The Effectiveness of Home Language Medium Instruction on Improving Primary School Students’ Mathematical Performance

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Dedication

This thesis is dedicated to all prospective researchers, Australian Indigenous peoples, especially Kunwinjku, and their communities.
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Statement of Authentication

I declare that the work presented in this research is original and of my own effort. The content of the thesis, to the best of my knowledge and belief, except where due reference is cited in the text. I hereby certify that I have not submitted this thesis before, either in full or in part, for a degree at this or any other university.

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Signature

Gopal Singh Sijapati

June 16, 2017
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<th>Description</th>
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<tbody>
<tr>
<td>ABS</td>
<td>Australian Bureau of Statistics</td>
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<tr>
<td>AIATSIS</td>
<td>Australian Institute of Aboriginal and Torres Strait Islander Studies</td>
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<td>BIITE</td>
<td>Batchelor Institute for Indigenous Tertiary Education</td>
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<td>CARG</td>
<td>Cognitive Anthropology Research Group</td>
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<td>DET</td>
<td>Department of Education and Training</td>
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<td>EAL</td>
<td>English as an Additional Language Learner</td>
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<td>ELAN</td>
<td>EUDICO Linguistic Annotator</td>
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<td>ESL</td>
<td>English as a Second Language</td>
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<td>H</td>
<td>High</td>
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<td>HREC</td>
<td>Human Research Ethics Committee</td>
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<td>HRSCATSIA</td>
<td>House of Representatives Standing Committee on Aboriginal and Torres Strait Islander Affairs</td>
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<td>KGP</td>
<td>Key Growth Point</td>
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<td>L</td>
<td>Low</td>
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<td>L1</td>
<td>First Language</td>
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<td>L2</td>
<td>Second Language</td>
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<td>M</td>
<td>Mean</td>
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<td>MD</td>
<td>Difference of Mean</td>
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<td>N</td>
<td>Number</td>
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<tr>
<td>NAPLAN</td>
<td>National Assessment Programme – Literacy and Numeracy</td>
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<td>NT</td>
<td>Northern Territory</td>
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<td>NT CF</td>
<td>Northern Territory Curriculum Framework</td>
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<tr>
<td>NT DET</td>
<td>Northern Territory Department of Education and Training</td>
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<tr>
<td>PNG</td>
<td>Papua New Guinea</td>
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<tr>
<td>RAHC</td>
<td>Remote Area Health Corps</td>
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<tr>
<td>REDI</td>
<td>Research Engagement, Development and Innovation</td>
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<tr>
<td>Acronym</td>
<td>Full Form</td>
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<td>SD</td>
<td>Standard Deviation</td>
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<td>SE</td>
<td>Standard Deviation</td>
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<tr>
<td>UN</td>
<td>United Nations</td>
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<tr>
<td>UNDRIP</td>
<td>United Nations Declaration on the Rights of Indigenous Peoples</td>
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<tr>
<td>UNESCO</td>
<td>United Nations Educational Scientific and Cultural Organization</td>
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<tr>
<td>WSU</td>
<td>Western Sydney University</td>
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Abstract

This study investigates the effects of *home language* as the *medium of instruction* on improving primary school students’ mathematical performance. It aimed to determine whether giving instruction in their home language to Kunwinjku speaking pupils, part of Australia’s Indigenous populations, would improve their mathematical learning. In particular, this study investigated the positive impact of *home language medium instruction* on learning number ordering and spatial language. This study is concerned with the implication of *home language medium instruction* on teaching mathematics in a diglossic, multilingual community.

The project is a cross-linguistic comparative study. The central hypothesis of the study was that indigenous students would improve their mathematical learning outcomes in English after being instructed in their home language. To test this hypothesis, the study employed two experiments in two different geographical contexts. In Experiments 1 and 2, the Animals in a Row matching task was administered. This research tool was developed based on the instructions devised by the Cognitive Anthropology Research Group from the Max Planck Institute for Psycholinguistics. A total of 12 school aged children, consisting of six English monolingual and six Kunwinjku speaking students, participated in the experiments.

The findings of the study show that the primary school students’ results improved in mathematics tasks after receiving instruction in their home language. In the pretest, before Kunwinjku instruction was employed, students scored lower (35 percent) than the average mark. But, more than 80 percent of participants (5 out of 6) improved their scores by 15 percent after being instructed in Kunwinjku, increasing from 35 to 55 percent. The results also show that the concepts of ‘before’, ‘after’, ‘front’ and ‘behind’ in mathematics can be taught effectively if they are instructed in students’ home language. The ratings of correct answers for the tasks corresponding to ‘behind’ and ‘front’ were higher after Kunwinjku instruction. This finding concords with the significance of culturally responsive education in which both a child’s home language and cultural experience have a dominant role.
Further, findings from the experiments suggest that primary school students have a better understanding to the *medium of instruction* and culture embedded in it in order to improve their mathematical performance. A connection between new and prior knowledge can be established by the use of home language as the medium of teaching that facilitates students' learning and leads to better results. Therefore, this study contributes significantly to the body of scholarship related to home language based bi/multilingual education programmes.
Although I had observed the significant impact of the *language of instruction* when I started teaching at primary school in Nepal in 2002, my interest in investigating *home language instruction* was sparked in 2009. In 2010, to collect data for my previous Master’s thesis, I visited 25 primary schools located in different regions of Nepal. My consultations with the Magar speaking students – one of the indigenous communities of Nepal – and informal observations on the *medium of instruction* employed in these schools further motivated my studies on the role of *home language* in primary education.

In the primary school where I taught in 2009, children from different ethnic and language backgrounds were taught in English and Nepali though many indigenous pupils used their native languages at home. As a teacher, I observed various issues regarding the *medium of language* used and the role it played in children’s learning. After a cursory study on Australian languages and their status, I realised that, as in Nepal, there were a considerable number of indigenous languages were dying in the Northern Territory of Australia.

During my Master of Research studies at Western Sydney University, I learned about Australian languages and the Northern Territory (NT) system of primary school education. It struck me that many schools in the Territory require English to be the *medium of instruction* even though approximately 30 percent of all NT primary school pupils are Indigenous and speak different Australian languages (Edmonds-Wathen, 2012). Given my interest in the role of language in classroom teaching, I determined the NT would be the best research site, where more than half (60 percent) of Indigenous people speak Aboriginal languages at home (Australian Bureau of Statistics (ABS), 2006). As such, in many remote schools, many students attend class knowing and speaking little or no Standard English.

The study of Edmonds-Wathen (2012) on a culturally responsive Early Years mathematics programme was particularly motivating. Edmonds-Wathen pointed out that the language and culture of non-indigenous teachers differs from that of
the students of indigenous cultures. Because of cultural differences in ways of learning mathematics, teaching indigenous pupils in English creates gaps in students’ developing understandings of the mathematical concepts being taught. By indicating the importance of home language instruction, Edmonds-Wathen (2012) hypothesised that indigenous children could learn school mathematics more effectively if they were instructed in their home language. However, teaching students in their home language remains a challenge in many multilingual communities in Australia (Clarkson, 2009).

Edmonds-Wathen’s (2012) hypothesis suggested the need for further research in the field of indigenous languages and their role in learning mathematics. The recommendation stimulated me and led me to investigate whether teaching in students’ home language could help to improve indigenous primary school children’s mathematics performance. This was one of the driving factors behind the present study, which was conducted in Minjilang, a remote Indigenous community, on Croker Island in the Northern Territory of Australia.

Minjilang is located just off the Cobourg Peninsula which is approximately 250 km to the north-east of Darwin. It is a small multilingual community with a population of approximately 300 people (Remote Area Health Corps (RAHC), n. d.). In the community of Minjilang, the NT Curriculum Framework (Northern Territory Department of Education and Training (NT DET), 2009a) has implemented only English as the language of instruction although at least Iwaidja, Kunwinjku, Mawng, Kunbarlang and English are spoken in the region. This is despite the increase globally in the use of home language in delivering the primary school curriculum (United Nations Educational Scientific and Cultural Organization (UNESCO), 2009). I wondered about investigating the effect of home language on learning mathematics in such a multilingual environment, where English, as the dominant language, is the only medium of instruction in the education system. The community of Minjilang was, therefore, selected as the appropriate research site for this research.
Chapter One
Introduction

1 General background

In a multilingual society different languages and their various varieties coexist, with different languages categorising the world in different ways (Lakoff, 1987). Earlier studies on the domains of multilingual language use have employed the concept of diglossia (Fishman, 1976), a type of language situation in which two different (‘related or unrelated’, p. 53) languages or varieties of a language, are used in different domains of daily life. In such situations, the languages have a hierarchical status relationship. Ferguson (1996) categorises such a hierarchical status relationship into ‘high’ (hereafter ‘H’) and ‘low’ (hereafter ‘L’) varieties of language (p. 49). These languages are also referred to as the dominant language with Edmonds-Wathen (2012) noting that the language that a child first learns to speak fluently is often called their “home language” (p. 27). The existing literature on child literacy names home language instruction as one of the key factors in determining effective learning (United Nations Educational Scientific and Cultural Organization (UNESCO), 2009).

In a diglossic society, the dominant language, for example, a colonizing language such as English and Spanish, in most of the cases, occupies the position of the ‘H’ language which is formally used in media, administration, health and education. The language of indigenous people is often the ‘L’ language that is used at home and in the speakers’ local environment. Holmes (2013) argues that government often declares a particular language as ‘H’ or ‘L’ in relation to the functions it plays in a society.

As noted above, in diglossic communities, the prestigious language (‘H’ language or variety) is used in formal education. The literature on the language-education relationship shows that in diglossic and multilingual societies, bilingual pupils who use an ‘L’ language at home often experience difficulty in the formal education.
setting where a 'H' language is the mode of instruction. In the learning
environment where a dominant language, for instance, English, is used, students
struggle to learn the language and thus the new knowledge being transferred in
that language. Benson (2002) argues that teaching children in the dominant
language makes them anxious about committing errors due to their inability to
speak in that language. MacIntyre and Gardner (1991) point out that anxiety can
impede learning processes and progress in various stages. They further argue that
students may be less able to attend to the content when their minds are full of
anxiety, thus falling behind in making a connection between new information and
existing knowledge.

A child’s language background in a multilingual or a diglossic society has both
social and cognitive implications that are culturally constructed. Mathematics
programmes which are determined by culture-specific activities and practices
usually explore the cognitive and linguistic relevancy to students’ prior knowledge.
The Cognitive Anthropology Research Group (CARG) at the Max Planck Institute
for Psycholinguistics in Nijmegen, the Netherlands, has designed a set of both
linguistic and non-linguistic investigation tools to investigate the connection
between language and cognition. The findings of the CARG studies are helpful in
relation to Whorf’s (1956) hypothesis that language determines how people
perceive and conceptualise the world. Recognising the relationship between
cognition and perception is crucial when considering the role of language as the
medium of teaching. The theory of linguistic relativism states the way we think is
completely determined and constrained by the language we speak natively
(Everett, 2013).

Research affirms the connection between language and cognition development
state that teaching children in a language other than their home language and/or in
Ferguson’s (1996) terms, their ‘L’ language, challenges them to learn a new
language and also puts extra cognitive load on them. Wigglesworth and
Lasagabaster (2011) and Rajah-Carrim (2007) also focus on the connection
between language and cognition development. They argue that children cannot develop their cognitive ability adequately when they are taught in a language other than their home language. This interconnectedness of language and cognition ability can be maintained firmly when bilingual children's cognitive perception of concepts is embodied in their 'L' language.

Copeland (1984), researching home language effects on mathematics education, notes that pupils perform badly in mathematics due to their inability to understand the dominant language and its cultural concepts. Ellerton and Clarkson (1996) argue that many children do not understand much of what their teachers are teaching about mathematics in classrooms when they are taught in the dominant language. The idea that the home language develops a strong foundation in mathematics literacy in a natural and faster way can be inferred from the study of Edmonds-Wathen (2012). Edmonds-Wathen points out that the use of dominant language in school excludes indigenous pupils from the benefits of using mathematical concepts which are culturally constructed. As mathematics is a part of culturally constructed education, it can be discussed based on the theory of linguistic relativity. Based on this theoretical framework students’ mathematical learning is shaped by the language and culture in which it is delivered and constructed.

Since the start of bilingual education in the 1970s in the NT in Australia, several studies, for example, Hill (2008), Murtagh (1982), Richards and Thornton (1981) and Stuckey and Richards (1982), have evaluated the intellectual significance of using students’ home language as the medium instruction in the Australian pedagogical practice. There has been very little of research on the domain of teaching mathematics education through the home language medium in NT schools. This gap in the literature provides an opportunity to investigate whether the use of an Indigenous Australian language as the medium of teaching improves pupils' learning outcomes in school mathematics education. The interconnection between home language and mathematical concepts pointed out in previous research informed the central hypothesis for the present study. The study
hypothesises whether home language instruction is more efficient in improving children’s mathematics performance than English based instruction.

1.1 Research aims and questions

This study investigates the effectiveness of home language instruction, specifically Kunwinjku instruction on primary level Kunwinjku students’ mathematics performance in the community of Minjilang on Croker Island, NT, Australia. It seeks to develop new insights into the impacts of home language instruction in facilitating students’ cognitive perception of mathematical concepts and interpretation which are influenced by culture-specific activities and practices. This study focuses on ordinality and spatial frame of reference, as included in the NT Curriculum Framework (NTCF) (Northern Territory Department of Education and Training (NT DET), 2009). There is a vast difference in conceptual understandings of the number ordering system between English and Australian Indigenous languages. A pedagogical goal of the study is to investigate whether Kunwinjku children understand the mathematical concepts better if their home language is the medium of instruction and whether home language instruction has positive effects on improving primary school aged pupils’ mathematical performance.

1.2 Research setting

To collect data on the questions mentioned above, I examined the impact of Kunwinjku as the language of instruction on learning school mathematics education in the community of Minjilang.

Minjilang is a small multilingual Aboriginal community situated on Croker Island, some 235 kilometers northeast of Darwin in northwestern Arnhem Land. The island occupies an area of 120 square kilometers and just 2 kilometers off the Cobourg Peninsula. It has a population of approximately 300 people, of which 150 are the speakers of the Iwaidja language (Remote Area Health Corps, n. d. p. 2). Three other languages, namely Mawng, Kunwinjku and English are spoken in the community (Edmonds-Wathen, 2012). The participants of this study were
Kunwinjku native speakers, who are part of Australia’s Indigenous population. The effectiveness of *home language medium instruction* on children’s learning outcomes can only be measured effectively if children are native speakers of that language. Due to the number of Kunwinjku speaking children available in the region, Kunwinjku was, therefore, selected as the language of investigation for the study.

The Commonwealth of Australia (2012) indicates that Australian Indigenous languages are critically endangered, and continuing to die out at rapid rate. One of the main goals of this study is to contribute, to some extent, in documenting Kunwinjku. Before colonisation, around 270 distinct languages, subdivided into approximately 600 dialects, were spoken in Australia (Amery & Bourke, 1998). This figure is now 145, and of those, about 110 are on the verge of extinction (Commonwealth of Australia, 2012).

### 1.3 Methodology

This research employs an experimental method as it determines the relationship between two or more variables. By applying this method, researchers can control the influence of dependent variables (Phakriti, 2014). In this research project, a quasi-experimental method was employed because, according to Murray and Beglar (2009), this permits the researcher to select more than one experimental group and allows freedom for not applying any treatment on the control group. The rationale for selecting this approach was to fulfill the objectives of this thesis by analysing the correlation between the effects of using Kunwinjku as the medium of instruction and potential learning outcomes on students’ mathematics education.

### 1.4 Limitations

This study had some limitations. First, the data were gathered only from Kunwinjku students studying at Mamaruni School in the community of Minjilang on Croker Island and it was limited to six participants. Second, the study was limited to Kunwinjku and Standard Australian English as the *medium of instruction*. One of
the challenges during the study was to have a significant number of primary school age Kunwinjku pupils attending school. Finally, the results of the study might be influenced by such dependent variables as learners’ motivation, their family status and inborn talent.

1.5 Thesis Structure

This thesis is developed across six chapters. Chapter Two reviews the literature on the role of home language instruction in education. It discusses the significance of using home language instruction in primary education in terms of enhancing and improving students' performance, cognitive perceptions of concepts embodied within the language and culture and self-esteem development. It also shows the role of language in identity construction and provides an overview of bilingual programmes in NT.

Chapter Three, as the second part of literature review, examines the domain of home language instruction and mathematics education. This chapter elucidates how mathematics is culturally constructed and learnt in daily life. It considers the role of home language instruction in cognitive perceptions of mathematical concepts embedded within the culture. This chapter explains how spatial language and thought in English and indigenous language are recognized, and reviews spatial thought as included in the NT Curriculum Framework.

Chapter Four describes the methodology employed in the study. It includes the research design, research tool, ethical considerations and ethics approval by the Western Sydney University Research Ethics Committee and the guardians of the participants. The chapter details the two experiments – baseline and experiment – conducted in two different geographical areas. The baseline test (Experiment 1) was designed to pilot the Animals in a Row matching task that verifies the appropriateness of the tool that was employed in the experimental group. The experimental test (Experiment 2) was conducted on Kunwinjku students residing in the community of Minjilang on Croker Island, NT. Experiment 2 is further
developed into two sessions. Session I was conducted in English *before* Kunwinjku instruction and Session II was conducted in English *after* Kunwinjku instruction. This chapter also provides the rationale for the t-test as a method for analysing the data statistically.

**Chapter Five** describes the processes of data analysis elicited from the Animals in a Row matching task and presents the results. It presents data separately elicited from both the pilot and experimental tests and analyses them statistically by using the dependent one sample paired t-test.

**Chapter Six** discusses the main findings and provides general discussion and recommendations. Evidence is presented throughout the chapter that shows the positive effects of *home language instruction* on students’ mathematics performance. This chapter also describes the significance of the study and identifies its limitations and potential future directions.

