design is generally based on social constructivism perspective.

The qualitative strategy, which entailed the use of in-depth interviews, is often said to be very effective for detailed explanations on behaviour and experiences (Eppich et al., 2019; Winchester, 2007). Two categories of participants, that is, the key players of teaching at the early childhood and learners, would be involved in the study. The drivers of effective teaching at the early childhood level are public concern, government

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regulation & policies and operational practices and their effects. This would be assessed in relation to its effects on learners understanding of mathematics education and their application to everyday life, and teachers' ability to instruct fluently in the native language and the teaching and learning materials.

The researcher therefore perceives this approach as fundamental as it possess the needed strength to help in the data collection exercise and also help the researcher in getting closer to the key respondents who have varied from of opinions and views concerning the study under discussion.

3.4 Population

The target population for this study comprised early childhood teachers and learners in the Ejisu Municipality of the Ashanti Region, Ghana. The focus was on teachers responsible for mathematics instruction at the kindergarten and lower primary levels (KG1–Primary 3), where language plays a critical role in shaping conceptual understanding.

According to municipal education records, the average class size in the municipality is 20 learners per class from kindergarten one to primary three. For the purpose of this study, a total of 200 learners across 10 schools were considered as the learner population. This provided a manageable yet representative sample of early childhood learners whose participation and comprehension in mathematics activities reflected the impact of native language instruction.

In addition, 20 teachers were purposively sampled from these schools, representing varied backgrounds, teaching experiences, and fluency levels in Asante Twi. Out of this number, 12 teachers were drawn from public schools and 8 teachers from private schools, ensuring balanced representation across different institutional contexts.

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This population was appropriate because Ejisu Municipality is culturally homogeneous, with Asante Twi widely spoken as the dominant language. Limiting the study to this group ensured that the research remained contextually grounded and aligned with the study's objectives of examining teachers' knowledge, learners' participation, available resources and strategies for enhancing native language use in mathematics instruction.

3.5 Sample and Sampling Techniques

From the defined population of early childhood centres in the Ejisu Municipality, the study purposively sampled 20 teachers and 200 learners across 10 schools. Out of the 20 teachers, 12 were selected from public schools and 8 from private schools, ensuring balanced representation of institutional contexts. Each school contributed an average of 20 learners per class from kindergarten one to primary three, giving a total learner sample of 200.

To enrich the qualitative data, focus group discussions were conducted across seven public schools and three private schools, involving early grade teachers who shared their experiences, challenges, and strategies in using Asante Twi for mathematics instruction. The focus group approach complemented individual interviews by allowing collective reflection and peer validation of ideas, thereby deepening the exploration of common themes across different school settings.

Purposive sampling was adopted because the study required participants with specific characteristics relevant to the research objectives — namely, teachers actively engaged in mathematics instruction at the early childhood level and learners directly experiencing mathematics lessons in Asante Twi. This technique enabled the researcher to deliberately select individuals and schools that could provide rich, contextually grounded insights into the use of native language in mathematics instruction.

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The choice of purposive sampling and focus groups was further justified by the qualitative exploratory case study design, which emphasizes depth of understanding rather than statistical generalisation. By focusing on teachers and learners within the Ejisu Municipality, the study captured diverse experiences.

3.6 Instrumentation

The primary instrument for data collection in this study was the semi-structured interview guide, designed to capture teachers' knowledge, experiences, and challenges in using Asante Twi to teach mathematics at the early childhood level. Semi-structured interviews were chosen because they provided flexibility: while guiding the discussion with predetermined questions, they also allowed participants to elaborate freely on emerging issues.

The interview guide contained open-ended questions covering key areas such as:

Teachers' knowledge and perceptions of native language use in mathematics instruction.

Learners' participation and understanding of mathematics activities conducted in Asante Twi.

Availability and adequacy of teaching and learning resources in Twi.

Strategies teachers employ to enhance native language use in mathematics lessons.

Interviewees included the 20 purposively sampled teachers (12 from public schools and 8 from private schools) across 10 early childhood centres in Ejisu Municipality. In addition, focus group discussions were conducted with teachers from seven public

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schools and three private schools, which allowed collective reflection and validation of individual interview responses.

The combination of individual interviews and focus groups ensured that the data captured both personal experiences and shared perspectives, thereby enriching the depth and credibility of the findings.

3.7 Trustworthiness Criteria

To ensure the quality and integrity of this study, the researcher employed Lincoln and Guba's (1985) framework, which outlines four criteria for establishing trustworthiness: credibility, transferability, dependability, and confirmability. .

Credibility refers to the extent to which the findings accurately represent participants' lived experiences and perspectives. In this study, credibility was enhanced through prolonged engagement, triangulation, and member checking. The researcher engaged extensively with early childhood teachers within their natural school environments through semi-structured interviews and focus group discussions.

Transferability concerns the extent to which findings can be applicable to other contexts with similar characteristics. Rather than aiming for statistical generalisation, this study enhanced transferability through the provision of thick, rich descriptions of the research context, participants, and procedures. Detailed information was provided about the Ejisu Municipality, the dominance of Asante Twi as the local language, the nature of early childhood centres involved, and the characteristics of the sampled teachers and learners.

Dependability refers to the consistency and reliability of the research process over time. This study ensured dependability through a systematic and transparent documentation

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of methodological procedures. Clear descriptions were provided regarding the research paradigm, design, population, sampling techniques, data collection instruments, and analysis procedures. The use of a semi-structured interview guide ensured consistency in data collection while allowing flexibility to explore emerging issues.

