ENHANCING CHILDREN'S FORMAL LEARNING OF EARLY NUMBER KNOWLEDGE THROUGH INDIGENOUS LANGUAGES AND ETHNOMATHEMATICS: THE CASE OF PAPUA NEW GUINEA MATHEMATICS CURRICULUM REFORM EXPERIENCE

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The Government of Papua New Guinea undertook a significant step in developing curriculum reform policy that promoted the use of Indigenous knowledge-based systems in teaching formal school subjects in any of the country's 800-plus Indigenous languages. The implementation of 'new' elementary Cultural Mathematics Syllabus is in line with the above curriculum emphasis. In line with the aims of these reforms, the research reported here investigated the influence of children's own mother tongue and traditional counting systems on their development of early number knowledge formally taught in schools. The study involved 125 school children from 14 elementary schools in three provinces. Each child participated in a task-based assessment interview focusing on eight tasks relating to early number knowledge. The results obtained indicate that, on average, children learning their traditional counting systems in their own language spent shorter time and made fewer mistakes in solving each task compared to those taught in Tok-Pisin or English only. Possible reasons accounting for these differences are also discussed.

Background

Since 1992, the Government of Papua New Guinea (PNG) through the National Department of Education developed education and curriculum reform policies that emphasized more on the community-based education through the use of vernacular languages and Indigenous knowledge-based systems in teaching formal school subjects (DOEPNG, 2003; 2002). One of the aims of the reforms is to preserve the country's linguistic and cultural diversity of 800-plus Indigenous languages, many of which are in danger of becoming extinct as a result of older generation not able to pass on the wealth of local knowledge and oral history to younger generation. This is partly a result of many school-age children taken away from their local communities because of formal schooling (Nagai, 1999; Nagai & Lister, 2003; Matang, 2002; Owens, 2001). The implementation of the community-based education reform policies has resulted in the establishment of elementary schools at the village level. Thus, the emphasis of the current reforms is in sharp contrast to the past mathematics curriculum content and classroom practices used in schools. These were informed by dominant 'absolutist' view that promoted the idea that mathematics is *culture*- and *value-free* knowledge (Bishop, 1991; Ernest, 1991) thus is independent of human thinking and influence. All classroom teaching was done in English as an official language of instruction. The curriculum content also lacked the necessary local content that reflected students' own home and cultural background. Consequently, the curriculum emphasis was also in conflict with the commonly accepted educational theory which promoted the view that learning is more effective and meaningful if teaching begins from what the students already know and are familiar with (D'Ambrosio, 2001; Kaleva, 1995; Matang, 1996; Matang, 2005; 2006; Matang & Owens, 2004).

Curriculum Reform and Cultural Mathematics Syllabus (CMS)

The implementation of curriculum reform via the 'new' elementary Cultural Mathematics Syllabus (CMS) is a significant shift from previous mathematics curriculum content used in PNG schools since the end of World-War 2 in 1945 (Matang, 1996). It takes into account the concerns raised by mathematics educators (e.g. Bishop, 1991; D'Ambrosio, 2001; 2006; Matang & Owens, 2004) of the need to integrate the students' everyday cultural practices of mathematics or ethnomathematics into the formal mathematics curriculum. Thus, it emphasises more on the role of children's own thinking, cultural background, language, and everyday out-of-school mathematical experiences in their learning of school mathematics (DOEPNG, 2002; 2003; Matang, 2005; 2006; Wright, 1991; 2002).

The significant feature of CMS is its emphasis on utilising the children's own mother tongue or vernacular in teaching school mathematics in their first three years of formal education. The CMS also encourages teachers to take advantage of the existing Indigenous knowledge found in the cultural practices of mathematics that also include students' own everyday mathematical experiences. This is officially acknowledged as part of the Rationale for Cultural Mathematics Syllabus that reads:

> Students at Elementary will be able to link new mathematical concepts from … their existing cultural knowledge. … [They] will integrate this knowledge so that they can confidently use mathematics in their everyday lives. The Elementary Cultural Mathematics course provides many opportunities for relevant and purposeful learning in an environment that is built on the principles of home life (DOEPNG, 2003, p. 1&2).