### 1.6 Conclusion

An ancillary aim of this chapter was to sketch a broader picture of the study that motivated the present study. Another more pragmatic purpose of the chapter was to outline the remainder of the thesis and to demonstrate how themes of each chapter would be woven into a cohesive set of discussions offering support for the existence of the literature related to child literacy and pedagogy.
Chapter Two
Home language in primary school education

This chapter illustrates the centrality of using children’s home language in their school environment to facilitate improved learning outcomes. This chapter defines home language, establishes its significance for children’s identity and reviews relevant literature on including the home language as the medium of instruction in formal education settings. It details how instructing children in their own language facilitates better results in learning, reduces students’ repeating the same grade and school drop outs, and develops students’ cognitive ability and cultural identity.

2.1 Definitions of home language

People acquire one or often more languages at different stages of their life span. Different scholars have defined the language learned in different phases of life differently. Edmonds-Wathen (2012) notes that the language that a child first learns to speak fluently is often called their “mother tongue”, “native language”, “home language” or “first language” (p. 27). The language acquired in a child’s early years that becomes his/her natural instrument of thoughts and communication is called their mother tongue (Pinnock & Vijayakumar, 2007). Skutnabb-Kangas (2003) defines home language as the language that identifies a speaker as a native speaker. This thesis uses the terms ‘mother tongue’, ‘home language’ and ‘first language’ interchangeably to denote the language used by a child to communicate and interact with their family. The language a child learns in addition to their home language is called their second language. The first and second languages are abbreviated to L1 and L2 respectively in the domain of language acquisition.

In the context of multilingualism where, for example, children learn their mother’s and father’s languages the categorisation of L1 and L2 may not hold, however. Even if children learn their mother’s language first, they are expected to learn their
father’s language fluently, too (Elwell, 1982). In this regard, the father's language would be considered as an L1, not as an L2 (Edmonds-Wathen, 2012).

In Northwest Arnhem Land, many people speak more than two languages natively. In this study, these speakers are considered native speakers of Kunwinjku as they have acquired it since their birth as the L1. However, most children in the region also learn English early in life and speak it fluently. But they are not exposed with Standard English until their school starts. Here, Standard English is the L2. Therefore, in this study 'home language based education or home language medium of instruction' means education which uses a child’s mother tongue in the classroom as the medium of instruction (United Nations Educational Scientific and Cultural Organization (UNESCO), 2009).

### 2.2 Medium of instruction

The term *medium of instruction* refers to the main language used to conduct the majority of teaching and learning activities in the school curricula, as determined by the government policy of a nation (Pinnock & Vijayakumar, 2009). Yi Lo and Macaro (2012) define *medium of instruction* as the language used to deliver the teaching-learning content in a classroom. It is argued that the language selected as the *medium of instruction* should be made wisely since any language that is unfamiliar and less comprehensible to students often impedes their classroom learning processes (Nsibambi, 1999). It cannot be expected that pupils will perform well in subjects unless they master the language employed as the *medium of instruction*. Consequently, the attainment of knowledge and skills for all students depends on what language is used as the *medium of instruction* (Kamdem & Trudell, 2011; Mulumba & Masaazi, 2012).

Effective learning in the classroom is more successful if the *medium of instruction* is well-known to students (Walter, 2015). Unsurprisingly, the *home language* is a friendly language to students and helps to create a positive attitude toward learning. As Christ (1997) indicates, quality education is guaranteed not only by
the language of instruction we implement but also by how positively we think about it. The practice of home language in education may, thus, cultivate positive thoughts in learners. As a result, the medium of instruction is, in many instances, paramount in the achievement of knowledge and skills.

2.3 Significance of instructing in home language

This section establishes the significance of home language instruction in respect to cognitive advantages of education, cultural identity and self-esteem development. It also establishes the necessity of implementing home language medium educational initiatives to promote indigenous and minority language development.

2.3.1 Cognitive advantages

There is a close connection between language and cognitive development, and there is evidence that home language medium instruction helps foster children's cognitive ability, literacy and numeracy skills (Bunyi, 1997; Obondo, 1997). The primary level curriculum documented in North America, Europe and rest of the world has identified some cognitive benefits of education in one's home language (Victorian Curriculum and Assessment Authority, 2008). In contrast, instructing children in a language other than their home language not only requires them to learn a new language but also puts an extra cognitive load on them (Lee, 1993; Prinsloo, 2007). Research shows that learning outcomes will be impaired if children try to learn in a language they are not fluent in. For instance, in mathematics education many indigenous children do not comprehend their teachers' delivery and textual meaning because they are not instructed in their home language (Clements & Ellerton, 1991) and school mathematical concepts are constructed in Western thoughts.

The ways of number ordering in English differ vastly from those in Australian Indigenous languages. For instance, in English the numbers that come ‘after’ and ‘before’ are ‘greater’ and ‘smaller’ respectively; in Indigenous language, the
concepts for ‘greater’ and ‘smaller’ are connected to height and size, but in the inverse relation (Edmonds-Wathen, 2012, p. 234). For instance, the ‘bigger’ sister comes first than the ‘smaller’ sister although the age of the bigger sister is greater. When indigenous students (e.g., Kunwinjku speaking children) are taught school mathematics in English they therefore understand less of what they are taught. Here, English does not support their cognitive perceptions of mathematics concepts; instead it adds to their cognitive load for two reasons. The first is because cognitive perceptions in English differ from that of Kunwinjku. The second is because Kunwinjku students may not readily understand their teacher’s delivery due to their lower proficiency in English. Supporting this viewpoint, Lowell and Devlin (1998) point out that Aboriginal children often fail to perform better in classroom learning due to their unfamiliarity within the language in which they are taught.

Cognitive load theory is a framework on how learning and problem solving difficulties are manipulated based on the instructional design (Sweller, 1994). Instruction induces learning via the cognitive and social processes that develop interactions in the classroom and learning outcomes (Ellis, 2012). Each learning task has three types of cognitive load: intrinsic, extraneous and germane which are processed in an additive relationship (Paas, Renkl, & Sweller, 2003). Pass, Renkl and Sweller define these three types of cognitive load. The intrinsic cognitive load includes elements of interactivity as the driver that imposes working memory capacity demands intrinsic to the material being learned. The extraneous cognitive load is the unnecessary load that interferes with schema acquisition and automation. The cognitive load that is the result of these resources being devoted to schema acquisition and automation, and that enhances learning is called germane cognitive load (Pass, Renkl & Sweller, 2003, p. 2). Based on these definitions, when the instructional design incorporates irrelevant cognitive activities, it imposes load on learners that impedes the schema acquisition and automation which are fundamental mechanisms of learning.
Earlier versions of the theory focused on the relationship between intrinsic and extraneous cognitive load and working memory (Sweller, 1994; Sweller & Low, 1992). Working memory is in “all forms of complex thinking such as reasoning, problem solving and language comprehension functions as the pool of operational resources that perform the symbolic computations and thereby generate the intermediate and final products” (Just & Carpenter, 1992, p. 122). The working memory has a fixed load limit which is an important factor in instructional formats. Pass, Renkl and Sweller (2003) argue that the total cognitive load can be reduced if there is a reduction in intrinsic cognitive load, thus, freeing working memory capacity. Intrinsic cognitive load requires working memory capacity for elements of interactivity. When the instructional procedure requires learners to engage more in the cognitive activities, a heavy extraneous cognitive load is imposed because working memory resources are used for activities that are irrelevant to schema acquisition and automation. Therefore, students will have extraneous cognitive load when the instructions are delivered in a language in which they are not fluent. This usually happens in the school curricula where students are taught in a language that is not their home language.

Research demonstrates that teaching in the dominant language imposes an extraneous load on indigenous students (Sweller & Low, 1992). To Kunwinjku pupils, the principal informants of my study, for example, learning school mathematics in English imposes extraneous cognitive load because it incorporates a high level of element interactivity. Here, the need to learn mathematical concepts and English can be taken as an ineffective instructional format as it requires interactions between many elements that need to be learnt simultaneously. When learning requires extra engagement and effort, it imposes extraneous cognitive load which interferes with learning (Chandler & Sweller, 1991).

Research indicates the positive impact of home language instruction on school curricula since it facilitates learners to achieve cognitive perceptions of subject matter as an integration of schema acquisition. In this case, home language facilitates children’s progress in processing information because they can
assist their new knowledge to their culturally constructed prior knowledge. The transformation of conceptual understanding developed in early stages of life into new content can be made if the instructional design is performed in a language children have learnt from an early age. Consequently, children gain familiarity with the new information via the help of the language they speak fluently. The cognitive load is reduced as learning gradually becomes more automated within the learning process, freeing cognitive resources for other activities. As a result, the intrinsic cognitive load is reduced when learning is made through schema acquisition and automation (Pass, Renkl & Sweller, 2003). The use of home language helps to maintain the germane or effective cognitive load in children’s mind that enhances their learning processes. In this way, cognitively it is easier for children to learn the new knowledge of any subject matter in a language they are fluent in.

The positive effects of home language on children’s learning is further demonstrated by the interdependence principle developed by Cummins (1979). He points out that learning in the first language also facilitates learning a second language. His ‘developmental interdependence hypothesis’ proposes that “the level of L2 competence which a bilingual child attains is partially a function of the type of competence the child has developed in L1 at the time when intensive exposure to L2 begins” (p. 233). In this case, home language can contribute to cognitive resourcefulness for L2 students (Ellis, 2012). Ellis further argues that those L2 learners whose L2 proficiency is low may be better able to develop ideas for L2 learning if they conduct pre-similar learning activities in their L1 (p. 169). For example, indigenous students who have low proficiency in the dominant language they are taught in may be able to perform better in ordinality skills in that language if they conduct pre-ordinality activities in their home language.

Children can perform better in any area of learning when they have an opportunity to assimilate new and prior knowledge via their home language. For instance, Stapa and Majid (2009) found that Malaysian students who produced essays after generating the ideas for a written essay in L1 Bahasa Malay achieved significantly higher marks in the essays than those who generated ideas in L2 English. In their
longitudinal study of Spanish speaking minority children in Canada, Ramirez et al. (1991) showed that children taught through their home language performed better in English language task than those taught English using English as the *medium of instruction* from the very beginning stages of learning.

Usborne, Caouette, Qumaaluk, and Taylor (2009) also demonstrate the positive impact of home language on future success in second language learning skills. In their longitudinal study of Inuktitut speaking children in Canada’s Arctic community, the children performed better in both English and French due to their first language skills achieved in Year Three. By examining the research reviews on bilingual education and second language acquisition, Silburn, Nutton, McKenzie, and Landrigan (2011) acknowledge that the opportunity for students to learn in L1 in their early years of schooling benefits minority language children in their long term achievement and facilitates their acquisition of their second language. These studies support cross-language transfer and suggest the significance of *home language instruction* for enhancing the learning of Aboriginal students.

The home language effects on students’ performance in English reading can be seen in the case study by Waters (2001). Waters showed that students who were not instructed in their home language before shifting to English performed poorer in reading than those who were taught via bilingual education delivery modes. He found that the student group who took classes regularly in English performed below the average range of performance (40-60 percent) than those who took a bilingual class. This suggests that the more students are taught in a monolingual education system, the lower the results may be. The longitudinal study by Thomas and Collier (2002) conducted in the United States also showed that the experimental group who received a full six years of instructional support in their first language achieved 70 percent in learning outcomes, while those who received no instructional support in their first language remained at 11 percent. Further, and drawing on the research of Dutcher and Tucker (1997) and Patrinos and Velez (1996), the World Bank (2005) published a report claiming that children perform
better when the language of their classroom instruction is familiar and easily understandable. These studies thus support the effectiveness of *home language instruction* in learning literacy skills.

### 2.3.2 Reduction in student drop-out

Beyond the development of cognitive ability and better achievements in literacy skills, education in *home language instruction* is also helpful in reducing the number of students who repeat years and dropout of school (Hovens, 2002). Effective learning often takes place where an interactive and child friendly environment is the norm (Benson, 2002). Research indicates the home language is the most potent way of establishing a strong home-school relationship, wherein students’ positive attitudes towards school and life are developed (Benson, 2004). Putting it differently, when the learning environment is tied to their language and culture children can confidently concentrate on their learning and accept new challenges. Consequently, they are more satisfied within the education system and motivated to attend school regularly (United Nations Educational Scientific and Cultural Organization (UNESCO), 2009).

In contrast, the use of dominant language in the classroom can make children sit quietly and promote anxiety and boredom because they fear committing an error due to their lower ability in the dominant language (Benson, 2002). Language anxiety, which belongs to situation-specific anxiety (Ellis, 2012), influences the quantity and quality of learner participation in classroom. Therefore, in instances where dominant language is the *medium of instruction*, pupils’ minds are often governed by doubts, hesitations and unanswered questions. MacIntyre and Gardner (1991) point out that anxiety can impede the learning process in various stages and research shows that indigenous pupils experience anxiety when learning in the dominant language (Benson, 2002). MacIntyre and Gardner (1991) further argue that students may be less able to attend to learning new input when their minds are full of anxiety, thus they lag behind in connecting new information to their existing knowledge. As a result, the smooth operation of working memory
is interrupted. In group and pair activities learners are required to perform in front of the whole class, and in such situations learners’ minds can easily become disengaged due to their incompetency in the instruction of dominant language. Such experiences may lead them to eventually drop out of school.

Teaching in the dominant language negatively influences student attendance (Smits, Huisman, & Krujiff, 2008). Smits, Huisman and Krujiff in their study, based on data from 22 countries and nearly 160 language groups, show that a large proportion of students were absent in almost all countries due to the dominant language education system. The authors further showed that the number of children enrolled, and whose language was the medium of education, was relatively higher than those whose home language was not the medium of instruction. Similarly, the proportion of student dropouts in groups whose language was the medium of instruction was lower than those whose home language was not used in the school curricula. Patrinos and Velez (1996) also showed that the percentage of students who repeated classes throughout schooling was less in bilingual mother tongue schools compared to the monolingual Spanish schools, constituting 25 and 47 percentage respectively. In Australia, the report ‘Our land, our languages: Language learning in Indigenous communities’ by the Commonwealth of Australia (2012) indicated that the implementation of Indigenous language in school curricula led to an increase in school attendance. The report further showed that in Queensland, between 2008 and 2010, the overall proportion of Indigenous children’s participation in kindergarten rose from 6 to 35 percent.

2.3.3 Development of self-esteem

Education in a home language may contribute to empowering indigenous students’ cultural identity. Cummins (1986) argues that the empowerment of cultural attainment develops students’ self-confidence and self-esteem, thus improving their abilities in both the indigenous and mainstream language. Wright and Taylor (1995) support this. Their research showed that Aboriginal students who were
taught in their heritage language developed their self-esteem and collective esteem to a greater extent than those educated in a dominant language. As education in its broader sense is the process of cultural transmission, the *medium of language* delivers this in the classroom. Craven and Bodkin-Andrews (2011) argue that good education builds on culture because effective teaching is embedded in culture. Therefore, home language can function as a vehicle to develop cultural identity because it facilitates learners articulating and appreciating their history, both of which help to raise the status of their linguistic group.

Teaching in the mother tongue is a cornerstone of social inclusion and cultural heritage as it preserves cultural identity and diversity in language use (Mweri, 2014). Effective learning often occurs when students have opportunities to participate in their social group (Ellis, 2012). The use of home language forms a social bonding amongst the learners. A child’s ethnolinguistic heritage or the “the ethnic and speech community” (Benson, 2004, p. 205) the child has grown up in, is protected only if children have access to communicate in their own home language. Using children’s home language in the education system promotes and recognizes their status and participation in mainstream education as equal with the dominant language. In this respect, the significance of home language based education cannot be underestimated in terms of cultural identity development and promoting and maintaining linguistic solidarity.

### 2.3.4 A case study from Papua New Guinea

The educational model of Papua New Guinea (PNG) provides a model for multilingual education in multilingual societies. PNG is the most linguistically diverse country in the world with more than 800 distinct languages being spoken (Malone & Paraide, 2011). Out of these languages, English, Tok Pisin and Hiri Motu are recognised as official languages in PNG.

Since the start of the formal education system in PNG in the 1870s (Malone & Paraide, 2011), English has been the *medium of instruction*. However, due to a
growing dissatisfaction with the elite education system and increased recognition of the advantages of learning in a home language, PNG switched from using English as the medium of education to vernacular language based education in the 1980s. The formulation of inclusive language and education policy for PNG was incepted in the late 1980s and was a major innovation in primary education for minority language students (Malone & Paraide, 2011). Later, in 1995, the PNG government established a mother tongue-based bilingual education programme that institutionalised vernacular languages as a separate education subject and as the *medium of instruction* in the first three years of formal education. One of the reasons behind implementing the community’s languages in PNG’s school curricula was the inefficiency of English as the medium of instruction. PNG had successfully implemented more than 400 languages into the formal education system by the early 2000s. Given the role of home language in early grades of schooling, today, PNG primary schools use local languages as the medium of education in the first two years and English from the third year of schooling (Department of Education Papua New Guinea, 2004).

The mother tongue-based bilingual education programme used in PNG recognises the pivotal importance of *home language instruction* for indigenous students. However, there were several barriers to its successful implementation. Many local communities, for example, trained local teachers in their own language, employed local teachers and prepared literacy programmes in their vernacular languages. To enact these deeds, the PNG government needed to exert its strong political will power to build up a systematic government policy. Because of their commitment to achieving this, PNG is recognised as a leading model of home language based multilingual education in the world. The PNG case study is relevant to this study as it affirms the effectiveness of *home language instruction* in a multilingual school curricula.
2.3.5 Māori immersion and revitalisation: A case study from New Zealand

An effective home language education programme, when combined with political will power and community support, can contribute in preserving language shift more effectively (Crystal, 2000; Fishman, 1976). Crystal (2000) and Fishman (1991) state that children’s first language in education can assist in effective language revitalisation. In New Zealand, Māori, one of the indigenous languages, was considered as an endangered language by the late 1970s (Paulston & McLaughlin, 1994). The data from the Māori Language Commission showed that Māori had only about 50,000 native speakers, and that this number would decrease by around 10,000 over the coming decade (Nicholson & Garland, 1991). To revitalise Māori, the New Zealand government established Māori language medium schools in the 1980s where the use of Māori only was mandatory in the curricula (Edmonds-Wathen, 2012).