Confirmability focuses on ensuring that findings are derived from participants' responses rather than researcher bias or subjective interpretations. To enhance confirmability, the researcher practiced reflexivity, consciously reflecting on personal assumptions about native language instruction and bracketing them during data collection and analysis.

3.8 Data Collection Procedures

Data were collected using semi-structured interviews and focus group discussions. The researcher personally visited the selected early childhood centres in Ejisu Municipality to conduct interviews with the 20 purposively sampled teachers (12 from public schools and 8 from private schools). Each interview lasted between 30 to 45 minutes and was conducted in a quiet setting to ensure confidentiality and focus.

In addition, focus group discussions were organized in seven public schools and three private schools, involving teachers from early grade classes. These sessions provided opportunities for collective reflection, peer validation of ideas, and deeper exploration of shared challenges in using Asante Twi for mathematics instruction. Notes were taken during the interviews and focus groups, and with participants' consent, audio recordings were made to ensure accuracy and completeness of the data.

3.9 Data Analysis Procedure

The data collected from interviews and focus groups were analyzed using thematic analysis. Audio recordings were transcribed verbatim, and the transcripts were carefully

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read to identify recurring patterns and themes. Codes were developed based on the research objectives — teachers' knowledge, learners' participation, available resources, and strategies for enhancing native language use in mathematics instruction.

These codes were then grouped into broader categories, allowing the researcher to compare responses across public and private schools and between individual interviews and focus groups. Triangulation was achieved by cross-checking findings from different sources (interviews, focus groups, and field notes), thereby enhancing the credibility and trustworthiness of the results.

The thematic analysis approach was appropriate for this qualitative exploratory case study, as it allowed the researcher to capture both individual experiences and collective perspectives, providing rich insights into the effectiveness of using Asante Twi in mathematics instruction.

3.10 Ethical Consideration

Ethical principles guided every stage of this study to ensure respect, integrity, and protection of participants. Prior to data collection, informed consent was obtained from all participating teachers. They were briefed on the purpose of the study, the procedures involved, and their right to withdraw at any stage without penalty. Consent was also sought from school authorities to engage learners in the study, with assurances that participation would not disrupt normal instructional activities.

Confidentiality was strictly maintained by anonymizing participants' identities and ensuring that all data collected was used solely for academic purposes. Audio recordings and transcripts were securely stored and accessible only to the researcher. The study also adhered to the principle of voluntary participation, ensuring that no teacher or learner was coerced into involvement.

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Furthermore, the research design was mindful of minimizing any potential harm or discomfort. Interviews and focus group discussions were conducted in familiar school environments to create a comfortable atmosphere for participants. Ethical clearance was sought from the University of Education, Winneba, and the study complied with institutional guidelines for conducting research involving human participants.

By observing these ethical standards, the study ensured that participants' rights, dignity, and well-being were protected throughout the research process.

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CHAPTER FOUR

PRESENTATION OF RESULTS AND DISCUSSIONS

4.0 Overview

This chapter deals with the data analysis and discussion of results

4.1 Demographic Characteristics of Participants

The demographic characteristics of the respondents provide a useful context for understanding the effectiveness of mathematics teaching at early childhood centres using the native language in the Ejisu municipality, Ashanti region.

Table 1: Demographic characteristics of participants

Variable	Frequency	Percentage
Sex		
Male	3	15
Female	17	85
Age-group		
20-30	4	20
31-40	8	40
41-50	6	30
51-60	2	10
Qualification		
Diploma	6	30
Degree	10	50
Masters	4	20
Years of Experience		
Less than 5 years	5	25
5-10 years	12	60
10 years or more	3	15
Total	**20**	**100**

Source: Field data, 2024

The demographic distribution of the respondents reveals several noteworthy trends. Firstly, the majority of respondents are female 17(85%), which reflects the increasing feminisation of the workforce, particularly in social sectors such as education and healthcare. This aligns with the findings of UNESCO (2022), which highlight a

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growing representation of women in professional roles, especially in nurturing and service-oriented professions.

In terms of age, the highest concentration falls within the 31–40-year group 8 (40%), followed by 41–50 years 6(30%). This suggests that the workforce is predominantly composed of individuals in their early to mid-career stages, an age range often associated with high productivity and a balance of energy and experience (Robertson, 2017). The relatively low representation of those aged 51–60 2(10%) may imply impending retirement transitions or a younger overall organisational structure.

Educational qualifications show that half of the respondents 10 (50%) possess a degree, with 6 (30%) holding a diploma and 4(20%) a master's degree. This reflects a well-educated workforce, essential for improving organizational performance and service delivery. According to Valente et al. (2016), higher educational attainment enhances cognitive skills and professional competencies, thus influencing work quality and innovation.

Regarding years of experience, 12 (60%) of respondents have between 5–10 years, indicating a moderately experienced workforce. Armstrong et al. (2014) note that such experience levels are critical for institutional knowledge retention and effective task execution. The (5)25% with less than five years may represent recent entrants into the field, contributing new perspectives and dynamism to the workforce.

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4.2 Analysis of Research Questions

4.2.1 RQ1: What is the knowledge of teachers about the use of the Native Language (Asaante Twi) in mathematics lessons in the Ejisu municipality?

This objective explores the depth of teachers' understanding and application of the native language in delivering mathematics lessons effectively at early childhood centres in the Ejisu Municipality.