In terms of using any of the 800-plus Indigenous languages of PNG as language of formal classroom instruction, including Tok-Pisin and English, the Department of Education stated this explicitly as part of the Secretary's message (DOEPNG, 2003, p. iv) that reads:

> Students' language abilities, already gained in their home environments, must be respected, built on and extended. Vernacular languages have a large part to play in our students' formative years and their first language should be used to promote a deeper understanding of difficult concepts when this is necessary.

The education and curriculum reforms are also used by PNG Government to promote and preserve the rich cultural and linguistic diversity of the 800-plus Indigenous languages of PNG which are fast disappearing as a result of dominant 'Western' influence promoted through the formal school system (Matang, 1998; 2002; 2006; Nagai, 1999; Nagai & Lister, 2003). For this study, the reforms as well as the rich cultural heritage of the 800-plus Indigenous languages provided an ideal research context to compare any observed differences in performances of school children from different language groups on task-based early number assessment. The above research context therefore provided the rationale for conducting this research entirely in PNG.

Ethnomathematics and Indigenous languages of PNG

Ethnomathematics is a multi-disciplinary field of research drawing on cultural anthropology, linguistics, mathematics, mathematics education, and mathematical cognition (Bishop, 2004; D'Ambrosio, 2001; 2006; Matang, 2005: 2006). In the context of this study, the term ethnomathematics provides a general framework to investigate the relationships and the interplay between culture, language and mathematics. This has implications for mathematics education in terms of educational theory, policy, and practice. Ethnomathematics is also an academic field concerned with the study of Indigenous cultural knowledge of mathematics embedded in the everyday cultural practices of mathematics. Its main aim is to engender a deeper understanding and appreciation of the formal concepts of mathematics in relation to its everyday application thus further provides a rationale for studying and teaching school mathematics (Bishop, 1991; 2004; D'Ambrosio, 2001; 2006; Masingila, 1993; Matang, 1996; 1998; 2002; 2003; 2005; 2006).

Evidence from comparative studies investigating the relationship between number and language and its impact on children's numerical development in different countries (e.g. Clarkson, 1993; Dowker, 2005; Dowker and Lloyd, 2005; Fuson, 1991; Fuson & Kwon, 1992; Miura et al, 1988; Miura & Okamoto, 1989; Park, 2000; Saxe, 1991; Song & Ginsburg, 1987) have provided strong support for formal education systems around the world to use children's own mother tongue in teaching school mathematics particularly those from diverse cultural backgrounds. In particular, these studies have shown superior performances by children from non-English speaking countries compared to their counterparts in English-speaking countries like the United States. Dowker and Lloyd (2005) noted that better performances by children from non-English-speaking countries may relate to the influence of cultural characteristics such as the way in which numbers and arithmetical relationships are expressed in a language. In particular, Dowker (2005) noted that the "degree of regularity of an oral counting system could be important *either* because the base system that it uses is made explicit *or* because the oral counting system is consistent with the written counting system; and that the two need not be exactly the same" (p. 211). Both of these observations are true of the relationship between Indigenous languages of PNG and their respective traditional counting systems (see Table 1 & 2) where the oral counting words are consistent with the sequence of written numerals for the English number system used in schools. In the everyday context, these number and arithmetical relationships are made explicit during any counting task through the use of respective number words for *cyclic pattern* and *frame pattern* numerals (see examples in Table 1) aided by the physical use of fingers and toes (Matang, 2005; 2006).