In 1982, as a part of the language revitalisation programme, the first Te Kohanga Reo or "language nest" was formed for kindergarten children. The number of sites multiplied and had reached over 500 by 1988 (Benton, 1991). Supporting the immersion programme, the government further declared Māori an official language through the Māori Language Act of 1987 (Paulston & McLaughlin, 1994). May (1999) shows that the participation of Māori children aged 2-4 years in early childhood education increased from 30 percent in 1982 to 53 percent in 1991, as a result of Te Kohanga Reo. The effect of Māori medium instruction is also evident in the 1998 Picot Report that states “It is clear that the revival of the Māori language and culture is seen not as an end in itself, but as the key of lifting the educational performance of Māori children” (The Picot Report, 1988, para. 7.2.1, as cited in Paulston & McLaughlin, 1994). The Māori immersion education programme in Aotearoa/New Zealand is the most successful attempt in the domain of language revitalisation by which both pedagogical outcomes and cultural identity are achieved.
From the aforementioned discussion, it can be noted that cultural groups wish to use their home language in education in order to construct cultural identity as well as achieve cognitive benefits. While the significance of implementing Māori language for the Māori community was a key reason for establishing the language and cultural identity programme in New Zealand, the improvement of educational performance cannot be underestimated. The two previous case studies from PNG and New Zealand demonstrate that home language implementation and revitalisation programmes can be successful when government and local communities are genuinely committed.

2.4 Language and identity

This section demonstrates the role of language in the construction of identity in general and Australian Indigenous identity in particular. Specifically, it elucidates the position of language in relation to identity in an Aboriginal community, particularly Northwest Arnhem Land, the sample area of the present study. Generally, the choice of language one makes distinguishes him/her from the other. By using common language, individuals construct their ‘being’ as language allows the world to come into ‘being’ (Heidegger, 1993). Through their selection of language use individuals feel their own identity (Quirk, 2000) which includes both “self-identification” and the “perceptions of others” (Hall, 1996, p. 3). Language can also construct an identity for a particular group of people through the common language they use. Medina (2010), drawing upon Anzaldua’s (1987) work, states that cultural solidarity becomes possible when people share their values, experiences, problems, needs, interests, etc. through using a common language. Functioning like a fingerprint, language reflects one’s personal identity and, is thus unique to every individual (Hattum, 2014).

As mentioned above, through the use of a common language, people express and formulate common needs and interests for the wellbeing of the whole community. In this respect, the relationship between language and identity is a motivating factor to implement the language of a particular community in the school curricula.
(Edmonds-Wathen, 2012). However, the Australian Indigenous identity formulated within the community of Minjilang, Croker Island, NT, can be, for example, regarded as the diversity in language spoken within Northwest Arnhem Land. The subsequent sections provide an overview of Kunwinjku people and their identity on Croker Island, language policy in the NT, and the status of bilingual programmes for Indigenous peoples.

2.4.1 The Kunwinjku speaking people on Croker Island

The participants of this study were Kunwinjku native speakers who reside in the community of Minjilang, located on Croker Island, NT. The Australian Bureau of Statistics (Australian Bureau of Statistics, 2006) reports that 915 Kunwinjku people lived in the NT; this constitutes a portion of the minority among Australia’s Indigenous population who use their home language in all their daily operations. Like other Indigenous communities, Kunwinjku people, generally live within a small community of approximately 10 to 50 residents on average (Etherington, 2006). The Kunwinjku community on Croker Island which has a growing population is an example of this.

Kunwinjku language is spoken also in other areas namely, Goulburn Island, Maningrida, Kunbalanya (Oenpelli) and Jabiru, which are interconnected due to the long history of marriage practice amongst Aboriginal people. Kunwinjku people marry those who are geographically and linguistically close because marriage is a way of developing exchanges between clans (Harvey, 2001). Therefore, the Kunwinjku identity formation is closely connected not only by language but also by geographical affiliation.

Cheng (2015) recommends that indigenous identity be viewed via the identification borders of individual identity, community identify and external identity. Based on these border-lines, as shown in Figure 1, I classify the identity of Kunwinjku speakers residing on Croker Island.
The personal identity of Kunwinjku people on Croker Island is established through their home language through which they perceive and identify themselves as unique individuals with their own race, class, gender and youth. Similarly, these factors provide them with a distinct community identity among other Australian Aboriginal people. Since the community identity includes interconnectedness of sacred traditional homelands and sacred traditions (Peroff, 1997), the Kunwinjku people on Croker Island share clans membership, values, customs, land and marriage practices with neighbouring clans. These practices also inform the external identity which is the national identity that indicates the country a person belongs to (Cheng, 2015). In this respect, Kunwinjku people are Australian citizens with a continuous adherence to their traditional kinship and marriage systems. Kunwinjku people therefore continue to define their identity against other citizens and Aboriginal people from other language groups (Etherington, 2006).

The three identities of Kunwinjku people are preserved and maintained via their home language. The Kunwinjku speaking Indigenous identity is thus an external cultural identity which is reflected in their shared values, language, traditions and beliefs.

2.4.2 Language endangerment and shift in Australia

Australia will continue to lose Indigenous languages if nothing is changed in its educational policy. Australian education language policies are one of the crucial causes behind the loss of Indigenous languages in Australia. Because Australia’s education system is founded on the norm of monolingualism, English is the
medium of instruction. In communities, as in Minjilang, where a dominant language governs the community, school is the first domain in which Indigenous children meet English. They need to use English throughout their schooling years because it is the only medium of instruction. In most of the cases, language functions as a tool of cultural transmission when it is used in the education system. Teaching young generations of the clan in a home language could be one of the most effective ways of preserving language in the socially dominant community, as demonstrated in the case studies from PNG and New Zealand. If the English medium education system continues in Indigenous communities, sooner, rather than later, English will become the normal language for all community members to communicate with each other. This will create a language shift in these communities and in the context of Croker Island, NT, Australia, from Kunwinjku to English. The challenge then is to preserve and revitalise Indigenous languages. The preservation and revitalisation of Indigenous languages can be proactively promoted by implementing home language instruction in school curricula, as evident in the previous case studies from PNG and New Zealand. As such, teaching Kunwinjku children in their home language could help in the development of Kunwinjku on Croker Island, NT.

In this study, it is worthwhile to understand how language becomes endangered to better understand the causes of Australian Indigenous language endangerment and shift. Language shift usually occurs in a culturally dominant society, where inadequate language policies and uneven power relations exit in the social fields. In such conditions, indigenous and immigrant people see the dominant language as a route to succeed in the wider society (Hatoss, 2013). Most Indigenous languages spoken in Australia are critically endangered and are dying out at a rapid rate (Commonwealth of Australia, 2012; McConvell & Thieberger, 2001). Linguistic changes can occur due to political, economic and social changes within a community, and this ultimately results in either language shift or language death (Holmes, 2013). Generally, language becomes endangered when a speech community is influenced by another and/or when a community stops speaking a language and begins to speak another. It is natural that when we die, the language
we speak also dies if we do not pass it to younger generations. If no one speaks a language any more, that language becomes extinct. The language dies with the death of its last speaker. Language can also become extinct due to the devastation of a speech community by war, diseases, death and/or displacement of people (Edmonds-Wathen, 2012). In Australia, many Aboriginal languages died as direct result of the massacre of Aboriginal communities or their death from previously unknown diseases spread by Europeans (Holmes, 2013). Holmes further exemplifies the case of Tasmania where the whole Indigenous population of between 3000 and 4000 people was exterminated within 75 years.

In the last 200 years, 50 indigenous languages have disappeared and around 130 languages have less than 50 speakers (Hatoss, 2013). Colonisation imposed language shift and language death at a rapid rate in Australian Aboriginal communities. As a consequence, today 90 percent of Aboriginal people in Australia do not speak their home languages (Mühlhäuser & Damania, 2004). The map displayed in Figure 2 shows the Cobourg Peninsula and its surrounds in the NT where the languages of Garig, Wurrugu and Ilgar have no speakers left (Edmonds-Wathen, 2012). Table 1 shows the number of speakers for Aboriginal languages in NT, Australia as recorded in the 2006 Census.

![Figure 2: Languages of West Arnhem Land (Source: Evans (2000, p. 94))](image_url)
Table 1: Total number of speakers of Indigenous languages in NT, Australia

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<td>88</td>
<td>Akarrre</td>
<td>0</td>
</tr>
<tr>
<td>Garwa</td>
<td>87</td>
<td>Amurdak</td>
<td>0</td>
</tr>
<tr>
<td>Marra</td>
<td>58</td>
<td>Antekerrrepenh</td>
<td>0</td>
</tr>
</tbody>
</table>

Note: Only major languages are tabulated as per the purpose of study (Source: ABS 2006 Census)

2.4.3 Language policy in Northern Territory educational settings

A report by Lo Bianco (1987) was Australia’s first comprehensive national language education policy document that conveyed and advocated the spirit of multilingualism. Following this document, several other policies at national and federal levels were developed. In Australia, bilingual programmes were not implemented until the early 1970s and due to the attitude of society and
government, Australia’s education system still remains monolingual. However, in the NT, a few isolated Aboriginal bilingual education programmes existed at some schools before 1970s (Ozolins, 1993). These were referred to as ‘Indigenous Language Maintenance’ programmes, and alternatively known as ‘Model 1’ programmes (Devlin, n. d.).

Bilingual education programmes in the NT are categorised into two forms (Usborne et al, 2009). The first category aims at shifting children from their heritage language to the dominant language. The second is a two-way bilingual programme which aims to extend the use of the heritage language in order to maintain the cultural and linguistic diversity and also introduce English as a second language. The NT Department of Education and Training explains the objectives of these bilingual education programmes as follows:

- Language Maintenance Programmes aim to extend and develop learner’s first language skills in listening and speaking, reading and writing. Students learn initial literacy through their first language and use literacy as a tool for their first language study throughout their schooling. The knowledge and skills that students learn in their first language assists in their learning of, in and through English (Northern Territory Department of Education and Training (NT DET), 2008).

Although the primary goal of these bilingual programmes is to master English, Aboriginal languages are also taught as first or second language in the NT schools (Amery & Bourke, 1998). By 2008, eight NT schools had bilingual programmes (Devlin, n. d.). However, the successful operation of all these eight bilingual schools was constrained by a number of factors. These included the low rate of student attendance and the lack of well-trained, fluent teachers in the language of instruction although some initiatives attempted to train the teachers via the Batchelor Institute for Indigenous Tertiary Education (BIITE). For instance, the BIITE trained five, four and two Aboriginal teachers in 2006, 2007 and 2008 respectively (Devlin, n. d.). This decrease in the number of trained teachers impacted negatively on the successful implementation of bilingual programmes in the region.
However, some bilingual programmes were implemented for the purpose of transferring the Western school knowledge rather than indigenous knowledge into the distinct domains, also known as Two-Way Schooling (Harris, 1992). It was because of the lack of trained teachers that contributed to this approach emerging. An example is the Two-Way Garma mathematics programme which was implemented in the Yolngu community in Northeast Arnhem Land. In the programme, the Yolngu kinship system was used to explore recursion (Watson-Verran, 1992). Though the Two-Way Garma maths does not underpin both indigenous knowledge and Western knowledge together, it is widely considered as an instance of culturally responsive mathematics education (Robinson & Nichol, 1998).

Some controversies about the impact of bilingual education programmes have been made at different levels of Australian society since their inception. Many were critical of the NT’s education policy (House of Representatives Standing Committee on Aboriginal and Torres Strait Islander Affairs (HRSCATSIA), 2012). As a result, the NT Government changed the bilingual education programme and announced the Compulsory Teaching in English for the First Four Hours each school day policy in 2008. Focusing on the development of literacy and numeracy in English rather than on Indigenous languages, the NT DET presented this policy as ‘a bilingual / multilingual education approach’ in which students could use their home languages whenever they needed in the morning (Northern Territory Department of Education and Training (NT DET), 2008a). This policy has strictly stood against the bilingual education, reporting that the Indigenous students who enrolled at bilingual schools performed relatively poorly in the National Assessment Programme – Literacy and Numeracy (NAPLAN) tests than those who were taught in English (Devlin, 2010). Furthermore, pointing out the weakness of the bilingual programmes, the NT Government states that there is no obvious improvement in student outcomes. Based on the data documented in the NAPLAN tests, the federal government started withdrawing the investment in bilingual pedagogy. The First Four Hour English policy thus dismantled several
bilingual education programmes, restricting the use of Indigenous language as the *medium of instruction*.

However, the effectiveness of the first four hours in English policy has been debated amongst the community members, pedagogues and language experts (House of Representatives Standing Committee on Aboriginal and Torres Strait Islander Affairs (HRSCATSIA), 2012). This policy also contradicts the international policy to indigenous language rights, accepted by the Australian government in 2009, and the United Nations Declaration on the Rights of Indigenous Peoples (United Nations Declaration of the Rights of Indigenous Peoples (UNDRIP), 2007) states:

> Indigenous peoples have the right to establish and control their educational systems and institutions providing education in their own languages, in a manner appropriate to their cultural methods of teaching and learning (Article 14.1).

Due to the widespread opposition to the first four hours in English policy, the NT Government modified the policy with the new policy ‘Framework for learning English as an additional language policy’ (Northern Territory Department of Education and Training (NT DET), 2012). The new policy states as follows:

> Home/local languages can and should be used where appropriate to support the learning and acquisition of concepts. There will be times, particularly in the early years, when it may be better to introduce concepts using the home/local language. This is good teaching practice and is to be encouraged. This is the Department’s approach for English as an additional language teaching and one that is used across Australia and internationally (p. 1).

But this policy has today been a barrier to sustain the bilingual programmes in many Indigenous communities in NT. The community of Minjilang, where this present study is based on, situated on Croker Island, is an evidence of this; none of the effective bilingual education programmes have yet been implemented. English has always been the *medium of instruction* in school curricula in NT, Australia (Edmonds-Wathen, 2012), thus empowering the monolingual education policy in multilingual society.
The research discussed previously suggests that to revitalise the loss of linguistic heritage in the NT, and other parts of Australia, the main focus should be on operationalising *home language* use in education as school is the first place where sustainable language maintenance can be maintained. Australia should not take the indigenous language policy as a supplementary to developing English competency in indigenous students (Commonwealth of Australia, 2000). Rather, it should be considered as the means of developing Indigenous education. The NT government’s decision to withdraw the bilingual education policy should not also be made depending on the Indigenous students’ results in the NAPLAN test as many factors that affect the test results. Some include the *language of instruction*, teachers’ proficiency in that language, teachers’ training and other learning resources.

The perspective of the current status of bilingual programmes discussed above underscores the necessity of implementing the effective bilingual programmes in Minjilang as well as other Indigenous communities in Australia. In a diglossic community, for example, in Minjilang, where the majority of students speak more than one languages, including *Kunwinjku*, the community desires education to be delivered in their own language to, maintain, revive and reclaim their linguistic heritage; this is arguably the government’s responsibility to implement well-organised bilingual education programmes (Devlin, n. d.; Amery & Bourke, 1998). Getting education through *home language instruction* has been established as a basic human right by the UN and endorsed by the Australian government. In the meantime, English is necessary to be acquired as it offers many choices and makes future lifelong learning possible (Devlin, n. d.). To fulfill the necessity of both home language and English medium teaching in Indigenous communities in Australia, the state and territorial governments should demonstrate a strong political will to design appropriate bilingual programmes as well as to implement them sustainably.
2.4.4 Conclusion to language and identity

This chapter has shown how identity, especially cultural identity, is constructed through the use of a common language people speak in a particular community. Croker Island, as a part of Northwest Arnhem Land, reflects its identity as a multilingual society where a social bonding is constructed through the use of at least four languages namely Kunwinjku, Iwaidja, Mawng and English. However, due to the power attached to it, English (as discussed in Chapter 1) has become the standard language thereby bringing other languages, including Kunwinjku, under threat of extinction.

Since the use of the home language in education is a key element in helping to build and recognise cultural identity, bilingual education programmes are the best way to revitalise languages. The effectiveness of the Māori immersion schools in New Zealand highlights this. The NT DET language policy prioritises facilitating English language acquisition rather than revitalising and protecting Indigenous linguistic heritage and improving pedagogical outcomes for Aboriginal students. With the intention of developing literacy and numeracy in English, the NT education policy has launched the Compulsory Teaching in English policy that has devalued the significance of bilingual education programmes in many Aboriginal communities in NT, Australia.

The successful operation of home language based bilingual and biliteracy programmes requires trained teachers who are fluent in the language of instruction and high levels of systematic support. In this context, Australia is far behind other countries such as Papua New Guinea and New Zealand who have successfully and effectively implemented mother tongue based education systems. Both examples demonstrate strong commitment and political willingness to work to overcome the difficulties of multilingualism and multiculturalism.
Chapter Three

Home language in mathematics education

The present study focuses on Kunwinjku children who live in Minjilang, a remote community on Croker Island, NT, Australia. They use the Kunwinjku language to conceptualise, understand, interpret, relate and connect culturally with the world. In mathematics learning, the Kunwinjku language and its learning approaches differ vastly from those of English. This chapter reviews the theory of linguistic relativity that deals with the role of home language in mathematics education from culturally responsive and cognitive perspectives to explain how pupils’ cultural backgrounds impact classroom learning. The chapter also describes the NT’s mathematics Curriculum Framework in respect to spatial orientation, on which this project focuses.

3.1 Linguistic relativity

Lambert (1974) considers language to be a key to defining culture. Language also helps us to conceptualise the world we see. Showing the interconnectedness between speech and conceptual development, Vygotsky (1986) states, “the speech structures mastered by the child become the basic structures of his thinking” (p. 51). As every language possesses specific structures, it helps us view the world differently and facilitates distinct conceptual developments. The notion that language shapes the way we think, and that the people whom we communicate with, and who speak different languages think differently, is known as linguistic relativity. It is also called Sapir-Whorf hypothesis which proposes that cognition and thinking align with the languages people speak (Everett, 2013, p. 14).