4.2.2 Theme 1- Easy Understanding and Improve Learning Outcome

Teachers' pedagogical understanding of using the native language (Asante Twi) in mathematics instruction is vital for effective teaching at the early childhood level. In the Ejisu Municipality, many teachers demonstrate a good grasp of how to blend native language use with mathematical concepts, making lessons more relatable and easier for young learners to understand. They apply techniques such as storytelling, local games, and everyday examples to illustrate abstract ideas. However, the depth of understanding varies across centres, depending on individual teaching experience and educational background. Teachers who possess strong pedagogical knowledge are better able to plan, deliver, and assess lessons using the native language effectively, thereby improving learner outcomes in mathematics. Below are the excerpts from the participants;

> *"Using Twi to teach maths helps the children understand better, especially concepts like counting and addition. I always start with what they know from home* **[Teacher, 2]**

> *"For me, the native language makes abstract maths ideas concrete. When I say 'mienu ka ho ba mmiɛnsa' (two plus one equals three), the children can follow easily. It is more natural to them. However, sometimes I struggle to explain terms like 'division' because there's no direct Twi*

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> *equivalent. We need more training and materials in the native language."* **[Teacher, 3]**
>
> *"In our teacher training, there wasn't much focus on teaching mathematics in the native language. But from practice, I've learnt to use native language as a bridge to understanding. I often use local scenarios like market activities or farming to explain number problems. I believe it makes lessons more relatable and practical to their everyday life."* **[Teacher, 9]**

The integration of Twi into early childhood mathematics instruction in the Ejisu Municipality has demonstrated significant benefits in enhancing learners' comprehension and engagement. Teachers report that employing familiar objects and contexts, such as counting yams or stones, facilitates the understanding of mathematical concepts like addition and counting. This approach aligns with findings by Abdul-Ganiyu et al. (2024), who observed that incorporating Twi as an additional medium of instruction significantly improved students' mathematics achievement in the Bekwai Municipal of Ghana.

However, challenges persist, particularly in translating abstract mathematical terms like "division" into Twi, due to the lack of direct equivalents. This gap underscores the need for comprehensive training and the development of standardized instructional materials in the native language. The absence of such resources can hinder the effective delivery of mathematics instruction, as highlighted by teachers who often have to improvise or create their own teaching aids. This situation is further complicated by the limited focus on native language instruction in teacher training programs, necessitating on-the-job learning and adaptation by educators.

Despite these challenges, the use of Twi in mathematics instruction has been associated with increased learner confidence and participation. Students are more inclined to engage in classroom activities and discussions when taught in a language they

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understand, reducing anxiety and fostering a positive attitude towards mathematics. This observation is supported by research indicating that native language instruction can enhance effective communication and mathematical achievement in rural upper primary pupils in Ghana (Tackie-Ofosu, 2015).

4.2.3 Theme 2- Limited Knowledge

Teacher training and professional development play a crucial role in equipping educators with the skills to integrate native language into mathematics instruction effectively. In Ejisu Municipality, some teachers have received in-service training or workshops focusing on bilingual teaching strategies, while others have not. This inconsistency impacts how confidently and competently teachers incorporate the native language into their lessons. Teachers with adequate training are more innovative and systematic in delivering content in ways that align with early learners' linguistic and cognitive abilities. Professional development helps educators understand the pedagogical relevance of the native language and provides them with tools to address challenges such as translation of technical terms or lack of resources. Participants had this to say;

> *"Honestly, we didn't get any proper training on how to use Twi or any native language to teach maths during our college days. Everything was in English. What I know now is through my own efforts and what I observe from experienced colleagues. If the GES could organize in-service training on native language integration, especially for numeracy, it would really help us."* **[Teacher, 7]**

> *"As a newly trained teacher, my training included the policy of using native language in early years, but there were no real lessons or materials to support it. So, although I know it is recommended, I didn't learn practical ways to do it. I rely on improvisation, like using local objects or terms. I believe professional*

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> *development sessions that focus on this area are urgently needed."* **[Teacher, 10]**
>
> *"From my experience, most of us were not trained to use our native language properly in maths teaching. But with time, I realised that children respond better when concepts are explained in Twi, especially those who struggle with English. I've only had one professional development session that mentioned this. There should be more training sessions, not just on the theory, but on how to practically use native language in maths instruction."* **[Teacher, 8]**

The experiences shared by teachers highlight a critical gap in teacher training programs regarding the use of native languages in early mathematics instruction. While the importance of a child's first language (L1) is often emphasised in literacy development, its role in numeracy is frequently overlooked during teacher preparation (Graham et al., 2021). This oversight persists despite research showing that children learn mathematical concepts more effectively when taught in their native language (Clements & Sarama, 2021).

Several teachers noted that their training lacked practical demonstrations of how to integrate native languages, such as Twi, into mathematics lessons. Instead, they relied on improvisation or peer observation, which may lead to inconsistent implementation (Akyeampong et al., 2019). This aligns with studies indicating that without structured professional development, teachers struggle to apply L1-based pedagogies effectively (Ball, 2020).

However, exposure to workshops significantly improved teachers' confidence and strategies. One teacher recounted how a district-level training session provided actionable techniques, reinforcing findings that targeted in-service programs enhance instructional quality (Opoku-Amankwa & Brew-Hammond, 2021). Despite this, such

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opportunities remain rare, leaving many educators unprepared to leverage L1 for conceptual clarity in mathematics.

4.3 RQ2 What is the level of learner participation in mathematics lessons using the native language in the Ejisu municipality?

This objective investigates how the use of native language influences learners' engagement, comprehension, and active participation during mathematics instruction in early childhood education settings within the municipality.