Table 1: *Selected Indigenous languages and traditional counting systems of PNG*

PNG Indigenous language		**Selected PNG Traditional counting systems**		
Name of Language	Language Type	'Cyclic' Pattern Numerals	'Frame' Pattern Numerals	Examples of 'Operative' Pattern
Kâte	NAN	(2, 5, 20)	1, 2, 5, 20	24 = 20+2+2
Yabem	AN	(5, 20)	1, 2, 3, 4, 5, 20	12 = 5+5+2
Gahuku	NAN	(2, 5)	1, 2, 5	3=2+1; 7 = 5+2
Adzera	AN	(2, 5)	1, 2	5 = 2+2+1

Existing linguistic evidence suggest that the 800-plus languages of PNG make up one sixth of the World's total known languages (Lean, 1992). There also exist more than 800 individual traditional counting systems since every language will have its own traditional counting system which is part and parcel of the ethnomathematical knowledge systems of PNG (Lean, 1992; Matang, 2005; Owens, 2001; Smith, 1986). All the languages in PNG can be classified into two distinct groups, the Austronesian (AN) and the Non-Austronesian (NAN) or Papuan languages. While there are minor differences between the counting systems of AN and NAN languages, an analysis of each traditional counting system (see Table 1) reveals that the counting number words are highly integrated with the respective Indigenous languages in terms of *cyclic pattern* and *frame pattern* numerals (Lean, 1992; Smith, 1980; 1986). The Indigenous languages and their counting systems are structurally inseparable such that they provide the important numerical and linguistic foundations for children beginning their early number learning. It is for these reasons that Edgeworth and Edgeworth (in Dowker, 2005) pointed out that English speakers may be at a disadvantage compared with speakers of some other languages due to the relatively irregular English counting system because of inconsistent number relations between the counting words and its figurative numeral system.

Role of Traditional counting systems in early number learning

More than two-thirds of the 800-plus Indigenous languages of PNG are NAN languages (Lean, 1992, Smith, 1986). Therefore, the Kâte language and its traditional counting system, a NAN language, represent the majority of the traditional counting systems in PNG. An analysis of the Kâte counting system (see Table 1 & 2) reveals that it is a digit-tally system that uses the Kâte counting words for hands and feet, and both fingers and toes to symbolise counting words physically (Matang & Owens, 2004; Smith, 1986). It comprises of 2 as the 'primary' cycle, 5 which is *one hand* as the 'secondary' cycle, and 20 which means *one man* as the 'tertiary' cycle (see Table 2). The physical use of fingers and toes in any counting task has long been recognised as an important counting strategy for children beginning their early number learning. Its role in early number development was noted by Edward Tylor of Oxford University in 1871 that the practice of counting on fingers and toes lies at the foundation of our arithmetical science (in Lean, 1992). The overall structure of the Kâte counting system is therefore a combination of the 'pair system' and the 'quinary-vigesimal' system. Its frame pattern and cyclic pattern numerals are (1,2,5,20) and (2,5,20) respectively (see Table 1). Further analysis reveals that each Kâte number word is a compound of 2 or 3 equivalent single number words chosen from the set of frame pattern number words for 1, 2, 5, and 20 so that for example, 7 is a compound of equivalent Kâte words for "five" and "two", 28 is a compound of "twenty", "five", "two" and "one", and so on. When this number combination principle is used, the resulting operative patterns in Kâte are illustrated as 7=5+2, 28=20+5+2+1, and so on.

Table 2: *Relationship between English (Hindu-Arabic) and traditional Kâte numeration systems*

English Numeral in Figures	Equivalent Kâte Number Word	Kâte 'Operative' pattern for each counting number words
1	moc	1
2	jajahec	2
3	jahec â moc	3 = (2+1)
4	jahec â jahec	4 = (2+2)
5	memoc	5
15	me-jajahec â kike-moc	15 = 10+5 or 15 = 5+5+5
20	ŋic-moc	20
28	ŋic-moc me-moc â jahec-â-moc	28 = (20+5)+(2+1)