The strongest version of linguistic relativity asserts our thinking is completely determined and constrained by the language(s) we speak natively (Everett, 2013, p. 14). A more moderate view of linguistic relativity holds that our thoughts and behaviours are influenced by the language we speak natively, but are not
completely determined by it. Everett (2013, p. 8) claims it is difficult to transfer concepts from one language to another, and that using a different language presents obstacles. For instance, the cognitive perception of number ordering skill in English cannot be easily transferred to Kunwinjku because each uses different and specific linguistic patterns to describe and explain the same concepts of ordinality. This is particularly relevant to mathematics learning. For example, many Australian Indigenous languages do not have words for numbers greater than ‘three’ (Dixon, 1980). Even though many Indigenous languages lack words for higher numerals, there may be no difficulty in understanding concepts of ordering transferred to English because having words for numerals may not have anything to do with the concept of ordering. However, Kunwinjku students have difficulty in understanding the concepts of ‘first’ and ‘last’ because they appear to be derived from ‘in front of’ and ‘behind’.

Linguistic relativity emphasises the distinct role of language in interpreting experience and influencing thought (Lucy, 1997, p. 296). It also indicates that indigenous children may perform poorly in mathematics education where their ways of thinking and language differ from the language of instruction due to the linguistic dissimilarities (Everett, 2013). In such cross linguistic dissimilarities, the different linguistic structures in English disadvantage indigenous children in interpreting their experience and thoughts. Linguistic relativity as an argument therefore favours culturally responsive educational approaches that include using students’ home language in the classroom. However, it has been demonstrated that the strong form of linguistic relativity cannot be considered as correct. The reason is that there are lots of similarities between languages, and that differences in them may not always be obstacles to learning.

3.2 Reviewing the model of culturally responsive education

Edmonds-Wathen (2012) uses the term “culturally responsive mathematics education” (p. 13) based on the general theme of culturally responsive education. The focus of culturally responsive education is to ensure the school environment
and culture, where it differs to students’ culture, includes and respects the cultural differences in mathematics learning. This is the case in Mamaruni School in the community of Minjilang, where Western mathematical thought has been adopted and dominates even though it is not closely related with the Kunwinjku learning style of mathematics. Edmonds-Wathen (2012) points to “understanding” and “responding” (p. 14) as the two main features of culturally responsive education. Understanding includes two elements such as knowledge and empathy. Knowing students’ cultural backgrounds means gaining knowledge about them and having positive attitudes towards students’ culture is to empathize with their community. Responding to culture includes understanding something about the culture. Edmonds-Wathen further explains that knowledge and empathy are interconnected, meaning that without a deep knowledge of culture, teachers will react to culture rather than respond to it. Responding to the content without understanding is reacting. Many authors, for example, Nicol, Archibald, and Baker (2010) consider pupils’ cultural backgrounds as the core theme of culturally responsive (mathematics) education, where the role of language in mathematics education reflects students’ cultural perspectives. The use of home language in culturally responsive education approaches is an essential aspect, as language itself embeds the characteristics of a particular culture.

Using students’ home language in the classroom works to bridge the gap between home and school; in this way students’ culturally acquired knowledge automatically becomes a strong foundation of new learning. Kunwinjku students may, for example, learn the English counting system better if they are taught through their culturally constructed ways of learning. In many Aboriginal languages, including Kunwinjku, counting includes verbal tags, five-counting using fingers and toes, and body counting (Harris, 1987, p. 32). Further, Harris exemplifies that Kunwinjku speakers use “hand one” and “hand two” to mean “five” and “ten” respectively (p. 39). As such, using the culturally acquired learning system can help enhance students’ performances in new areas of learning.
Students may respond to mathematics lessons when they use their own culturally shaped learning styles that make their mathematics learning more relevant (Bucknall, 1995; Graham, 1984; Malloy & Malloy, 1998). Brenner (1998) showed that the Hawaiian Creole speaking children performed better when they were tested in Hawaiian Creole English. The participants showed a greater understanding of the Hawaiian Creole English phrase than of the Standard English word. This finding supports the scope of home language as a bridge to dominant language instruction in the classroom.

Teaching Kunwinjku students using English does not reflect a culturally responsive approach to the children’s education. Nor does it facilitate effective learning because understanding the worldview in indigenous and Western cultures significantly differs. Research, as discussed above, suggests Kunwinjku pupils will grasp the school mathematics lessons more easily if they are instructed in their home language first, and then in English because they relate the new thoughts to their culturally shaped knowledge and interpret in their own language that facilitates them in better understanding. This stems from Kunwinjku children lacking the conceptual understanding in English to some extent that is as important as their language ability to conceptualise the new world. Cultural and home language and cognitive ability are both influential and both are important facets in the present study which aims to help Kunwinjku pupils improve their performance in mathematics lessons.

3.3 The role of home language in mathematics education

Chapter Two focused on the significance of home language medium teaching in respect of cognitive benefits and culture and identity maintenance; this section specifically shows the impact of home language on improving learning outcomes in mathematics lessons.

As discussed above, meaningful learning is significantly impeded when a school education system does not implement a preferred language of instruction in which
both teachers and students can communicate fluently. To perform better in mathematics at school, students need to be taught in a familiar language because learning mathematics in an unfamiliar language presents cognitive challenges that add to their cognitive load (See 2.3.1). When students have extra cognitive load, their learning is impeded. This is because students need to engage two levels of interpretation to understand the task (Clarkson, 2009). One is comprehending the language involved in teaching mathematics, the other is understanding the mathematical concept itself which can pose numerous challenges. In such contexts, the non-native language acts as a barrier to making sense of mathematical concepts encoded in that language.

In the case of the community of Minjilang, using Kunwinjku as the medium of teaching would enable the Kunwinjku students to draw on their understandings of mathematical concepts from their culture and this would provide a stronger foundation for them to develop their understanding in English. In his study, Clarkson (2009) uses the example of one bilingual Vietnamese girl aged four years to demonstrate this point. The young girl completed counting problems in her home language first and then performed them in English later. She did this because the counting system in her native language differed from that of English and she had limited proficiency in English. This approach worked to transform the culturally acquired knowledge into new learning. This finding supports the effectiveness of culturally responsive education in enhancing students' understandings when they are able to learn about and examine the mathematical concepts through their native language first.

Niesche (2009), in his research from Western Australia, demonstrates the significance of students' culture in teaching mathematics. He found that indigenous children performed better in mathematics education when the native language was used as the medium of instruction. Similarly, Espada (2012), in her research in the Philippines, found that the home language helped children to transfer prior knowledge patterns and gain insights into mathematical learning. She examined the influence of Warray as a medium of instruction on 34
kindergarten pupils. The findings of her study showed students taught in Warray scored better results than those taught in English with the mean for the experimental group almost double than of the control group mean at 40 and 20 respectively. A similar finding was also noted by Bamgbose (2004) who used experimental design to examine the effects of teaching in Yoruba, in Nigeria. The experimental group had lessons in Yoruba for all six years of primary education, and the control group was taught in Yoruba for the first three years and in English for the last three years. Both groups were evaluated in five subjects, including mathematics at the conclusion of the six years. The results showed that the experimental group consistently performed better than the control group.

The work of Brock-Utne (2013) highlights another aspect of teaching students in their home language. He found that students seemed passive and had a fear of being called upon to answer questions when they were taught in English whereas they actively participated and engaged in all group work when they were taught in Kiswahili, their home language. In the context of mounting empirical evidence arguing for the value of using *home language medium instruction* in teaching mathematics, researchers emphatically advocate for culturally relevant educational uses of children’s first language for instruction and content in the curriculum that incorporates the local learning styles (Haddad, 2007). If the students are taught using familiar cultural experiences, they draw on their early mathematical knowledge, often acquired at home, to make sense of the new mathematical concepts and make their learning more comprehensible. In the context of this study, these results highlight the potential effectiveness of shifting the current monolingual approach to teaching in the NT to a more culturally inclusive bilingual approach.

### 3.4 Mathematics and culture

This section focuses on how mathematics varies across different cultures and how it operates within the language of a particular culture. It deals with *ethnomathematics* or mathematics from a culturally relevant perspective. This
section also exemplifies how a typological framework of describing spatial language varies in Australian languages and English. It provides some of the references of spatial orientation, as used in the NT Curriculum Framework.

3.4.1 Ethnomathematics

According to Bishop (1998), there are two types of mathematics. They are termed ‘big M mathematics’ and ‘small m mathematics’. ‘Big M mathematics’ includes mathematical practices of the Western academic tradition while ‘small m mathematics’ includes mathematical activities practiced in various cultures. Borba (1997) defines ethnomathematics as the mathematical knowledge which is expressed in the language code of a given sociocultural group. Ethnomathematics thereby falls under the ‘small m’ category of mathematics which is defined by D’Ambrósio (2006) as:

The mathematics practiced by cultural groups, such as urban and rural communities, groups of workers, professional classes, children in a given age group, indigenous societies, and so many other groups that are identified by the objectives and traditions common to these groups (p. 1).

However, some mathematical activities conducted in the culture are considered to be ‘big M mathematics’. The practice of number and pattern in African cultures, for example, proposed by Zaslavsky (1979), contextualises the variety of numbering practices over the African continent and is recognised as ‘big M mathematics’. In contrast, the Garma Maths of the Yolngu in Australia, based on the recursion in the Yolngu kinship systems, is not recognized as part of ‘big M mathematics’ (Watson-Verran, 1992) because it represents ethnomathematics in which people’s ways of learning mathematics are culturally constructed.

In this study, I argue that teaching mathematics in the home language is like incorporating ethnomathematical practices into the classroom as a cultural product. Chapter Two described the case of Papua New Guinea (See 2.3.4), which switched from teaching mathematics in English to teaching mathematics in local languages. Teaching students in vernacular languages integrates local
mathematical knowledge and practices that benefit students and help them transfer ethnomathematical practices to English (Matang, 2006). This demonstrates that mathematical learning becomes meaningful when mathematics is explained and learnt in a relevant content (Zaslavsky, 1998). In teaching mathematics therefore, using ethnomathematic ideas would be helpful in facilitating effective learning processes and experiences for students as it would recognise the mathematical knowledge brought from homes and communities to inform children’s conceptual understanding of mathematical vocabulary.

This benefit can be achieved when the language of instruction also reflects the same culture in which ethnomathematics and language are intertwined. Showing the interconnectedness between language and mathematics, Gattengno (1970) argues that the mental functions or structures that are needed to learn a language are akin to those used in doing mathematics. He further argues that anyone who succeeds in mathematising his/her linguistic domains also becomes capable of mathematising other domains. This indicates learning becomes meaningful only if students are taught in the language in which they are linguistically competent. Kunwinjku speaking pupils in NT however lack this opportunity due to the monolingual education system (i.e., English medium) policy. Implementing both home language instruction and ethnomathematical ideas should therefore be done carefully and respectfully given the complexity of Australia’s multilingual society.

3.4.2 Spatial language as a cultural construct

Space is a culturally situated concept. Therefore, it differs from culture to culture. Lakoff and Núñez (2000) explain space as the background setting in which objects are located. As space and spatial thinking vary with language and culture, they need to be critically examined when designing mathematical education. In any educational system where Western thoughts dominate and are adopted, as in the NT schools, it is important to take account of cultural differences in mathematical understandings. The development of spatial thought and language in indigenous children may differ from children of a Western culture. The conceptualisations of
space in Papua New Guineans, for example, vary to that of speakers of Indo European languages, as evidenced in Bishop’s (1979) study that showed some tests that involved pictorial information were difficult to interpret due to cultural variants. Similarly, Pinxten, van Dooren, and Harvey (1983) found that the concept of Navajo space was quite unfamiliar to Western thought.

When teaching spatial conceptions to Kunwinjku children, it is important to use Kunwinjku conceptions of space rather than Western spatial conceptions as they are different. Evans (2010, p. 165) exemplifies this in his study on the Kayardild language in which the terms ‘right hand’ and ‘left hand’ are never used to locate objects or places as they are employed in English with expressions like “the path to your right”. Kayardild people do not locate the objects oriented relative to their body. Instead, they use an absolute frame of reference. If learning a mathematical lesson is to be authentic, effective and fruitful, it is therefore important to consider the role of home language as the teaching medium through which children might extend their conceptualisation of spatial language and thinking.

3.4.3 Spatial thought in the Northern Territory Curriculum Framework

Space is a fundamental part of many areas of mathematics (Edmonds-Wathen, 2012). The NT Curriculum Framework (NTCF) (Northern Territory Department of Education and Training (NT DET), 2009b) includes the mathematical concepts of shape and location in the early years of education. The NTCF includes Band Levels which are the achievement levels expected to be fulfilled at each stage of a child’s education. They are described with multiple indicators and a vocabulary for key mathematical concepts, for example, ‘front’ ‘behind’ ‘forward’ ‘backward’ ‘between’ ‘left’ and ‘right’ are the learning outcomes expected to be met at the KGP stage 2 band level (NT DET, 2009b). This vocabulary is in English, not in Indigenous languages, and the NTCF does not acknowledge any differences in the conceptual acquisition of spatial terminology used in Indigenous languages and English. This shows no consideration is given for Indigenous students in the NTCF mathematics curriculum. Current approaches to teaching spatial skills to
Indigenous children thus exclude their home language, as well as their conceptual acquisition of spatial language, and therefore increase the likelihood of them performing poorly in mathematics lessons.

3.4.4 Frame of reference

Frame of reference refers to the differences in the ways that people may conceptualise space. Specifically, it is the manner of talking about where one thing is located in relation to another in a horizontal plane (Edmonds-Wathen, 2012, p. 219). Research proposes that representations of space utilise one of three possible frames of reference: absolute frame of reference, intrinsic frame of reference and relative frame of reference (Wolff & Holmes, 2011). An absolute frame of reference involves the location of the figure in relation to a fixed direction or landmark. In this frame of reference, a coordinate system is used in which the main axes are placed within the larger environment (e.g., *The house is to the north of the tree*). An intrinsic frame of reference describes the location of the figure in relation to a part or facet of the ground (e.g., *The book is at the handle of the cup*) and a relative frame of reference describes the axes with respect to the viewer’s own body (e.g., *The book is to the left of the cup*). As Levinson (2004) has argued, there are cross-cultural differences in people’s conceptualisations within these frames of reference. For example, the absolute frame of reference is used in Australian Indigenous languages, in Kunwinjku, the cardinal directions are demonstrated in small scale space, while in English the relative frame of reference is used, such as locating a book on a desk, and the absolute point of reference is preference (Barton, 2009). In Kunwinjku, the cardinal directional terms such as *North, South, East* and *West* are also used as intrinsic and relative frames of reference (Edmonds-Wathen, 2012), as depicted in Figures 3 and 4 below. Moreover, Australian languages use grammatical cases to demonstrate absolute directions (Haviland, 1998; Laughren, 1978).
Teaching spatial skills to indigenous children in English might be a greater challenge since they are unable to readily translate their culturally learnt conceptualisation of space into the Western thought of mathematics education. Identifying the role of home language in the culturally dominant society led to the development of the research questions (See Chapter 1.2) for this study.

3.5 Introduction to Kunwinjku

Kunwinjku is one of the languages spoken on Croker Island, though it is not indigenous there. Evans (2003) describes it as a variety of Bininj Gun-Work. Though some linguistic data on Kunwinjku were collected from the present study, key literature was reviewed to provide some more linguistic data for the readers. Calwell (1988), pointing out the linguistic differences between Kunwinjku and English, claims that Kunwinjku is based on “verb stems” to which prefixes, suffixes and infixes are added to provide greater meaning. For example:

(1) **Yire (one person)**

\[ Yi-re \]

2PL.PRS-go

‘You go’

(2) **Ngunere (two people)**

\[ Ngu-ne-re \]

2PL.PRS-go
‘You go’

In the example given above, the suffix ‘Re’ is the verb stem for ‘go’, and used to denote who is being spoken to (Calwell, 1988, p. 32). Calwell further claims that the Kunwinjku language also differs in the use of prepositions from those of English and has a less complicated set of prepositions. In addition, Harvey (2001, p. 120) presents some kinship terms in Kunwinjku, such as the terms “kaga” and “toa” are used to refer a man’s mother’s brother and his father’s sister respectively.

Edmonds-Wathen (2012) states that as in English, the cardinal directions are used frequently in Kunwinjku. The sentence “Gumeke! Walem!” gareh “Gakbi!” or “Goyek! Ngale gareh garri! (Over there! To the south! or maybe ‘North!’ or ‘East! Maybe to the west!”) (p. 676) used in a story in the Bininj Gun-Work grammar (Evans, 2003) exemplifies its use. Edmonds-Wathen (2012) further speculates that in Kunwinjku the use of absolute directions might be possible in a comparatively small-scale space, such as locating a pen on a table (p. 214). Some key differences in respect of spatial language in English and Kunwinjku are that English does not use cardinal directions but has a system of relative orientation and Kunwinjku often uses absolute orientation whereas English often uses relative orientation. To describe the standing location information in Kunwinjku, the word “kad” is used, whereas “facing towards or looking at” is denoted by the word “gonad” (Edmonds-Wathen, 2012, p. 214). An example of how facing direction is reflected in Kunwinjku is presented below:

*Bale kabolknan, gonda or kureh, kureh nguta or kureh kabolknan?*

<table>
<thead>
<tr>
<th>Bale</th>
<th>kabolknan</th>
<th>gonad</th>
<th>or</th>
<th>kureh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Which way</td>
<td>3SG.look</td>
<td>here</td>
<td>or</td>
<td>that.way</td>
</tr>
<tr>
<td>Kureh</td>
<td>nguta</td>
<td>or</td>
<td>kureh</td>
<td>kabolknan</td>
</tr>
<tr>
<td>That way</td>
<td>you</td>
<td>or</td>
<td>that.way</td>
<td>3SG.look</td>
</tr>
</tbody>
</table>

‘Which way is he facing, here or there? Is he looking towards you, or where?’