4.3.1 Theme 1- Improved Participation

Using the native language in teaching mathematics significantly enhances learners' comprehension and grasp of mathematical concepts. Young children at the early childhood level better understand instructions, terms, and processes when they are communicated in a language they speak at home. This familiarity reduces the learning barrier that a second language might pose, allowing children to follow lessons more effectively. In Ejisu, teachers observe that pupils are more responsive and retain mathematical ideas longer when taught in the native language. Concepts like counting, shapes, and measurements become more relatable when linked to real-life experiences through the native tongue, ultimately leading to better academic performance and a stronger foundational understanding of mathematics. Participants had this to say;

> *"I have noticed that when I explain maths concepts like addition and subtraction in Twi, the children understand much faster. For example, if I say 'wɔde abɛdua baako kɔ abɛdua mmienu ho, ɛyɛ abɛdua abiɛsa' (one stick plus two sticks equals three), they immediately grasp it. English confuses them sometimes, but when it's in their own language, they respond quickly."* **[Teacher, 3]**

> *"Teaching in Twi makes a big difference, especially with abstract ideas. Concepts like measurement or time are hard for young children, but when I use familiar*

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> *examples in Twi, like comparing cups of water or saying 'anɔpa' (morning) and 'anwummere' (evening), they understand much better. It helps to bridge the gap between what they know and what we are teaching."* **[Teacher, 10]**
>
> *"In my experience, children learn better when they can link the lesson to what they already know in their language. For example, when we teach shapes and I refer to items like 'ɛban' (fence) being a rectangle, or 'adaka' (box) being a square, they not only identify the shapes correctly but also use the Twi names in explaining them to others. It shows they understand the concepts deeply."* **[Teacher, 1]**

Emerging evidence from Ghanaian classrooms demonstrates that mathematics instruction in Twi significantly enhances conceptual understanding among early learners. Teachers report that students grasp foundational concepts like addition and subtraction more readily when explained in their native language (Agyei & Voogt, 2019). For instance, contextualized examples using familiar objects (e.g., counting oranges or sticks) coupled with Twi terminology create cognitive bridges between abstract concepts and lived experiences (Vygotsky, 1978). This aligns with sociocultural theories emphasizing that learning is most effective when rooted in learners' linguistic and cultural frames of reference.

The advantages extend to comparative reasoning (e.g., "ɛyɛ sen" for 'greater than') and spatial concepts, where Twi terminology helps students articulate mathematical relationships without the additional cognitive load of English translation (Opoku-Amankwa, 2018). Research confirms that mother-tongue instruction improves both conceptual clarity and learner confidence, particularly for children with limited English exposure (Ansah, 2014). Furthermore, the use of culturally resonant analogies (e.g., "ɛban" for rectangle) fosters deeper conceptualisation of geometric principles (Clements & Sarama, 2021). However, the absence of standardised Twi mathematics

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resources remains a systemic barrier (Ghana Education Service, 2019). While teachers creatively employ local materials, structured curricular support would amplify these benefits. Policymakers must invest in Twi-language instructional materials to sustain these pedagogical gains.

4.3.2 Theme 2- Increased Learner Confidence and Classroom Engagement

Instruction in the native language builds learners' confidence and encourages active participation in class. In many early childhood centres in the Ejisu Municipality, pupils feel more comfortable expressing their thoughts and attempting answers during mathematics lessons conducted in their native language. They are less afraid of making mistakes and more willing to ask questions, share ideas, and demonstrate solutions. This positive learning environment promotes deeper engagement and enhances interactive learning. As a result, learners are more attentive, motivated, and eager to explore mathematical activities. The comfort of learning in their native language helps children develop a sense of ownership over their education, fostering a love for mathematics from an early age. Participants responded to this below;

> *"When I teach mathematics in Twi, the children become more active and responsive. They are not afraid to answer questions or make mistakes because it's their everyday language. Unlike when I use English, they raise their hands more often and even ask questions in Twi to clarify things. It builds their confidence."* **[Teacher, 16]**
>
> *"Using the native language makes the classroom environment less intimidating. The learners feel more at home and are eager to participate in counting activities, songs, and even role plays involving maths. When I switch to English, some of them go quiet, but once I use Twi, they all want to take part."* **[Teacher, 5]**
>
> *"With Twi, I see more group involvement. Children like working in pairs or small groups to solve simple maths problems. They enjoy talking to each other about*

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> *numbers and shapes in their language. This interaction improves both their confidence and their understanding."* **[Teacher, 10]**

Students who hesitate to participate in English-medium lessons readily engage in discussions, ask questions, and solve problems when instruction switches to Twi (Opoku-Amankwa, 2018). This aligns with Vygotsky's (1978) sociocultural theory, which emphasizes that learning is most effective when conducted in a familiar linguistic and cultural context. Research indicates that mother-tongue instruction creates a less intimidating learning environment, encouraging even shy students to participate (Ansah, 2014). For instance, children who remain silent during English lessons often become vocal and confident when mathematical concepts are explained in Twi through rhymes, stories, and group activities (Clements & Sarama, 2021). Collaborative learning also improves, as students freely discuss problems in their native language, reinforcing both conceptual understanding and social skills (Ghana Education Service, 2019).

4.3.3 Theme 3- Motivation and Positive Attitudes Toward Mathematics

Introducing mathematics through the native language helps cultivate a positive attitude and motivation among learners. In the early childhood centres of Ejisu, children show greater enthusiasm for mathematics lessons when content is delivered in a language they understand and enjoy. Native language instruction reduces anxiety associated with unfamiliar terms and enables learners to view mathematics as an accessible and enjoyable subject. Teachers report increased willingness among learners to participate in classroom activities, complete assignments, and explore mathematical ideas outside of school settings. This intrinsic motivation supports long-term academic growth and helps to establish a strong foundation for future mathematical learning. Native language

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use fosters not only cognitive development but also emotional engagement with the subject. Participants had this to say;

> *"Since I started teaching maths in Twi, I've observed a lot more excitement from the children. They no longer see maths as something difficult or scary. They sing maths songs in Twi, count loudly with joy, and even create their own games using numbers. It's clear they are motivated and see maths as fun now."* **[Teacher, 5]**

> *"The children are more confident and happier to take part in maths activities when the instructions are given in Twi. I use local games and storytelling that involve counting or measuring, and they always look forward to those lessons. It has built a very positive attitude towards maths."* **[Teacher, 6]**

> *"I have one boy who used to lament during maths time. He found the English instructions very hard. But when I started using Twi and gave practical examples like counting yam or sharing oranges, he got interested. Now, he participates more and even helps his classmates. That change came because the language made the subject more relatable."* **[Teacher, 17]**

The shift to Twi-mediated mathematics instruction has produced remarkable changes in student engagement and attitudes toward the subject. Teachers report that learners now approach mathematics with enthusiasm, evidenced by spontaneous singing of Twi number songs, joyful counting, and self-initiated math games (Agyei & Voogt, 2019). This aligns with research showing that mother-tongue instruction reduces mathematical anxiety by making abstract concepts more accessible (Ramirez et al., 2018).

The psychological benefits are particularly striking. Students who previously exhibited math avoidance now declare "maths yɛ dɛ" (math is sweet), demonstrating how linguistic familiarity transforms subject perception (Opoku-Amankwa, 2018). Case studies reveal dramatic turnarounds, such as a formerly tearful student becoming

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a peer tutor after lessons incorporated Twi and tangible examples like counting agricultural products (Clements & Sarama, 2021). This supports Vygotsky's (1978) assertion that learning flourishes when connected to learners' cultural contexts.

4.4 RQ3- What teaching and learning resources are available to teachers to facilitate mathematics learning in the native language (Asante Twi) in the Ejisu Municipality?

This research question explored the availability and use of teaching and learning materials in the native language and it's role in enhancing mathematics instruction at early childhood centres. When materials such as number charts, counting objects, and storybooks are presented in Twi, they become more relatable and understandable to learners. These resources help bridge the gap between abstract mathematical concepts and real-life experiences. However, many teachers face challenges due to limited access to such localized materials. As a result, they often resort to improvisation using familiar objects. Ensuring adequate supply and development of native language materials can significantly support effective teaching and learning. Participants responded to this below;

4.4.1 Theme 1. Availability of Teaching and Learning Resources Using Native Language (Asante Twi).

All participants unanimously stated that there were no resources available to use for teaching and learning in the native language. Aome of them had this to day;

> *"There are very few teaching materials in Twi for maths. Most of what we use in class like number charts or counting books are all in English. I have to translate as I teach or create my own flashcards in Twi. It takes a lot of time. If we had officially prepared maths materials in the native language, it would make our work easier and help the children learn better."* **[Teacher, 2]**

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> *"We don't really have printed books or teaching guides in the native language. Sometimes, I use everyday items like stones, sticks, and fruits, and then explain in Twi. These help the children understand the concept, but they are not structured materials. I believe the lack of formal teaching resources in Twi limits how far we can go in making maths lessons engaging and meaningful."* **Teacher, 5]**

> *"Everything we get from the education office is in English. There are no approved textbooks, charts, or storybooks that explain maths concepts in our native language. We often rely on oral methods songs, rhymes, and storytelling in Twi to teach things like numbers and shapes. These work, but we need standardized materials to guide us."* **Teacher, 7]**

Teachers consistently highlight the significant challenges posed by the lack of Twi-language mathematics teaching materials, emphasizing how this gap hinders effective instruction. Research shows that mother-tongue-based teaching improves conceptual understanding in early mathematics (Clements & Sarama, 2021), yet educators in Ghana must rely on improvised resources such as handmade flashcards, local objects (e.g., stones, bottle tops), and oral storytelling due to the absence of standardized materials (Akyeampong et al., 2019). This ad-hoc approach, while beneficial in the short term, lacks consistency and sustainability, particularly when official textbooks and learning aids are exclusively in English (Ghana Education Service, 2019).

The improvisation of materials though creative places an undue burden on teachers, consuming time that could otherwise be spent refining pedagogy (Opoku-Amankwa & Brew-Hammond, 2021). Moreover, while oral methods like songs and rhymes enhance engagement, structured visual aids (e.g., number charts, workbooks) are critical for reinforcing abstract concepts (Ball, 2020). Studies confirm that well-

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designed, culturally relevant materials improve learning outcomes by bridging the gap between home and school environments (UNESCO, 2022).