(Adopted from Edmonds-Wathen, 2012, p. 214)
In Kunwinjku the term *injalku* is used to denote the concept of ‘left’ which could be used in a relative sense as well as intrinsically, as given in the following examples:

(1) *Gundalk kadi injalku*

\[
gundalk \quad kadi \quad injalku
\]

Tree \quad 3SG.stand \quad left

‘The tree is standing on the left’

(2) *Biwong injalku*

\[
biwong \quad injalku
\]

3SG>3SG.PAST-gave \quad left

‘It’s on his left’

(Adopted from Edmonds-Wathen, 2012, p. 217)

Edmonds-Wathen also summarises that in Kunwinjku the relative use of ‘left’ and ‘right’ is for denoting location information rather than direction. Similarly, the use of body parts is used for referring intrinsic relations. Another key difference is that in an ordinality system, a greater or higher number in English comes after the lower number whereas in Australian Indigenous languages, including Kunwinjku, the concepts of ‘higher’ or ‘lower’ are linked in the inverse relation (Edmonds-Wathen, 2012, p. 234). From this perspective, it can be speculated that in Kunwinjku the larger numbers are ‘before’ or ‘in front of’ the smaller numbers and the small numbers are ‘behind’ the larger numbers or come ‘after’ them.

Based on the aforementioned explanations, it is evident that Kunwinjku is a unique language with its own culturally embedded concepts. It is also evident that given these culturally informed mathematical concepts, Kunwinjku pupils will be at a disadvantage when they are taught in English because of the significant linguistic differences between Kunwinjku and English.
3.6 Conclusion

This chapter has established the significance of using home language in mathematics education. As languages shape the way we think, using home language instruction is an essential aspect of culturally responsive (mathematics) education. In the NT, virtually all schools use English as the medium of teaching. This disadvantages indigenous students. To make the current NTCF more culturally responsive, the knowledge and understandings indigenous students have already acquired from their homes and communities need to be utilised so that Indigenous students can more readily grasp mathematical concepts as ordinality and spatial skills via the NTCF including spatial references, as expressed and used in the Indigenous languages. This requires research into the correlations between understanding mathematical concepts and the role of home language medium instruction. The next chapter details the research methodology employed to examine the effectiveness of home language on improving indigenous students’ mathematical learning outcomes.
Chapter Four
Methodology

The main aim of the present study was to investigate whether the mathematical learning achievements of Kunwinjku pupils would improve if they were instructed in a home language rather than Standard English. This study was developed to support previous research on the effectiveness of *home language medium instruction* on children’s literacy (Bunyi, 1997; Obondo, 1997; Benson, 2004). The methodology used to conduct the study was a quantitative approach. A mathematical achievement test in the Animals in a Row matching task was employed as experimental design to gather the data. Primary school aged children were asked to solve 20 mathematical problems orally. The results of the test were processed statistically using a t-test. This chapter describes the design of the project and details the methods employed to answer the research questions. It explains the theoretical framework of the quantitative methodology used, and its usefulness in the study. It also describes why a quasi-experimental design was employed and it discusses ethical considerations involved in the study.

4.1 Research design

This study was an experimental study that statistically analysed data on the impact of *home language medium instruction* in teaching the primary level mathematics concepts of ordinality and spatial language. Data elicited in the study were collected using a quantitative methodology. Quantitative methods are useful in research studies, as the relationship between variables can be analysed mathematically through statistical analysis. A quantitative research approach is often used when a study is formulated with a hypothesis that needs to be tested for confirmation or rejection (Newman & Benz, 1998, p. 2). As a qualitative method, participants’ behaviours were also observed in the experiments. In the present study, the intervention was the application of home language instruction.
Within the quantitative research framework, a quasi-experiment was used. This method, according to Murray and Beglar (2009), allows the researcher to choose more than one experimental group. The rationale for choosing the quasi-experiment was to achieve the objectives of the study by analyzing the correlation between the effects of using home language instruction and students' learning performance.

Based on this research design, two sample groups were selected. They were a control and an experimental group. The control group represented English monolingual students who participated in Experiment 1 (3 males and 3 females, mean age of 8 years), while the experimental group represented the Kunwinjku pupils who participated in Experiment 2 (4 females and 2 males, mean age of 7 years). Experiment 1 was designed to observe the effective functionality of the research instrument, as described in 4.2.1. Experiment 2 was designed to investigate the mathematical learning performance of Kunwinjku pupils under two conditions. In this study therefore, only the experimental group was studied with respect to the independent variable.

### 4.2 Methods

#### 4.2.1 Experimental tool

One task, the Animals in Row matching task, was employed as an experimental tool in the study. The task was designed to test the mathematical performance of Kunwinjku pupils when it was delivered in English. The task was a type of 'card matching game' (see Figure 5), in which the participants had to solve a basic mathematical problem relating to ordinality and spatial orientation skills like 'in front', 'behind' 'left' and 'right' verbally, using the cards as visual stimulus material. The participants in both Experiment 1 and Experiment 2 were seated individually and separately, around one meter away from each other.

The Animals in a Row matching task was developed based on a non-linguistic investigative tool developed by the Cognitive Anthropology Research Group at the
Max Planck Institute for Psycholinguistics in Nijmegen (CARG, 1993). The CARG developed such a tool to explore how language and cognition are related. Through the use of the Animals in a Row matching task, students’ conceptual understandings of spatial frames of reference were assessed in the experiments.

4.2.2 The Animals in a Row matching task

The Animals in a Row matching task was a picture-to-picture matching task designed to test the participants’ performance in the area of ordinal ranking. By nature, it was a non-linguistic task performed individually within a group of six participants. All participants were shown a row of five animals’ images ordered 20 different ways and with different orientations. To show the various arrangements, 20 different posters of A3 size were developed in which the images of five animals namely ‘cow’, ‘pig’, ‘horse’, ‘kangaroo’ and ‘dog’ were displayed in different colours (see Figure 5). All the posters were placed in sequential order, as per the order of 20 questions.

Figure 5: Row of animals in different positions of arrangements
The posters were identified with two English letters. The first refers to the card itself (C) and the second refers to the letter of the card order as assigned by English Alphabetical order starting from ‘A and going through to T’. A reference such as ‘CA’ thus refers to the first card that corresponds problem number 1.

Six sets of five cards, showing photos of five animals, were also developed (see Figure 6). Each set had the same photos of five animals in the same size, but differed in colours. All participants were provided with a set of the cards, and asked to hold them in their hands. The cards were post card size and made from thick paper.

Figure 6: A set of five animals’ photos
4.2.3 Limitations of the task

Some limitations to the task were observed. All participants in Experiment 2 were familiar with the name of the five animals in English and Kunwinjku. For the control group, the task closely matched their previous experience of school mathematics. The task was not closely connected to the language background or school mathematics lessons of the experimental group. Therefore, these factors made it more difficult for them to understand their role and the questions.

4.3 Sample procedure

Experiment 1 was designed as a pilot test which was conducted at Ashfield Public School, in the Sydney metropolitan area in New South Wales, Australia. This experiment was conducted to test how monolingual English speakers performed in the Animals in a Row matching task. Six monolingual native English speaking students (Transitional to Year 4) participated in the test. Experiment 2 was conducted with six Kunwinjku speaking students, residing in the community of Minjilang, located on Croker Island in the NT, Australia. They were students of Mamaruni School situated in the same community. This test was not conducted on school premises because the request for permission to the school principal was not acknowledged. Non-probability sampling was used to select participants because the study did not rely on the use of a randomisation technique to select Kunwinjku participants. This was due to the small sample size available. Consequently, convenience sampling was employed to select the Kunwinjku participants who were the students aged from Transitional to Year 3 (i.e. 4 to 10 years old). By contrast, the English monolingual participants were selected randomly.

4.3.1 Participants

A total of 12 students participated in the experiments. The six English monolingual students were regular school attenders, with a good understanding of school mathematics and English as their first and only language. The six Kunwinjku speaking children were not regular students and spoke Kunwinjku as one of their
home languages. They also spoke other Indigenous languages and English outside school, but not Standard English as their first language.

The randomly chosen English monolingual sample group was selected with the consent and help of the Ashfield school principal and class teacher. Before visiting the school, I contacted the school principal and detailed the purpose of the study, seeking permission to conduct the experiment that was subsequently granted. To ensure that they were not re-identifiable, the participants of the control group were given generic pseudonyms, EC1 through EC6. Here, the first English alphabet refers ‘English’, the second ‘Child’ and numerical digit refers the number of participant. The following Table 2 shows their details:

<table>
<thead>
<tr>
<th>Pseudonym</th>
<th>Age</th>
<th>Standard</th>
<th>Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td>EC1</td>
<td>7</td>
<td>3</td>
<td>Female</td>
</tr>
<tr>
<td>EC2</td>
<td>7</td>
<td>3</td>
<td>Female</td>
</tr>
<tr>
<td>EC3</td>
<td>8</td>
<td>3</td>
<td>Male</td>
</tr>
<tr>
<td>EC4</td>
<td>9</td>
<td>4</td>
<td>Male</td>
</tr>
<tr>
<td>EC5</td>
<td>9</td>
<td>4</td>
<td>Female</td>
</tr>
<tr>
<td>EC6</td>
<td>8</td>
<td>3</td>
<td>Male</td>
</tr>
</tbody>
</table>

The second field experiment involved data collection from the experimental group with the help of Heleana Wauchope, the teacher at Mamaruni School. Heleana is a native speaker of Kunwinjku and helped to coordinate and select the sample group of Kunwinjku pupils. Through Heleana, the parents were informed about the purpose of the study and a good rapport was established with the participants. Heleana administered the experiment. As for the control group, the indigenous children who participated in the experiment were given generic pseudonyms, KC1 through KC6. Here, the first English alphabet refers ‘Kunwinjku’, the second ‘Child’ and numerical digit refers the number of participant. Their details are given in Table 3 below.
Table 3: Participants of experimental group

<table>
<thead>
<tr>
<th>Pseudonym</th>
<th>Age</th>
<th>Standard</th>
<th>Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td>KC1</td>
<td>7</td>
<td>Transitional</td>
<td>Male</td>
</tr>
<tr>
<td>KC2</td>
<td>5</td>
<td>Transitional</td>
<td>Female</td>
</tr>
<tr>
<td>KC3</td>
<td>7</td>
<td>2</td>
<td>Male</td>
</tr>
<tr>
<td>KC4</td>
<td>8</td>
<td>3</td>
<td>Female</td>
</tr>
<tr>
<td>KC5</td>
<td>8</td>
<td>2</td>
<td>Female</td>
</tr>
<tr>
<td>KC6</td>
<td>7</td>
<td>2</td>
<td>Male</td>
</tr>
</tbody>
</table>

4.3.2 Participant consent

For Experiment 1, participants’ consent was obtained from the principal of Ashfield Public School, NSW, Australia. On behalf of the parents, the principal agreed to provide consent for all participants. All participants were given an information sheet (See Appendix 4). Given that participants were minors, each was not supposed to sign the form. However, they were asked for their voluntary participation. Consent for students to participate in Experiment 2 was given orally by their parents. All participants were informed verbally that they could withdraw their participation at any time of the experiment. The consent forms of the Experiment 1 and Experiment 2 are included in the Appendix 4 consecutively.

4.3.3 Limitations of sample population

Due to the relatively small population and availability of Kunwinjku speaking children in the small community, the study was limited to six Kunwinjku pupils.

4.4 Stimuli and procedure

All participants in both Experiment 1 and Experiment 2 were presented with the Animals in a Row matching task. In Experiment 1, participants were instructed in Standard English. In Experiment 2, all instructions were presented in Standard English first and then in Kunwinjku. In both experiments, participants were identified as the Matcher, and the teacher was the Director. Before the start of the task, all participants were instructed on their roles (in English in Experiment 1 and English and Kunwinjku in Experiment 2), and were encouraged to ask any question or to have the instructions repeated at any point during the test.
Experiment 2 had two sessions; in Session 1, all the participants received the instructions in English, while in Session 2, the instructions were delivered in Kunwinjku.

In Experiment 1, the questions were asked by the assistant teacher and as the facilitator, I recorded the participants’ answers. Experiment 2 was administered by Heleana Wauchope, and as the facilitator, I again recorded the participants’ answers. In both experiments, the Director posed the problems, and each Matcher had to identify the position of the animal in the poster by facing down the card that correctly matched the problem. For example, the Director asked “Which animal is standing in first place in the animal row?”, showing ‘CA’ (See Figure 5). 20 problem-solving questions were asked one after another. Although all participants were allowed to ask to repeat the instruction of the problems until they understood clearly, they were not permitted to show their chosen card to each other. No specific amount of time was set for both experiments because the task could continue for as long as required to solve all the problems.

In Experiment 2, the language of instruction was the independent variable. Other dependent variables included the children’s family background, age, interest and the impact of the memory gained from the first round of the test. The dependent variable was the performance in the experimental task. In order to maintain its effects on the second round of the test, there was a delay between the first and second session. However, none of the participants was told the answers in the first session. The gap between the first and second session was 30 minutes. Thus, Experiment 2 lasted about 120 minutes in total.

4.5 Data processing

All data were recorded into the data elicitation file. Each file was named with the date and experiment number. I recorded Experiment 1 data in separate spreadsheets because no audiovisual file was created in this experiment. Experiment 2 was also recorded in a video file in a lossless mov format. The
following equipment was used: iPad with Filmic pro, iRigPro preamp, Sennheiser DC10 wireless transmission system, and a Countryman Omnidirectional lapel microphone on Heleana Wauchope. The file was then imported into ELAN (EUDICO Linguistic Annotator) and an annotation file was created. ELAN is a linguistic annotation software programme developed for language analysis and used by many linguists (Hellwig, Van Uytvanck, & Hulsbosch, 2010). The ELAN file was used to transcribe the audio data of Experiment 2.

The data elicited from both Experiments 1 and 2 were kept in separate spreadsheets. The demographic information of all the participants was recorded first, in a separate file, then, the results from both tests were recorded in two separate files. All the correct and incorrect answers provided by each participant were identified and recorded. The files were labeled with the date, type of experiment and other descriptors such as time duration and background of the participants. Dr. Robert Mailhammer, principal supervisor of the study, Dr. Aug Si of University of Cologne and Prof. Nicholas Evans of Australian National University transcribed the data and instructions asked in Kunwinjku.

4.6 Process of data analysis

The questions asked in the study included number ordering and spatial skills. Under spatial skills, the mathematical vocabulary used to indicate the location was classified as ‘forward’, ‘backward’, ‘front’, ‘behind’, ‘left’, ‘right’ and ‘between’. The ordinality skills were separated under the categories of ‘first’, ‘last’, ‘second’, ‘third’ and ‘fourth’. All the correct responses made by each student in both experiments were recorded. As mentioned, the main goal of the study was a comparison between participants’ mathematical performances in English and Kunwinjku medium instruction. Thus, in Experiment 2, the same sample group participated in the pre-intervention (before Kunwinjku instruction) and post-intervention (after Kunwinjku instruction) tests.
To investigate the effects of home language medium instruction on students’ mathematical performance, I analysed the two scores of the same sample group as achieved in the two sessions of the same test. To analyze the data statistically, I used a t-test as a statistical analytical tool. Under this tool, the paired sample t-test, sometimes called the dependent sample t-test, was used to determine whether the mean difference between the two sets of observations was not statistically significant. This study tested the null hypothesis that the mean of the correct responses in the Kunwinjku condition equaled the mean of English effect. To determine whether the difference in mean value was statistically significant, I analysed the p-value that gave the probability of observing the test results under the null hypothesis. If the p-value was lower than the convention value of 0.05 (i.e. 5 percent), there was a lower probability of getting a result by chance. Thus, a low p-value that indicated a decreased support for the null hypothesis was expected. Further, I used tables and graphs to present the results. As the study was based on a small sample size, quantities were used for the purpose of comparison and clarification, and I performed simple statistical operations while analyzing the data.

4.7 Ethical considerations

This project was approved by the Human Research Ethics Committee of Western Sydney University (Approval number H10237). The research followed and upheld the guidelines stipulated by the National Health and Medical Research Council (National Health and Medical Research Council, 2003).
Chapter Five
Data analysis and interpretation

This chapter elucidates an interpretation of data. The first section of the chapter details how data collected from Experiments 1 and 2 were grouped and coded. The second section of the chapter interprets the data statistically and describes the types of variables and statistical tools employed to analyse the data. It also presents the findings in various graphic forms.

5.1 Mathematical concepts tested in experiments

The central idea of this study was to compare the effects of using Kunwinjku and English as the medium of instruction and the impact on students’ mathematical performance in the early grades of primary school. Based on the NT Curriculum Framework, the basic mathematical concepts of ordinality ranking and spatial skills were tested. The number ordering skill included the concept of ‘first’, ‘second’, ‘third’, ‘fourth’ and ‘last’. These terms were used to test the concept of location. Under the concept of spatial orientation, the terms ‘behind’, ‘in front’, ‘left’, ‘right’, ‘before’ and ‘after’ were tested. Most of the questions included the concepts of ordinality with the combination of frame of reference, including both relative and intrinsic frames of reference. Table 4 shows the list of vocabulary that were included in the questions.