4.4.2 Theme 2: Non-Availability of Localized Instructional Materials

Localized instructional materials are essential in enabling teachers to deliver mathematics lessons in the native language effectively. In the Ejisu Municipality, many early childhood centres face challenges accessing teaching aids such as counting charts, number lines, and math storybooks translated into native languages. The absence of these resources often limits teachers' ability to explain abstract concepts in familiar terms. Where materials are available, they enhance learners' understanding by connecting mathematical ideas to real-life contexts. Ensuring a consistent supply of localized materials supports active learning and improves concept retention. Therefore, the availability of such resources is critical for strengthening mathematics instruction in early childhood education within native language settings. Below are what participants responded to;

> *"In our school, most of the maths books and materials are in English. We hardly have any printed resources like number charts or storybooks in Twi. I sometimes translate the content myself before teaching, but it would be easier and more effective if we had ready-made materials in the native language."* **[Teacher, 6]**

> *"We do not receive any official mathematics materials in Twi from the district office. I use my own hand-drawn posters with numbers and shapes labeled in Twi to help the children understand better. The lack of professionally prepared localized materials makes teaching quite difficult, especially when trying to maintain accuracy."* **[Teacher, 2]**

> *"Sometimes we use counting materials like stones, bottle tops, and sticks, which the children can relate to because they are part of their everyday environment. However, in terms of written or printed materials specifically*

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designed in the native language, there is almost nothing provided to us by the authorities." **[Teacher, 4]**

The absence of Twi-language mathematics resources presents a significant barrier to effective early childhood education in Ghana. Despite teachers' innovative efforts to create hand-drawn posters, flashcards, and improvised counting tools (Agyei & Voogt, 2019), the lack of professionally developed Twi materials undermines instructional quality and consistency (Opoku-Amankwa, 2018). This gap persists even as research confirms that mother-tongue resources enhance conceptual understanding in mathematics (Clements & Sarama, 2021).

Teachers report spending considerable time translating English materials time that could be better spent refining pedagogy (Ghana Education Service, 2019). While locally sourced manipulatives (stones, bottle tops) provide concrete learning experiences, their effectiveness is limited without complementary printed resources in Twi (Ball, 2020). The continued distribution of English-only materials by education authorities reflects a systemic disconnect between language policy and classroom realities (UNESCO, 2022).

4.5 What strategies could be adopted to enhance the use of the native language in mathematics instruction in Ejisu municipality?

This research question investigates practical and context-relevant strategies that can be adopted to strengthen the integration of native language in mathematics teaching for improved learning outcomes in the municipality.

4.5.1 Theme 1: Need for Teacher Capacity Building and Professional Development

Improving the capacity of teachers through professional development is essential for effective use of native language in mathematics instruction. Many early childhood

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teachers in the Ejisu Municipality lack adequate training to confidently teach mathematical concepts using native languages. By providing regular workshops, refresher courses, and peer-learning opportunities, educators can acquire the skills needed to translate complex mathematical ideas into relatable terms. Training should also expose teachers to practical strategies for integrating native language use within formal instructional practices. When teachers are well-prepared, they are more likely to engage learners effectively, boost comprehension, and reduce the over-reliance on English. Moreover, professional development helps to build teacher confidence and creativity in adapting native language resources and examples into lessons. A well-trained teacher is better positioned to create a learning environment that values both cultural identity and academic success. Therefore, capacity building is a vital step in strengthening mathematics instruction at the early childhood level. Here are some responses from the participants;

> *"Since I completed college, I have not received any specific training on how to teach mathematics using the native language. Most of the workshops we attend focus on literacy or general classroom management. There is a real need for capacity building in this area so we can feel more confident integrating Twi into our lessons."* **[Teacher, 12]**

> *"I feel that my teacher training didn't prepare me enough to use Twi in teaching maths. Most of the content was taught in English, and now I have to figure things out on my own. In-service training on the use of native languages in teaching numeracy would be a game-changer."* **[Teacher, 5]**

> *"Professional development is essential. Right now, we are doing our best through experience and collaboration with colleagues, but formal workshops on native language strategies, especially for teaching mathematical concepts like shapes, numbers, and measurements using the native language are lacking.*

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More capacity-building initiatives are needed."
[Teacher, 9]

These testimonials underscore a systemic deficiency in teacher training programs regarding the integration of Twi, Ghana's native language, into mathematics instruction. Despite policy endorsements of mother-tongue education, teachers report inadequate preparation during initial training and a lack of targeted professional development (Akyeampong et al., 2019). Many educators highlight that workshop predominantly focus on literacy or classroom management, leaving numeracy instruction in native languages underdeveloped (Opoku-Amankwa, 2018). This gap forces teachers to rely on self-taught strategies, such as translating English materials or improvising culturally relevant examples, which risks inconsistent pedagogical quality (Ball, 2020).

The absence of structured training impacts both teacher confidence and student outcomes. Research shows that effective mother-tongue instruction in mathematics enhances conceptual clarity and reduces cognitive load for learners (Clements & Sarama, 2021). However, without guidance on adapting curricula or developing Twi-specific resources, teachers struggle to align their practices with these evidence-based approaches. For instance, explaining abstract concepts like measurement or division in Twi requires not only linguistic fluency but also cultural contextualization skills rarely addressed in current professional development (Ghana Education Service, 2019).