Table 4: List of vocabulary corresponding to ordinality and spatial skills

<table>
<thead>
<tr>
<th>Questions</th>
<th>Vocabulary Used</th>
<th>Mathematical Concepts Tested</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>First</td>
<td>Ordinality/Location outcome</td>
</tr>
<tr>
<td>2</td>
<td>First</td>
<td>Ordinality/Location outcome</td>
</tr>
<tr>
<td>3</td>
<td>Last</td>
<td>Ordinality /Location outcome</td>
</tr>
<tr>
<td>4</td>
<td>Second / After</td>
<td>Ordinality / Location outcome</td>
</tr>
<tr>
<td>5</td>
<td>Between</td>
<td>Location outcome</td>
</tr>
<tr>
<td>6</td>
<td>In front</td>
<td>Frame of reference</td>
</tr>
<tr>
<td>7</td>
<td>First / After</td>
<td>Ordinality /Location outcome</td>
</tr>
<tr>
<td>8</td>
<td>Fourth / After</td>
<td>Ordinality /Location outcome</td>
</tr>
<tr>
<td>9</td>
<td>Behind</td>
<td>Frame of reference</td>
</tr>
<tr>
<td>10</td>
<td>In front</td>
<td>Frame of reference</td>
</tr>
<tr>
<td>11</td>
<td>Third /Before</td>
<td>Ordinality /Location outcome</td>
</tr>
<tr>
<td>12</td>
<td>Second / After</td>
<td>Ordinality /Location outcome</td>
</tr>
<tr>
<td>13</td>
<td>Last / Behind</td>
<td>Ordinality /Frame of reference</td>
</tr>
<tr>
<td>14</td>
<td>Second/Before/After</td>
<td>Ordinality/Frame of reference</td>
</tr>
<tr>
<td>15</td>
<td>Behind</td>
<td>Frame of reference</td>
</tr>
</tbody>
</table>
5.2 Coding of data

The Animals in a Row matching task was used in Experiment 1 and Experiment 2. The data elicited from the experiments were coded with the first letter of the name of each animal’s. In this case, the letters ‘H’, ‘D’, ‘P’, ‘K’ and ‘C’ were used to refer the “Horse”, “Dog”, “Pig”, “Kangaroo” and “Cow” respectively. Each participant’s response was recorded in the data spreadsheet, as shown in Table 5, below. Then, all the answers were marked as ‘correct’ and ‘incorrect’ by ticking (√) and (×) each response respectively before being tallied.

Table 5: Sample of data codification

<table>
<thead>
<tr>
<th>Pseudonym</th>
<th>Question Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child1</td>
<td>H H C K P H C C C D D P K D C K C P C D D C</td>
</tr>
<tr>
<td>Child2</td>
<td>H H P P H C C P H D D H K H C H C D D K</td>
</tr>
<tr>
<td>Child3</td>
<td>H H P P D D D C D D K D K K D P C D K</td>
</tr>
<tr>
<td>Child4</td>
<td>H H P P C C D D D K D C K C P C C K</td>
</tr>
<tr>
<td>Child5</td>
<td>H C P K P H C C D D D K D C H C P C D C</td>
</tr>
<tr>
<td>Child6</td>
<td>H H P P H C C P D D P P K C K C P K D K</td>
</tr>
</tbody>
</table>

5.3 Animals’ names in Kunwinjku used in the task

In the Animals in a Row matching task, five animals’ images were used. They had their English names. Their Kunwinjku names used in the task were mentioned by Heleana Wauchope, a Kunwinjku native speaker. These names were also checked in the grammar note “Kunwinjku Kunwok: A Short Introduction to Kunwinjku Language and Society” by Etherington (1996). Four animals’ names, except that of the cow, were included in the book. The following table shows five animals’ names in Kunwinjku along with their English corresponding names.
Table 6: Five animals’ names in Kunwinjku with their corresponding names in English

<table>
<thead>
<tr>
<th>Kunwinjku Names</th>
<th>English Names</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duruk</td>
<td>Dog</td>
</tr>
<tr>
<td>Kung</td>
<td>Kangaroo</td>
</tr>
<tr>
<td>Bik</td>
<td>Pig</td>
</tr>
<tr>
<td>Djarrang</td>
<td>Horse</td>
</tr>
<tr>
<td>Buligang</td>
<td>Cow</td>
</tr>
</tbody>
</table>

5.4 Approach to glossing

The Leipzing glossing rules (Comrie, Haspelmath, & Bickel, 2008) were used to gloss the examples elicited in Kunwinjku. Based on four levels of glossing, the top level gives the Kunwinjku in word and/sentence form. The second level gives the Kunwinjku word parts (morphemes), the third level the English morphemic gloss using standard abbreviations. The final level gives a free translation in English. Morphemes are separated by a hyphen. An example adopted from the study of Edmonds-Wathen (2012, p. 216) is as follows:

*Nawu bale kureh right or left? (Kunwinjku)*

nawu  bale  kureh  right  or  left  
DEM   which.way  that.way  right  or  left  
‘Is he on the right or the left?’

5.5 Mathematical performance of control group

The control group answered 20 questions in Experiment 1. The answers of each participant were separated into two columns: correct and incorrect. For example, EC1 scored 12 right answers out of 20 questions (60 percent), whereas EC2 had 14 incorrect responses (30 percent). Out of six participants, two (EC5 and EC6) had an equal number of correct and incorrect answers, constituting of 10:10 ratio (50 percent) respectively. EC3 responded to 11 answers (55 percent) correctly, while EC4 had 11 incorrect answers. The following column graph presents the mean of correct and incorrect answers.
The figure shows that the mean for correct answers of six participants was 48.333. The results indicate the mean of incorrect answers (51.666) significantly differs from the mean of correct answers with an equal standard deviation (SD) of 10.327.

5.6 Mathematical performance of experimental group

Experiment 2 was designed to investigate Kunwinjku students' mathematical performance. To address the research question on whether the use of Kunwinjku as the language of instruction would be helpful in improving Kunwinjku students’ mathematics performance, this experiment was split into two sessions. The aim of the first session was to examine Kunwinjku pupils’ mathematics performance in English, while the second session aimed to examine the effects of Kunwinjku instruction on their mathematics learning. The results from this test were interpreted as follows.
5.6.1 Kunwinjku students’ mathematics performance in English (Session I of Experiment 2)

Six Kunwinjku students participated in Session I of Experiment 2. Due to the lack of availability of all participants at the same time, the test was conducted on two different days with four pupils participating on day one and the other two another day. English was the language of instruction in this first round of the test. In the data spreadsheet, the responses of each participant were recorded and coded (like in Table 5, see above). To calculate all the responses mathematically, they were separated as ‘correct answers’ and ‘incorrect answers’ (see Table 7) and the totals calculated. For example, KC 1, 2, 4 and 6 scored an equal number of right answers, consisting of 6 (30 percent), out of 20 questions. KC 3 and 5 responded correctly to 4 (20 percent) and 3 (15 percent) questions respectively. The table below shows that all the participants scored 30 percent or less. This indicates students’ lower levels of achievement of English as the medium of instruction on learning mathematics lessons.

<table>
<thead>
<tr>
<th>Number of Participants</th>
<th>Pseudonym</th>
<th>Correct Answers</th>
<th>Incorrect Answers</th>
<th>Total Questions</th>
<th>Performance in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>KC1</td>
<td>6</td>
<td>14</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td>2</td>
<td>KC2</td>
<td>6</td>
<td>14</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td>3</td>
<td>KC3</td>
<td>4</td>
<td>16</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>4</td>
<td>KC4</td>
<td>6</td>
<td>14</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td>5</td>
<td>KC5</td>
<td>3</td>
<td>17</td>
<td>20</td>
<td>15</td>
</tr>
<tr>
<td>6</td>
<td>KC6</td>
<td>6</td>
<td>14</td>
<td>20</td>
<td>30</td>
</tr>
</tbody>
</table>

Table 7: Kunwinjku students’ scores in English

5.6.2 Kunwinjku students’ mathematics performance in English after Kunwinjku instruction

In Session II, undertaken with the same sample group from Session I, the main difference was the medium of language. In this session, all pupils had to perform in English after receiving instruction in their home language, Kunwinjku. There was a 30 minute time interval between the first and second session of the test. All the data elicited from this test were recorded in the same manner as the first session. In this session, two pupils achieved 55 percent (11 out of 20) in total and two
pupils scored 45 percent. The lowest mark (i.e. 15 percent) was achieved by one participant. The following bar chart compares the scores obtained by each participant in Sessions I and II of Experiment 2.

![Kunwinjku Pupils' Scores in Mathematical Achievement Test Before and After Receiving Kunwinjku Instruction](image)

**Figure 8: Comparison of scores (Out of 20 Marks) obtained in first and second Session of Experiment 2**

The column graph above shows some improvement in the scores of five children in the second session of the test as compared to their scores achieved in the first session. Before getting Kunwinjku instruction, all the participants scored less than 40 percent marks on average. 66 percent (4 out 6) of students answered 30 percent (6 out of 20 questions) correctly. The other two participants achieved 20 and 15 percent respectively. But all the students, except one (83 percent), performed better after Kunwinjku instruction. The scores achieved after Kunwinjku instruction were significantly higher than that of the scores achieved before the Kunwinjku instruction (i.e., increased from 15 to 55 percent). The results indicate that the use of home language as the medium of teaching can have positive impacts on improving mathematics lessons in the primary level of education.
5.6.3 Comparing scores achieved by Kunwinjku students before and after getting Kunwinjku medium instruction: The dependent one-tailed (paired sample) t-test

The improvement in students’ scores after Kunwinjku instruction, as presented in Figure 7, is confirmed by the dependent one-tailed t-test, an appropriate test of statistical analysis. The rationale behind selecting this statistical analysis tool was that it relates an observation in one group to the observation in another group (Levshina, 2015). Though the observations in Experiment 2 came from the same sample group, they were paired. For example, each participant had two scores achieved from two sessions of the experiment, where the same stimuli were employed. There is a connection between the scores achieved in both sessions of the experiment. By using this test method, the mean of the pretest scores (Session I of Experiment 2) was compared with the mean of the posttest scores (Session II of Experiment 2) to assess if any differences occurred. The test scores achieved from Sessions I and II of Experiment 2 (i.e., measurement of the effects of English medium instruction on mathematics lessons before and after Kunwinjku instruction) represent the pretest and posttest.

To analyse the data statistically, first of all, I developed the null and alternative hypotheses. The alternative hypothesis was directional because it helped to investigate whether Kunwinjku instruction improved Kunwinjku students’ mathematics performance in comparison to English instruction. The alternative hypothesis was that the Kunwinjku effect mean was significantly greater than the English effect mean. The null hypothesis for the study was that there would be no difference between Kunwinjku mean effect and English mean effect on improving Kunwinjku students’ mathematical learning.

Each student’s scores were taken and recorded in two data frames. The observations are represented by the row names. Each dataset contains two variables. The first variable specifies the total number of correct scores achieved by each participant in the Animals in a Row matching task in the first session of
Experiment 2. The second column represents the total scores achieved by each participant in the second session of Experiment 2. The experiment was influenced by two types of variables: dependent and independent. The language of instruction was the dependent variable in the test. The variables such as students’ interest, age, memory power, etc. were the independent variables in this test that influenced the outcomes of the test. Table 8 shows the data frames used for conducting statistical analysis in the present study.

Table 8: Data frames used in the Sessions I and II of Experiment 2

<table>
<thead>
<tr>
<th>Observers</th>
<th>Variable1 (Students’ Scores before Kunwinjku Instruction)</th>
<th>Variable2 (Students’ Scores after Kunwinjku Instruction)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>3</td>
<td>11</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>11</td>
</tr>
</tbody>
</table>

The subsequent interpretation shows the summary of the statistical analysis, as depicted in Table 9.

Table 9: differences between pretest scores mean and posttest scores mean

<table>
<thead>
<tr>
<th>t-Test: Paired Two Sample for Means</th>
<th>Scores Before Kunwinjku Instruction</th>
<th>Scores After Kunwinjku Instruction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>5.167</td>
<td>8.167</td>
</tr>
<tr>
<td>Variance</td>
<td>1.767</td>
<td>9.767</td>
</tr>
<tr>
<td>Observations</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Pearson Correlation</td>
<td>-0.201</td>
<td></td>
</tr>
<tr>
<td>Hypothesized Mean Difference</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>df</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>t Stat</td>
<td>-2.026</td>
<td></td>
</tr>
<tr>
<td>P(T&lt;=t) one-tail</td>
<td>0.049520676</td>
<td></td>
</tr>
<tr>
<td>t Critical one-tail</td>
<td>2.016048373</td>
<td></td>
</tr>
<tr>
<td>P(T&lt;=t) two-tail</td>
<td>0.099041352</td>
<td></td>
</tr>
<tr>
<td>t Critical two-tail</td>
<td>2.570581836</td>
<td></td>
</tr>
</tbody>
</table>

A dependent one t-tailed paired sample t-test was conducted to compare the effects of Kunwinjku and English medium instruction on mathematics learning. There was a significant difference in the means for Kunwinjku effect ($\mu_1 = 8.167$) and English effect ($\mu_2 = 5.167$). This result does not support the null hypothesis because the Kunwinjku effect mean is higher than the English effect mean, which is significantly different. This result suggests that when children are taught in their
home language as the *medium of instruction*, their achievement in learning mathematics improves. This suggests using Kunwinjku rather than English as *the medium of instruction* helps to improve mathematical learning outcomes. Table 9 also shows a *t-distribution* that has five degrees of freedom(*df*), which corresponds to a sample size of six, with a critical value (t-value) of 2.015.

Table 10 below summarises how the mean of difference was computed. The analysis shows that the difference of mean (µd = 4) was greater than 0. This means there was no difference between µ1(Kunwinjku effect mean) and µ2 (English effect mean), i.e., the mean of difference (µd) is of 0 value. On average, the effects of Kunwinjku on mathematical improvements triggered a significantly higher number of associations of µd = 4, SE = 4.242, t-value = 2.015. The p-value (0.049) is slightly smaller than the alpha (0.05 or 0.01).

This shows that the result not being due to chance. Therefore, the alternative hypothesis that Kunwinjku medium instruction facilitates Kunwinjku students in improving mathematics performance is upheld through statistical analysis. It is therefore proposed that primary school students learn mathematical concepts better when they are taught with their home language alongside English.

Table 10: Mean difference and standard deviation

<table>
<thead>
<tr>
<th>Observations</th>
<th>Before Kunwinjku Instruction</th>
<th>After Kunwinjku Instruction</th>
<th>Difference (Score After-Before Instruction)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>6</td>
<td>3</td>
<td>-3</td>
</tr>
<tr>
<td>5</td>
<td>3</td>
<td>11</td>
<td>8</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>11</td>
<td>8</td>
</tr>
</tbody>
</table>

Mean of Difference (µd) 4
Sample Standard Deviation(SE) 4.242640687
Number (n) 6
Degrees of freedom (df) 5
5.6.4 Comparison between the results of Experiment 1 and Experiment 2

The effects of *home language medium instruction* on mathematics lessons are also presented in the Table 11 below. Both experiments where home language was used as the *medium of instruction* had higher means with higher standard deviation (e.g., $M = 48.333$, $SD = 10.327$ in Experiment 1; $M = 37.5$, $SD = 12.55$ in Experiment 2 *After* Kunwinjku Instruction). The results show that *home language medium instruction* helps students in improving their mathematics performance significantly because the Kunwinjku pupils, after being instructed in their home language, improved their performance and performed similar to English monolingual students did in Experiment 1.

<table>
<thead>
<tr>
<th>Observations</th>
<th>Control Group’s Scores (Experiment 1) %</th>
<th>Experimental Group’s Scores (Experiment 2) %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before Instruction</td>
<td>After Instruction</td>
</tr>
<tr>
<td>60</td>
<td>30</td>
<td>45</td>
</tr>
<tr>
<td>30</td>
<td>30</td>
<td>45</td>
</tr>
<tr>
<td>55</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td>45</td>
<td>30</td>
<td>15</td>
</tr>
<tr>
<td>50</td>
<td>15</td>
<td>45</td>
</tr>
<tr>
<td>50</td>
<td>30</td>
<td>45</td>
</tr>
<tr>
<td>Number (n)</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Mean (M)</td>
<td>48.333</td>
<td>25.833</td>
</tr>
<tr>
<td>Standard Deviation (SD)</td>
<td>10.327</td>
<td>6.645</td>
</tr>
</tbody>
</table>

*Table 11: Mean comparison between control group and experimental group*

5.6.5 Kunwinjku students’ performance on mathematical concepts corresponding to ordinality and spatial skills

20 different basic mathematical questions were asked verbally in the test. These questions (see Appendix 1) included different sorts of mathematical vocabulary corresponding to ordinality and spatial skills (see Table 4). The following Table 12 summarises Kunwinjku pupils’ performance on understanding them in English *before* and *after* receiving Kunwinjku instruction.
Table 12: Total number of correct and incorrect answers relating to mathematical vocabulary used in 20 questions

Table 12 shows that none of the participants (n = 6) answered those questions correctly which included the concepts of ‘before’ and ‘after’ in the first session of Experiment 2. Similarly, more than 83 percent (5 out of 6) of participants responded to the questions of ‘last’ and ‘front’ incorrectly before being instructed in Kunwinjku. This number decreased by 16 percent and came to 66 percent (2 out of 6) in the second session of the test. The results indicate the significant positive influence of using home language medium instruction in understanding the concepts of number ordering and spatial orientation skills.

5.7 Conclusion

The interpretation and analysis of data gathered from both experiments produced data that support the effectiveness of using home language as the medium of instruction to improve primary school students’ mathematical learning. In Experiment 1, the majority of participants answered more than 50 percent of questions correctly. As compared to the performance demonstrated in English medium instruction, the performance of Kunwinjku students significantly improved
in the task when they were instructed in Kunwinjku and English simultaneously. More than 95 percent of participants improved their results in the task after receiving instruction in their home language. The statistical analysis provides sufficient evidence to suggest that the Kunwinjku effect mean ($\mu = 9.666$) is greater than English effect mean ($\mu = 5.167$) on improving students’ mathematics learning outcomes. Other evidence is that the p-value ($p = 0.049$) is less than the alpha (0.5); this proves that the improvement in the second session of the test was not by chance. This result infers that primary students perform better in mathematics class when the medium of language (English) is accompanied with their home language. Chapter Six details the results of the tests, presents the major findings of the research and proposes future recommendations.
Chapter Six
Findings, discussion and recommendations

This study was driven by the assumption that primary school pupils could perform better in mathematics when they were instructed in their home language. The study thus aimed to examine the effects of Kunwinjku as the medium of instruction on improving Kunwinjku pupils’ mathematical learning performance. The Animals in a Row matching task was designed to determine whether the use of Kunwinjku as the language of instruction would improve mathematical learning outcomes effectively. The results of the study establish that primary level students perform better in mathematics lesson when they are instructed in their home language. This final chapter elaborates some of the major findings of the study, discusses their implications and limitations, and recommends avenues for further research from the study.

6.1 Major findings from Experiment 1

The main aims of Experiment 1 with the control group were (i) to investigate whether the Animals in a Row matching task would be a suitable tool for testing students’ mathematical achievement and (ii) to establish a baseline for Experiment 2. The results of Experiment 2 indicate that home language has a pivotal positive influence on students' learning mathematics more effectively. In Experiment 1, the majority of the participants (4 out of 6) achieved marks of 50 percent and above, while only one student stayed at 30 percent. The results also showed that the difficulty level of questions was high because the mean of incorrect answers (51.666) was higher than the mean of correct answers (48.333). No participant answered all questions relating to the made conceptual understanding of ordinality such as ‘first’, ‘second’, ‘third’, ‘fourth’, ‘after’ and ‘before’ correctly. In English, the number rank order follows each other; a lower or smaller and a higher or greater number come ‘before’ and ‘after’ respectively. However, in the Animals in a Row matching task, participants had to identify the number ranking by identifying the standing position of animals in a line. Participants had to use the knowledge of
spatial frame of reference, such as ‘left’, ‘right’, ‘in front’, and ‘behind’, to identify the correct order of the animal’s position in the row. Both the mathematical concept and language of instruction were based on the participants’ cultural background. But they failed to answer the questions relating to spatial thoughts correctly. This finding shows that better performance in mathematics in primary level education is not only affected by the medium of language but also determined by other variables such as cognitive level, age and family backgrounds of the students.

6.2 Main findings from Experiment 2

In the first session of Experiment 2 (Session in English before Kunwinjku instruction), none of the participants (n = 6) answered all questions relating to the concepts of ‘before’ and ‘after’ correctly. The effects of cultural differences where the concept of number ordering in Kunwinjku differs from that of English may contribute to this result. In English the concept of ‘before’ and ‘after’ is linked to the numbers in line where a number ‘after’ refers to ‘higher or greater’ and a number ‘before’ refers to ‘lower or smaller’. In Kunwinjku, they are linked to the height and size but in the inverse relation (Edmonds-Wathen, 2012). For example, a taller tree comes ‘before’ the smaller tree. The study found that all the participants comparatively performed better in the tasks relating to ‘in front’ and ‘behind’. For instance, on average, two students responded to the task of ordinality correctly, while four answered correctly for the tasks relating to spatial orientation. The results showed that the use of English medium instruction was not beneficial for Kunwinjku students while learning number ordering skills.

The findings also indicate that Kunwinjku students had difficulty in understanding the conceptual meaning of ‘in front’ and ‘behind’ in English because these terms are used intrinsically in English (Edmonds-Wathen, 2012). In Kunwinjku, the terms ‘in front’ and ‘behind/back’ are used in both relative and intrinsic frames of reference. Edmonds-Wathen (2012, p. 220) presents the following figure (See Figure 9) to describe how the terms ‘front’ and ‘behind/back’ are used both
relatively and intrinsically. In exemplifying it, Edmonds-Wathen further presented these two sentences “The man is back and the tree is front” and “A person behind a tree is facing towards me” which were used by Kunwinjku children in her study. In these sentences, children have used relative and intrinsic frames of reference ambiguously. As the conceptual understanding of spatial frame of reference differs culturally, there are differences between Kunwinjku and English spatial language. This highlights how the language of instruction influences students’ performance. Therefore, in the first session of the test, all the participants scored relatively lower marks from the problems relating to references of spatial orientation than in the second session of the test. On average, there were 16 correct responses for ‘in front’ and ‘behind’ in English medium instruction. In the second session, delivered in Kunwinjku, it was 33.

Figure 9: Tree and Man Task (Source: Edmonds-Wathen, 2012, p. 112)

6.3 Findings from observations

The behaviour of the participants in the Animals in a Row matching task was also observed as the part of qualitative data for the study. In Experiment 1, none of the participants were observed to be bored, distracted and inactive in the test. Even when the Animals in a Row ordering task was new to them, they engaged fully throughout the test, ran up to 45 minutes. This is an extended period of time to concentrate continuously. During the test, most of the participants asked the Director (Teacher) to repeat the instruction of the task and performed it enthusiastically. Even after the test, some participants were found to be matching the task cards and asked the Director to play again. This indicates the students’ excitement and motivation in the task. I posit this outcome was from the use of
home language medium teaching and the implication of mathematical concepts based on the students’ culture.

However, in the first session of Experiment 2, I observed that almost all participants were less motivated to accomplish the task. They were yawning, looking around and easily distracted from concentrating on the task. It was also noticed that they were not motivated and were asking the Director when the test would finish. I propose two reasons for this behaviour. The first is the use of English language as the medium of teaching. The second is that the mathematical concepts were not drawn from their home culture. My observations in the first session suggest that teaching mathematical concepts that are adopted from a new culture and in a language other than their home language does not facilitate children’s understanding, thus making them disinterested and disengaged with their learning. This result ties in with the literature reviewed in Chapter Two (see 2.3.2).

In the second session of the test, all Kunwinjku students’ behaviour changed. They were observed to be happy and interested in the task. None of them asked when the test would finish. Everyone was laughing and actively participating in the task. I propose this is an effect of the home language instruction that facilitated their understandings of the mathematical tasks being asked in the test. As observed in Chapters Two and Three, the impact of home language in children’s learning bridges the gap to learning difficulty, as it helps the learners to transfer their culturally endowed knowledge into their new field of learning.

6.4 Discussion

The findings from the two experiments of the present study suggest that by receiving instruction in their home language, the primary level students were able to improve their results in the mathematics tasks. Previous research has found that children of primary schooling perform better in classroom when they are taught in their home language (Benson, 2004; Waters 2001; Ramirez et al, 1991).
But it was unknown whether they were able to achieve better results in an English-medium teaching task after getting instruction in their first language. This addresses an important question, namely whether learning and testing performance of new knowledge in the dominant language (English) and after in a child’s home language instruction leads to improvement in learning performance. The findings are in accord with and extend previous research on the effects of home language instruction on students’ improvement of mathematical outcomes; they show that home language instruction motivates children in learning, and helps them to relate their prior knowledge into the new one so that the gap between the conceptual understandings of new and prior knowledge is narrowed.

Issues arise, however, when children who are taught in their home language and perform better in mathematics are taught and tested in English. In Chapters Two and Three, I noted the advantages of being instructed in home language are primarily observed in two areas. The first benefit is the reduction of cognitive load caused by learning a new knowledge in a dominant language of instruction. If the new knowledge is not supported by the medium of instruction, learning becomes monotonous and may adversely affect outcomes. The second benefit is to develop self-esteem in children that, in turn, increases children’s interest in learning. Here, I suggest that instructing primary school pupils in English along with their home language can effectively bridge the gap to reduce learning difficulty in mathematics. Learning mathematical concepts in primary school is challenging for every child, especially when they are taught in a language they are unfamiliar with. In the Australian education system where both language of instruction and mathematical concepts are adopted from the dominant cultural background to that of the learners, no substantial achievement can be obtained.

The study also examined the effect of home language instruction on learning number ordering with the combination of spatial skill knowledge. For example, in the question ‘Which animal is standing in first position behind the horse?’ (see Appendix 1, CS), the concept of ‘first’ and ‘behind’ are associated together. Here, the participants had to use their conceptual understanding of ‘behind’ to identify
the ‘first’ position of the animal in the line. I have borrowed the term “spatially grounded ordinality” (p. 265) from the study of Cheung and Lourenco (2015) to refer to both the spatial and number ordering concepts that were tested from the same question in the experiment. The results of the present study suggest that both ordinality and spatial orientation such as ‘front’, ‘behind’, ‘left’ and ‘right’ have their own cultural understanding, and are understood better when they are taught in the home language. I found that children of an Indigenous group (Kunwinjku) performed better in learning the ordinality and spatial skills in English only after being instructed in their home language (for example, 32 responses were correct in the test after receiving instruction in Kunwinjku which was double the correct responses made before Kunwinjku instruction). This study highlights the effectiveness of incorporating students’ cultural experiences in mathematics for enhancing performance.

In the present study, I evaluated the impact of Kunwinjku medium instruction on learning mathematics by applying a design within-subject design where two scores of the same group were analysed statistically. The dependent one sample paired t-test was used to compare the sample group’s scores. The findings showed a positive impact of home language medium instruction on improving primary level students’ performance in mathematics. In the pretest, before Kunwinjku instruction was employed, students’ scores were recorded lower (35 percent) than the average mark. But, more than 80 percent of participants (5 out of 6) increased their marks by 15 percent after receiving Kunwinjku instruction, increasing from 30 to 55 percent. Moreover, the ratings of correct answers for the problems corresponding to ‘first’, ‘second’, ‘behind’, and ‘in front’ were higher after Kunwinjku instruction. And these differences are statistically significant. This suggests that pupils whose home language is used along with the medium of English can help to facilitate substantial gains in primary school children’s mathematics education. This result is in line with previous cross-linguistic comparative studies revealing the influence of home language on learning mathematics (e.g., Chichewa vs. English speakers in (Kaphesi (2001))). Thus, from the findings of both experiments it can be concluded that home language medium
instruction promotes more effective learning of mathematics than of English language medium instruction.

6.5 Significance

The investigation of the effect of the home language as the medium of instruction in primary school mathematics education shows the significance of how a child’s home language can help to bridge cultural gaps in learning mathematical tasks. To my best knowledge, this is the first study to apply Kunwinjku instruction to learn mathematical concepts such as ordinality and spatial language in the dominant English medium education system in this Indigenous community. The poor performance of Indigenous pupils in mathematical achievement tests in Australia and around the world has been the main result of English medium teaching because learning mathematics in English differs from Indigenous cultures. This research strongly suggests that when the language of instruction does not support children’s cultural backgrounds, i.e. delivered in English, learning mathematics remains difficulty as it creates extraneous cognitive load.

The sample group’s performance in the experimental test showed that the concepts of ‘before’, ‘after’, ‘front’ and ‘behind’ in mathematics learning can be taught effectively if they are explained in the students’ home language. This finding concords with the significance of culturally responsive mathematics education (Edmonds-Wathen, 2012) in which both a child’s home language and cultural experience have a dominant role. The findings of this study suggest that learning in the classroom, for example, mathematics needs to be carried out in a child’s home language in order to achieve better outcomes. Using their own home language children develop a connection between new and prior knowledge so that learning can be easy and leads to better results. Therefore, this study contributes to the body of knowledge related to home language based bi/multilingual education programmes. The project is also significant for Australian Aboriginal Indigenous children’s education, especially in mathematics because it shows that
Indigenous students perform better in their class when they are instructed in English along with their home language.

This research is an experimental study that can be taken as a model of a cross-linguistic comparative study on the effectiveness of language of instruction on mathematics education. It can help teachers to understand the role of students' first language and cultures better, and be more responsive in their teaching. I hope that the findings reported in this thesis will contribute to improving mathematics education for the students of Minjilang, Indigenous language speaking students across Australia, and other students in cross-cultural and multilingual learning environments. I believe that in having multi-fold significance in terms of different aspects, this study performs a positive and interventionist contribution in implementing children’s home language as the medium of instruction. Finally, this research has emphasised the positive role of home language in classroom learning, especially to Kunwinjku students.

6.6 Implications and recommendations

The findings from this study have implications for mathematics education and may inform recommendations at teacher training and Department of Education level. The recommendations from the study are as follows:

Teachers should be aware that home language medium instruction is more effective in learning mathematics, as it helps the students to conceptualise the concepts in their language through which their cultural and home experiences can be brought into the classroom learning. Teachers should be aware that teaching the concepts of ordinality such as ‘before’ and ‘after’ and spatial concepts like ‘front’, ‘behind’, ‘left’ and ‘right’ are made more comprehensive when they instruct their students in their home language because the way of learning these mathematical concepts, for instance, in English differs in Kunwinjku.
To improve Indigenous children’s mathematical outcomes, the NT schools should employ a culturally responsive education system that includes a home language medium based bilingual programmes. Well-trained Indigenous teachers who have knowledge in Indigenous culture should be assigned to teach mathematics to Indigenous students. This study tested the hypothesis that indigenous children would learn mathematics effectively when taught in their home language. However, the study did not include a large sample population and the period of time between the tests before and after receiving Kunwinkju instruction was short. Due to the low number of Kunwinjku speaking children in the region, there was no control group from the same population group. Further research is thus warranted in a larger population that will accommodate two sample groups.

This investigation on the effect of home language on teaching mathematical concepts such as ordinality skills and spatial task could be extended to investigate factors such as the stage of spatial development, age of the students, the linguistic competence of Kunwinjku and the sequences of spatial language development and spatial thinking in Kunwinjku and English. More information on these facets will contribute to a better understanding of how to facilitate the mathematical learning of Kunwinjku students who are currently taught in English medium.

6.7 Limitations

This study had some constraints. One of them was my own inability to speak and understand Kunwinjku. To administer the Animals in a Row matching task, I needed a fluent speaker in Kunwinjku. My interaction with Kunwinjku students was thus very limited throughout the sessions. I tried to monitor the session by communicating in English with Ms. Wauchope who was assigned to conduct the test. My inability to make the participants understand clearly about the procedures of the test was one of the major drawbacks of this study. Another limitation of the study was the small size population \( n = 6 \). Although the study was successful in testing both the alternative and null hypotheses, there was insufficient data to analyse other variables such as participants’ linguistic competence in English and
Kunwinjku. A further limitation of the study was that it was not conducted in authentic classroom setting. Therefore, Experiment 2 was conducted out of school premises in which students’ performance might have been affected by the external environment.

6.8 Conclusion

This chapter has presented the main findings of the study, highlighting the significance of home language medium instruction in primary students’ classroom learning in mathematics. In particular, the results show how a child’s home language contributed to improving the mathematics performance of six primary school children. In sum, I used a one sample paired t-test that showed the Kunwinjku effect mean was greater than the English effect mean on learning mathematics. This evidence suggests a strong interconnection between home language and mathematics learning. In the experiment, I observed that children seemed to be more motivated in their interactions delivered in Kunwinjku than when they were delivered in English. Findings from the experiments suggest that primary students should have a better understanding to the medium of instruction and the culture embedded in it in order to enhance their mathematical performance. The effect of home language is especially strong when primary school aged children experience problems with learning ordinality and spatial language, as these concepts are better understood when a child’s culture and language are brought into learning.
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Glossary

Absolute

An absolute frame of reference involves the location of the figure in relation to a fixed direction or landmark. In the absolute frame of reference, a coordinate system is used in which the main axes are placed within the larger environment. For example, *The house is to the south of the tree.*

Australian language/Indigenous language

An Australian language has its own origin in Australia which belongs to Australian language family. It is spoken by the Indigenous peoples of Australia. The languages spoken by Australian Indigenous peoples are called Indigenous languages in the field of education in Australia. In this study, the term *Australian Indigenous language* is preferably used.

Bilingualism

In a general sense, bilingualism is considered as having some ability to use two or more languages. It is the use of at least two languages by an individual, however, the level of proficiency in both languages may vary. In this project, I have used the term *bilingual education programme* to refer to the education system where a child’s home language and any other dominant language are used as the *language of instruction.*

Bilingual speaker

An individual who uses or is able to speak two languages having an equal or nearly equal proficiency in both languages. I have used *bilingual speaker* in the thesis as the speaker who has a native proficiency in one language and is acquiring proficiency in the other.

Capitalisation of Indigenous

To follow the convention of using the proper noun, *Indigenous,* to describe Aboriginal and Torres Strait Island peoples and their languages, I have used the
capitalisation of Indigenous. However, to describe indigenous peoples or their languages in general, no capital form is used.

*Diglossia*

A type of language situation in which two different “related or unrelated” languages or varieties of a language are used to perform distinct functions in all the domains of daily lives (Ferguson, 1996, p. 53).

*Diglossic community*

A community in which a particular language or a variety of a language is used as the prestigious language or variety which becomes the language of communication in media, education, health and administration, and other languages or varieties have less prestigious status and used in home and local environment.

*Early Years*

The Transitional to Year 2 is called the early years of school in the NT, Australia. There should not be confusion with the early years of life which may refer to ages 0-4 years.

*ESL*

In this thesis, ESL is used as English as a Second Language which is more widely used term in the NT education practice. However, many NT Indigenous students learn English as a third, fourth or fifth language and they are technically called as English as an Additional Language (EAL) learners.

*Facing*

In the example of Man and Tree Task (See Chapter 6, p. 69), facing refers to the direction in which the man is facing towards tree, and it can refer any use of frame of reference.

*Figure*

A potentially moveable object with respect to the ground (Talmy, 1983).
Ground

A reference object with respect to which the figure is located (Talmy, 1983).

Home language

The main language that a child first learns to speak fluently is called *home language*. Edmonds-Wathen (2012) has used it as the alternative term for *native language, mother tongue or first language*.

Home language based education

Education which uses a child’s mother tongue in the classroom as the *medium of instruction*.

Indigenous language speaker

An Indigenous Australian who speaks one or more Australian languages but does not include the person who is non-Indigenous speaker of Australian languages.

Indo-European

In the thesis I have used *Indo-European* as a language family which includes most European languages and the Indo-Iranian languages such as Hindi and Persian.

Intrinsic

In the intrinsic frame of reference, the location of the figure is described in relation to a part or facet of the ground. For example, *The book is at the handle of the cup*.

Instruction/Medium of Instruction/Language of Instruction

A language determined officially as the main language in which most or all teaching and learning activities in education are conducted. In this thesis, the terms *medium of instruction* and *language of instruction* are used interchangeably.

Monolingualism

Monolingualism is the use of only one language, either by an individual speaker or by a community of speakers for communication. In this study, I have used the terms *monolingual speaker, monolingual education* and *monolingual community*
to refer to the use of only a single language in education or all domains of daily life.