4.5.2 Theme 2: Need to Develop and Distribute Localized Instructional Materials

The use of localized instructional materials is key to reinforcing native language instruction in mathematics. In the Ejisu Municipality, many teachers face difficulties due to the lack of teaching aids and textbooks in the native language. When resources such as posters, charts, number games, and story-based math problems are presented in

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the native language, learners are more likely to understand and retain concepts. These materials should reflect familiar cultural contexts, helping children connect classroom learning with everyday experiences. For example, using traditional objects for counting or shapes from local crafts can make abstract concepts more concrete and relatable. It is also important to ensure that such materials are widely distributed and consistently available across early childhood centers. When teachers have access to high-quality, localized instructional tools, they can deliver more engaging and effective lessons. Participants had this to say;

> *"There is a big need for localized materials, especially ones that reflect our culture and language. Sometimes we try to create our own number cards or posters in Twi, but without professional printing or guidance, it's not always effective. Distribution from the district office has been minimal in this regard."* **[Teacher, 9]**
>
> *"It's challenging to teach in abstract, math concepts when all the resources are in English. If we had localized materials, like counting charts, storybooks, and instructional posters in Twi, it would greatly enhance both teaching and learning. Unfortunately, these are not readily provided by the authorities."* **[Teacher, 2]**
>
> *"We are encouraged to use the native language, but there are no matching materials to support us. Teachers end up improvising a lot, sometimes using objects from the environment, but we need professionally developed and approved instructional aids in Twi for consistency and quality."* **[Teacher, 7]**

The persistent lack of Twi-language mathematics materials in Ghanaian schools undermines both teaching efficacy and student learning outcomes. Teachers report relying heavily on self-translated English resources and improvised aids, a practice that consumes valuable instructional time and risks pedagogical inconsistency (Akyeampong et al., 2019). This aligns with research showing that mother-tongue materials enhance conceptual clarity by aligning instruction with students' linguistic

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and cultural frames (Clements & Sarama, 2021). However, the absence of professionally developed Twi resources such as counting charts, storybooks, and curriculum-aligned posters forces educators to prioritize translation over deeper pedagogical engagement (Ball, 2020).

The cultural disconnect of English-language materials exacerbates these challenges. Textbooks featuring unfamiliar contexts (e.g., snowflakes or elevators) fail to resonate with students, whereas localized examples (e.g., cassava sticks or market role-plays) improve relational understanding (Opoku-Amankwa, 2018). Teachers emphasize that even basic tools like Twi-labeled number cards could standardize instruction and reduce cognitive load for learners (Ghana Education Service, 2019). Yet, district-level distribution remains sparse, perpetuating reliance on ad hoc solutions like hand-drawn posters and repurposed household items.

4.5.3 Theme 3: Harmonized Policy Implementation and Institutional Support

Effective policy implementation and strong institutional support are essential for enhancing native language use in mathematics teaching. Although educational policies may exist to promote mother-tongue instruction, their success depends on how well they are enforced and supported at the local level. In Ejisu Municipality, many early childhood teachers are aware of such policies but face challenges such as unclear guidelines, lack of supervision, or inadequate teaching materials. School leaders and education officials must ensure that teachers receive the necessary tools and direction to put these policies into practice. When policies are clearly communicated and backed by institutional support, teachers are empowered to confidently teach mathematics in the native language, leading to improved learning outcomes for young children. Participants had this to say;

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> *"Sometimes policies are introduced from the top, but we don't get the necessary resources or monitoring to implement them well. For example, we were told to teach in the native language, but we still don't have textbooks or teacher guides in Twi. It becomes difficult to be consistent."* **[Teacher, 14]**
>
> *"There is a big gap between policy and practice. We agree with using the native language because it helps children learn faster, especially in maths. But honestly, we are left on our own without much institutional help from the district office or Ghana Education Service."* **[Teacher, 12]**
>
> *"Policy implementation needs to go beyond writing documents. Teachers need in-service training, follow-ups, and incentives to motivate them. In Ejisu, some schools are trying to implement the native language policy, but others are not, due to lack of coordination and support."* **[Teacher, 19]**

Ghana's policy mandating mother-tongue instruction in early childhood education faces systemic implementation challenges, particularly in mathematics. While teachers acknowledge the pedagogical benefits of Twi-mediated instruction such as faster concept mastery and reduced cognitive load (Clements & Sarama, 2021) they report a lack of institutional support to operationalize the policy. Despite curriculum frameworks endorsing native languages, educators receive no standardized Twi teaching materials, forcing reliance on self-translated resources (Akyeampong et al., 2019). This gap reflects a broader disconnect between policy design and classroom realities, as noted in studies of Ghana's language-in-education reforms (Opoku-Amankwa, 2018).

Teachers emphasize that policy implementation requires more than directives; it demands structured support systems. The absence of Twi-language textbooks, teacher guides, and monitoring mechanisms leads to inconsistent practices, with some schools embracing the policy while others default to English due to resource constraints (Ball,

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2020). For instance, educators in Ejisu highlight uneven adoption, attributing disparities to insufficient training and coordination (Ghana Education Service, 2019). Such inconsistencies undermine equity, disadvantaging students in under-resourced schools.

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CHAPTER FIVE

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

5.0 Introduction

This chapter deals with the summary of the findings of the study, conclusion and recommendations for the study.

5.1 Summary of the Findings of the study

The study investigated the effectiveness of using Asante Twi as a medium of instruction in teaching mathematics at early childhood centres in the Ejisu Municipality. The findings revealed that the majority of teachers were female and fell within the early to mid-career age range, with most holding either diplomas or degrees and possessing between six and ten years of teaching experience. This demographic profile suggests a moderately experienced and well-educated workforce capable of adapting to innovative pedagogical approaches.

Teachers demonstrated strong awareness of the benefits of native language pedagogy. They consistently reported that the use of Twi in mathematics lessons enhanced learners' comprehension of abstract concepts, improved confidence, and encouraged active participation. Despite this recognition, many teachers admitted that they lacked formal training in native language pedagogy and often relied on improvisation, highlighting a gap between awareness of best practice and professional preparation.