*Mother tongue*

The main language acquired in a child’s early years that becomes his/her natural instrument of thoughts and communication. In this thesis, I have used this as a *first language* or *home language*.

*Mother tongue based education*

Education which uses, or is based on, a child’s mother tongue, in the classroom as the *language of instruction*.

*Multilingualism*

Multilingualism is the use of more than two languages, either by an individual speaker or by a community of speakers for communication. In this study, I have used the terms *multilingual speaker*, *multilingual education* and *multilingual community* to refer to the use of more than two different languages in education or all domains of daily life.

*Relative*

A relative frame of reference describes the axes with respect to the viewer’s own body. For example, *The pen is to the left of the cup*.

*Remote*

In the thesis, I have used the term remote to refer to communities which are classified very remote according to the Australian Standard Geographical Classification used by the Australian Bureau of Statistics.

*Vernacular language*

In this study I have used vernacular language as a native language or native dialect of a specific population of indigenous peoples, especially as distinguished from the standard language or a variety of language.
Appendices

Appendix 1

Questionnaire (in English)

(1) In this poster card/CA, which animal is standing in first position/place in the animal row?
(2) In the card CB, name the animal standing in first place/position of animal row?
(3) In the card CC, which animal is standing in last place of animal row?
(4) In card CD, show the animal standing in second position after the ‘horse’?
(5) In card CE, name the animal standing between dog and kangaroo?
(6) To which animal does the card CF show standing in front of pig?
(7) In this card /CG, which animal is standing in first place after horse?
(8) In the card CH, which animal is standing in fourth position after ‘pig’?
(9) Name the animal which is standing behind the kangaroo in card CI.
(10) In card CJ, which animal is standing in front of pig?
(11) In card CK, which animal is standing in third position before kangaroo?
(12) In card CL, which animal is standing in second position after cow?
(13) In card CM, which animal is standing in last position behind cow?
(14) In card CN which animal is standing in second position before pig and after dog.
(15) In card CO which animal is standing behind pig.
(16) Name the animal standing in the second position behind kangaroo in the card CP.
(17) Name the animal which is standing in the right of dog in card CQ.
(18) In card CR, which animal comes in fourth position before horse?
(19) In card CS, name animal which is standing in first position behind horse.
(20) In card CT, show the animal which is standing in front of dog and the left to horse.
Appendix 2

Answer Key

(A-1)

<table>
<thead>
<tr>
<th>Q. N. 1</th>
<th>CA</th>
<th>Dog</th>
<th>Q. N. 11</th>
<th>CK</th>
<th>Horse</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q. N. 2</td>
<td>CB</td>
<td>Horse</td>
<td>Q. N. 12</td>
<td>CL</td>
<td>Pig</td>
</tr>
<tr>
<td>Q. N. 3</td>
<td>CC</td>
<td>Cow</td>
<td>Q. N. 13</td>
<td>CM</td>
<td>Dog</td>
</tr>
<tr>
<td>Q. N. 4</td>
<td>CD</td>
<td>Dog</td>
<td>Q. N. 14</td>
<td>CN</td>
<td>Kangaroo</td>
</tr>
<tr>
<td>Q. N. 5</td>
<td>CE</td>
<td>Pig</td>
<td>Q. N. 15</td>
<td>CO</td>
<td>Kangaroo</td>
</tr>
<tr>
<td>Q. N. 6</td>
<td>CF</td>
<td>Horse</td>
<td>Q. N. 16</td>
<td>CP</td>
<td>Cow</td>
</tr>
<tr>
<td>Q. N. 7</td>
<td>CG</td>
<td>Dog</td>
<td>Q. N. 17</td>
<td>CQ</td>
<td>Pig</td>
</tr>
<tr>
<td>Q. N. 8</td>
<td>CH</td>
<td>Dog</td>
<td>Q. N. 18</td>
<td>CR</td>
<td>Kangaroo</td>
</tr>
<tr>
<td>Q. N. 9</td>
<td>CI</td>
<td>Cow</td>
<td>Q. N. 19</td>
<td>CS</td>
<td>Dog</td>
</tr>
<tr>
<td>Q. N. 10</td>
<td>CJ</td>
<td>Dog</td>
<td>Q. N. 20</td>
<td>CT</td>
<td>Cow</td>
</tr>
</tbody>
</table>
Appendix 3

Animals in a Row Matching Task Transcription (Example)

file:///private/var/folders/g6/hb5x3h8j4xqfhhh9rj5449br0000gp/T/com.microsoft.Outlook/Outlook Temp/GSMRes Kunwinjku session 20171120_AS.eaf
Montag, 29. Mai 2017 23:39

Metadata
Recorded 20 November 2016 in Minjilang community (next to house nr. 1). Participants; consultant: Heleana Wauchope; linguists: Gopal Singh Sijapati, Robert Mailhammer, equipment: iPad running FilmicPro; iRig preamp; Sennheiser Wireless DC10 with Countryman omnidirectional lapel microphone on Heleana

Transcription
mah wurdurd, karri-dirri wanjh; (???) mah ngarri-na nane bim ngan-bukkan; namekke mayh nakkanj kah-di kure darnkih; korroko karri-nang

Translation
ok children, so we'll play; {??}; ok we're looking at this picture; he's showing it to me; these animals they're here nearby; we saw them before

Transcription
yi-na naneh; namekke mayh kah-di darnkih; {kah-}nnnnnnkah-di kumekke korroko; darnkih kureh mayh

Translation
look at this; this animal is nearby; it was there before; near the animal

Transcription
yi-na nakka; mayh-kah kah-di; darnkih kureh; korroko kure djarrang; kan-bekka

Translation
look at this; there is an animal; it's nearby; previously it was the horse; show me

Transcription
mayh kureh dar [um]; kan-bukkan kumekke darnkih [uh]; darnkih kah-di kureh bikibiki; yi-nan kureh darn... 

Translation
this animal; show me the animal near; it's standing near that pig; it's standing in the middle towards the pig

Transcription
mayh yi-na na-mekkeh; yi-ngeybu namekke mayh kureh darnkih kah-di kun-bod; kureh kunj yi-na kureh konj.. kunj

Translation
look at this animal; you name this animal that is standing near the fly; there's the wallaby, you see, the wallaby

Transcription
yi-na nakka; nakka kah-di darnkih kureh kunj; korroko kureh kunj

Translation
look at this; this one is standing near the wallaby; before the wallaby

Notes
the word for 'south' is used for 'right'
Transcription: yi-na namekke mayh kah-di walem kureh duruk yi-na; walem kureh duruk yi-na

Translation: look at this animal, it is to the right of the dog, see; to the right of the dog, see

Notes: don't understand why kun-bod 'fly' is mentioned here; is it in front of the fly but behind the horse?

Transcription: duruk duruk djarrang djarrang; mah nearly there; yi-neybu namekke mayh kah-di darn(kih) korroko; kure djarrang

Translation: dog dog horse horse; ok nearly there; name that animal which is near and before; the horse

Notes: baleh walem la "what's right and?" is addressed to another adult; the word kabburrdi 'left' should actually be kakbi 'north'

Transcription: yi-neybu namekke mayh; kure korroko kah-di; kun-bod kure Djarrang

Translation: you name that animal; it is there before (in front); the fly towards the horse

Transcription: yi-na nakka mayh kah-di; korroko kureh duruk; baleh walem la?;

Translation: look at this animal it is; before the dog; what's right and?; left of the horse
Appendix 4

Plain Language Statements and Consent Forms

Plain Language Statement – Participants (English Monolingual and Kunwinjku Speakers)

Invitation to participate in a Research Study

Project Title: The effectiveness of home language medium instruction on improving Primary School students’ mathematical performance

Who is involved in the study?

This research study is being carried out by me, Gopal Singh Sijapati. I am an international student of Master of Research at Western Sydney University, Australia. In this project, Dr. Robert Mailhammer, a Senior Lecturer in Linguistics, as my principal supervisor is being involved. This research project has been approved by UWS Human Research Ethics Committee (Approval number H10237).

What will the researcher do?

I want to investigate how home language as the medium of instruction facilitates primary school aged children in learning mathematics. I have been attempting to find out whether primary school children perform better in mathematics tasks after being instructed in their home language. This will help the teachers and bi/multilingual education policy makers design effective bilingual programmes because we will identify the significance of using a child’s language and culture in mathematical learning.

I will ask you to participate in the Animals in a Row matching task, through which their mathematical performance will be tested. You will be asked 20 different mathematical tasks orally. You will answer to the questions by identifying the animals’ order in the row of their different position arrangements. I will take notes, audios and videos of your performance in the task.

What will the researcher do with the information collected from the experiments?

The data elicited from the experiments will be used to write my Master of Research thesis, which focuses on the effectiveness of teaching home language as the medium of instruction on primary school level mathematics. I will have copyright as the authorship. Further, the collected information will be used to write articles for journals and conference papers. None of yours personal information will be used without consent. You will be identified by your pseudonyms. I will not publish your photos and videos without your consent. I will keep all the files including audio and videotapes confidentially in my laptop for 3 years. After that, I will either destroy or hand over them to an appropriate indigenous organisation.
What if I want to withdraw from the study?
You are free to withdraw your participation from the project at any time. This is a voluntary participation. So, you can withdraw your information supplied in any photographs, audios and videos.

How do I know the results of the study?
A hard copy of the thesis will be provided to your local community library and you will be informed to access it. Any form of journal articles, if published, will also be supplied to your local community library.

Benefits of the study project
This research study might help you address your need of using your home language as the medium of instruction in classroom teaching. It might help the government to design appropriate bilingual education programmes in your community.

Risks
You might not want to participate in the experiment. Your parents or school principal and teachers will not force you if you do not like to involve in the experiment.

Questions and complaints
Any questions and complaints regarding the project, you are welcome to contact me, Gopal Singh Sijapati, in person or call me on 0452645694.

NB: Any complaints about your consent to this study may be directed to the presiding member, Western Sydney University Human Research Ethics Committee, Research Engagement, Development and Innovation (REDI), Locked Bag 1797 Penrith NSW 2751 Australia.
Plain Language Statement – Participants’ Parents (Kunwinjku)

Invitation to participate in a Research Study

Project Title: The effectiveness of home language medium instruction on improving Primary School students’ mathematical performance

Who is involved in the project?

This study is being carried by me, Gopal Singh Sijapati. I am an international student of Master of Research at Western Sydney University, Australia. In this project, Dr. Robert Mailhammer, a Senior Lecturer in Linguistics, as my principal supervisor is being involved. This research project has been approved by UWS Human Research Ethics Committee (Approval number H10237).

What will the researcher do?

I want to investigate how home language as the medium of instruction facilitates primary school aged children in learning mathematics. I have been attempting to find out whether primary school children perform better in mathematics tasks after being instructed in their home language. This will help the teachers and bi/multilingual education policy makers design effective bilingual programmes because we will identify the significance of using a child’s language and culture in mathematical learning.

I will ask your child to participate in the Animals in a Row matching task, through which their mathematical performance will be tested. They will be asked 20 different mathematical tasks orally. They will answer to the questions by identifying the animals’ order in the row of their different position arrangements. I will take notes, audios and videos of their performance in the task.

What will the researcher do with the information collected from the experiments?

The data elicited from the experiments will be used to write my Master of Research thesis, which focuses on the effectiveness of teaching home language as the medium of instruction on primary school level mathematics. I will have copyright as the authorship. Further, the collected information will be used to write articles for journals and conference papers. None of the participants’ personal information will be used without consent. All the participants will be identified by their pseudonyms. I will not publish your child’s photos and videos without your consent. I will keep all the files including audio and videotapes confidentially in my laptop for 3 years. After that, I will either destroy or hand over them to an appropriate indigenous organisation.

What if your children want to withdraw from the study?

Your child is free to withdraw their participation from the project at any time. This is a voluntary participation. So, they can withdraw their information supplied in any photographs, audios and videos.
How do I know the results of the study?

A hard copy of the thesis will be provided to your local community library and you will be informed to access it. Any form of journal articles, if published, will also be supplied to your local community library.

Benefits of the Study

This study might help you address your need of using your home language as the medium of instruction in classroom teaching. It might help the government to design appropriate bilingual education programmes in your community.

Risks

Your child might not want to participate in the experiment. If your child gets upset during the experiments, they can stop and talk to you.

Questions and complaints

Any questions and complaints regarding the study, you are welcome to contact me, Gopal Singh Sijapati, in person or call me on 0452645694.

NB: Any complaints about your consent to this study may be directed to the presiding member, Western Sydney University Human Research Ethics Committee, Research Engagement, Development and Innovation (REDI), Locked Bag 1797 Penrith NSW 2751 Australia.
Plain Language Statement – School Principal

Invitation to participate in a Research Study

Project Title: The effectiveness of home language medium instruction on improving Primary School students’ mathematical performance

Who is involved in the project?

This research study is being carried out by me, Gopal Singh Sijapati. I am an international student of Master of Research at Western Sydney University, Australia. In this project, Dr. Robert Mailhammer, a Senior Lecturer in Linguistics, as my principal supervisor is being involved. This research project has been approved by UWS Human Research Ethics Committee (Approval number H10237).

What will the researcher do?

I want to investigate how home language as the medium of instruction facilitates primary school aged children in learning mathematics. I have been attempting to find out whether primary school children perform better in mathematics tasks after being instructed in their home language. This will help the teachers and bi/multilingual education policy makers design effective bilingual programmes because we will identify the significance of using a child’s language and culture in mathematical learning.

I will ask your English monolingual speaking students to participate in the Animals in a Row matching task, through which their mathematical performance will be tested. They will be asked 20 different mathematical tasks orally. They will answer to the questions by identifying the animals’ order in the row of their different position arrangements. I will take notes, audios and videos of their performance in the task.

What will the researcher do with the information collected from the experiments?

The data elicited from the experiments will be used to write my Master of Research thesis, which focuses on the effectiveness of teaching home language as the medium of instruction on primary school level mathematics. I will have copyright as the authorship. Further, the collected information will be used to write articles for journals and conference papers. None of the participants’ personal information will be used without consent. All the participants will be identified by their pseudonyms. I will not publish your student’s photos and videos without your consent. I will keep all the files including audio and videotapes confidentially in my laptop for 3 years. After that, I will either destroy or hand over them to an appropriate indigenous organisation.
What if your students want to withdraw from the study?

Your students are free to withdraw their participation from the project at any time. This is a voluntary participation. So, they can withdraw their information supplied in any photographs, audios and videos.

How do I know the results of the study?

A hard copy of the thesis will be provided to your local community library and you will be informed to access it. Any form of journal articles, if published, will also be supplied to your local community library and you will be informed.

Benefits of the Study

This research study might help to address your students’ need of using their home language as the medium of instruction in classroom teaching. It might help the government to design appropriate bilingual education programmes in your community.

Risks

Your students might not want to participate in the experiment. If your students get upset during the experiment, they can stop and talk to you.

Questions and complaints

Any questions and complaints regarding the project, you are welcome to contact me, Gopal Singh Sijapati, in person or call me on 0452645694.

NB: Any complaints about your consent to this study may be directed to the presiding member, Western Sydney University Human Research Ethics Committee, Research Engagement, Development and Innovation (REDI), Locked Bag 1797 Penrith NSW 2751 Australia.
Consent Form – School Principal

Re: The effectiveness of home language medium instruction on improving Primary School Students’ mathematical performance

1. I consent to my students and teachers in my school being part of the study conducted by Mr. Gopal Singh Sijapati from Western Sydney University. Yes / No

2. I understand that this will involve Gopal conducting a mathematical test on English monolingual pupils from Transitional to Year 4. It will also involve Gopal instructing the students and asking questions. Gopal will record each student’s answer in the data elicitation sheet and take some photographs of these activities. The study will run around 45 minutes. Yes / No

3. I understand that the data will be used for research purposes, for example, to look at whether teaching mathematical basic concepts in home language facilitates more in better understanding or not. Yes / No

4. The name and age of the participants will not be used at all in this study and will be replaced by a pseudonym. I agree that the name of school and principal will be used in the acknowledgement. I understand that as with all research conducted at Western Sydney University, confidentiality will be safeguarded subject to any legal requirements. I know that participation in this study is voluntary and that my students can withdraw from the project at any time. Yes / No

Principal

Name: ___________________________ Date: ____________
Signature: _______________________

Ashfield Public School, Liverpool Rode, Ashfield, NSW, 2131

NB: Any complaints about your consent to this study may be directed to the presiding member, Western Sydney University Human Research Ethics Committee, Research Engagement, Development and Innovation (REDI), Locked Bag 1797 Penrith NSW 2751 Australia.
Consent Form – Parents (Kunwinjku)

Re: The effectiveness of home language medium instruction on improving Primary School Students’ mathematical performance

1. I consent to my child being part of the study conducted by Mr. Gopal Singh Sijapati from Western Sydney University. Yes / No

2. I understand that this will involve Gopal conducting a mathematical test on my child, Kunwinjku native speaker. It will also involve Gopal instructing my child and asking questions. Gopal will record my child’s answer in the data elicitation sheet and take some photographs, audios and videos of these activities. The study will run around 120 minutes. Yes / No

3. I understand that the data will be used for research purposes, for example, to look at whether teaching mathematical basic concepts in home language facilitates more in better understanding or not. Yes / No

4. The name and age of my child will not be used in this study and will be replaced by a code. I understand that as with all research conducted at Western Sydney University, confidentiality will be safeguarded subject to any legal requirements. I know that participation in this study is voluntary and that my child can withdraw from the project at any time. Yes / No

I consent to the participation of my child, __________________, in the above project.

Parents’ Name: ___________________________ Date: ____________

Parents’ Signature: _______________________

Minjilang, Croker Island, NT, Australia

NB: Any complaints about your consent to this study may be directed to the presiding member, Western Sydney University Human Research Ethics Committee, Research Engagement, Development and Innovation (REDI), Locked Bag 1797 Penrith NSW 2751 Australia.
Appendix 5

Animals in a Row Matching Task (Attachment)

(A-2)
Appendix 6
A set of five animals’ photos (Attachment)
(A-3)