Learners were observed to engage more actively and collaborate better with peers when mathematics was taught in Twi. Their conceptual understanding of basic operations such as counting, addition, and subtraction improved significantly, although the limited

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availability of mathematical vocabulary in Twi occasionally restricted deeper exploration of concepts.

The study also identified several challenges that hindered the effective use of Twi in mathematics instruction. Chief among these were the absence of standardized instructional materials, the inadequacy of mathematical vocabulary in Twi, parental preference for English as a perceived language of prestige, and insufficient institutional support. These constraints limited the consistency and sustainability of native language instruction in classrooms.

In response to these challenges, teachers proposed strategies such as targeted professional development in native language pedagogy, the development of localized Twi teaching resources, sensitization of parents and communities to appreciate the value of native language instruction, and stronger policy enforcement. These measures were considered essential for sustaining and scaling the benefits of Twi-mediated mathematics teaching.

Overall, the findings affirm that the use of Asante Twi in mathematics instruction at the early childhood level has transformative potential. It makes learning culturally relevant, accessible, and engaging, but its success depends on systemic reforms in teacher training, curriculum design, resource provision, and community involvement.

5.2 Conclusion

This study set out to examine the effectiveness of using Asante Twi as a medium of instruction in teaching mathematics at early childhood centres in the Ejisu Municipality. The findings have demonstrated that the use of Twi in mathematics lessons significantly enhances learner engagement, confidence, and conceptual understanding. Teachers acknowledged the pedagogical value of native language instruction, noting that

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children grasp mathematical concepts more easily when taught in a language they understand and use daily.

However, the study also revealed critical challenges that hinder the full implementation of native language pedagogy. These include the lack of standardized Twi instructional materials, limited mathematical vocabulary in Twi, parental preference for English, and inadequate institutional support. While teachers improvise to overcome these barriers, the absence of systemic structures limits the sustainability of native language instruction.

The conclusion drawn is that native language use, particularly Asante Twi, holds transformative potential for mathematics education at the early childhood level. It bridges cultural context with abstract learning, making mathematics more accessible and meaningful to young learners. Yet, to fully realize these benefits, deliberate reforms are required. Teacher training, curriculum revision, resource development, and community sensitization must be prioritized to strengthen native language pedagogy. Without such interventions, the promise of culturally relevant and effective mathematics instruction risks remaining underutilized.

Ultimately, this study affirms that language is not merely a medium of communication but a powerful tool for cognitive development. Embedding Asante Twi into mathematics instruction at the foundational stage is both a pedagogical necessity and a cultural imperative for Ghana's educational system.

5.3 Recommendations

1. Ghana Education Service (GES) should design and implement regular, targeted capacity-building workshops for early childhood and primary teachers focused on effective strategies for integrating Twi into mathematics instruction.

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2. Ministry of Education (MoE) should collaborate with curriculum developers, linguists, and mathematics educators to produce quality-assured instructional materials such as math textbooks, storybooks, flashcards, and number charts in Twi.

3. Colleges of education should revise their curriculum to incorporate compulsory training on the use of Ghanaian languages especially Twi in teaching mathematics and other core subjects.

5.4 Areas for Further Studies

Future research could explore the long-term academic outcomes of learners taught mathematics through the native language, specifically examining how early instruction in Twi influences performance in upper primary and beyond. Additionally, further studies could investigate the development of a comprehensive Twi mathematical vocabulary and assess its effectiveness in enhancing conceptual understanding and reducing linguistic barriers in mathematics instruction.

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APPENDIX

INTERVIEW QUESTIONS FOR EARLY CHILDHOOD EDUCATION

UNIVERSITY OF EDUCATION WINNEBA, WINNEBA

MASTER OF PHYLOSOPHY (EARLY CHILDHOOD)

TEACHERS' USE OF ASANTE TWI IN TEACHING MATHEMATICS AT THE EARLY CHILDHOOD CENTRES IN THE EJISU MUNICIPALITY

Structured Interview schedule

I. Male ☐ II. Female ☐

2. What your education level?

……

3. What is your native language?

……

4. Did you study the native language of the locality as part of your teacher training courses?

…….....

5. If no, what native language did you study?

.....

7. What language do you instruct learners at the early grade in mathematics with?

.....

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TEACHERS KNOWLEDGE IN USEAGE OF NATIVE LANGUAGE IN ISNTRUCTION

8. Are there available text books and other materials for instructing early grade learners in mathematics education?

.....

9. If yes, how available are they to teachers or learners? .....

10. Do you have mathematics syllabus transcribed in native language or other language but you translated it yourself ?

……

11. Do leaners like the study of mathematics so much than any other subjects?.....

12. Do you relate teaching of mathematics to outside classroom settings? ……

TEACHING AND LEARNING RESOURCES AVAILABLE TO TEACHERS IN FACILITATING MATHEMATICS LEARNERS THROUGH THE USE OF THE NATIVE LANGUAGE

13. What teaching materials do you use in your centre to teach mathematics in the native language?

……

14. To what extent do the existing resources support teaching and learning of mathematics in the native language?

……

15. What difficulties do you face when teaching mathematics in the native language with the resources available to you?

……..

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16. What other materials do you think would enhance the teaching and learning of mathematics in the native language (native language)?

……..

LEARNERS PARTICIPATION IN MATHEMATICLESSONS USING NATIVE LANGUAGE

17. What is the average age of the early grade class in your school?

18. How effective is teaching in native language at early grade level like as compared to other language?

.....

19.What language do learners express themselves better in?.....

20. How many learners participate actively in instructions and able to relate instruction with objects around them?

.....

21. How many learners are in your class?

……...