Unlike the disjoint number relationships found in the English numeration system, the Kâte counting number words automatically provide the important number relationships between the individual counting numbers in terms of their magnitude and order of occurrence in any counting task. For example, the Kâte number word for 8 is *"me-moc â jahec-â-moc"* when expressed in its operative pattern, it is 8=5+(2+1). Apart from emphasising the relative sizes of the counting numbers 8, 5, 2 and 1, the equation 8=5+(2+1) also reinforces four important mathematical concepts relevant to early number learning. Firstly, the *concept of addition* as an operation quantifying the counting numbers 5, 2, and 1, and observing 8 as the resulting *sum* representing the total quantity of all the addends. Secondly, the mathematical equation 8=5+2+1 emphasises the idea that the statement on the *left hand side is equal to the one on the right hand side*. Thirdly, the *order of operation* whereby the operation inside the grouping symbol "( )" must be performed first. In everyday counting tasks, the emphasis is usually placed on counting associations of two counting words "me-moc" and "jahec-â-moc" where the connecting Kâte alphabet "â" represents the idea of a *plus sign* (+) used in the English number system. Finally, the idea of using one of the cyclic pattern numerals of 2, 5, or 20 as *composite unit* in constructing larger numbers, for example 5 for numbers between 5 and 20, likewise 20 which is composite unit for every Kâte numeral beyond 20. This is an important number strategy necessary for performing the four basic number operations (Matang, 2005; Matang & Owens, 2004).

From the teaching and learning point of view, the above mathematical concepts are important prerequisites for children beginning their early number learning in formal school system. If relevant links are developed intuitively or formally by school children with assistance from teachers who are also native speakers of children's own mother tongue, then they should perform as well or better than those children taught in either Pidgin or English only (Matang, 2005; 2006; Matang & Owens, 2004).

Method

Participants

The study involved 125 school children, aged between 8 and 11 years, attending Grade 2 class from 14 different elementary schools in 3 provinces of PNG. The schools were randomly selected representing the linguistic and cultural diversity among elementary schools in PNG. In each school the class teacher was asked to select the top nine students (5 boys and 4 girls or vice versa) based on their internal school assessment. This is to ensure that each school was represented by the top performing students as means to maintain uniformity in the selection process. The participating schools were categorised into one of the 6 school groups based on the main language of formal instruction (LFI) used in teaching children when they begin their formal education with the Elementary Preparatory (EP) class in each school. These categories are Vernacular-only (VO) schools (N=27), Vernacular-Pidgin (VP) schools (N=36), Vernacular-English (VE) schools (N=9), Pidgin-only (PO) schools (N=18), Pidgin-English (PE) schools (N=9), and English-only (EO) schools (N=9). Schools were classified as Vernacular-Only if at least 80% of classroom time were conducted in children's own vernacular. The same criterion was applied for PO and EO schools. Schools were classified as Vernacular-Pidgin, Vernacular-English and Pidgin-English if at least 40% of the actual classroom time was conducted in either one of the two languages. All 14 schools serve communities that are located within a maximum of approximately one hours' walking distance of school children's homes.

Instrument

A highly modified version of the *Schedule for Early Number Assessment (SENA)* taken from the NSW Professional Package *Count Me in Too* (DET NSW, 2000) was used as the main instrument in this study. The task-based early number assessment (TENA) schedule consists of eight main task groups comprising a total of 40 sub-tasks. These are Numeral identification *(9 sub-tasks),* Forward number word sequence *(7 sub-tasks),* Backward number word sequence *(7 sub-tasks),* Subitising *(6 sub-tasks),* Counting *(3 sub-tasks),* Addition *(3 sub-tasks),* Subtraction *(3 sub-tasks)* and Multiplication/Division *(2 sub-tasks).* A teacher questionnaire was administered to all teachers in participating schools. An interview session was also conducted for 'Bridging' teachers to gauge their views on overall performances of elementary school graduates entering Grade 3 in lower primary schools.

Procedure

Each child participated in an individual task-based interview focusing on eight task groups relating to early number knowledge. Each interview session was conducted in either Kâte language, Pidgin or English based on children's choice and all sessions were videotaped. This allowed for the measurement of time spent by each child solving each task and determination for each child of the total number of incorrect responses (ICR) across all task groups. In each case, the final group mean is the mean for all students in that school group. The correct reaction times (CRT) for correct responses were measured in seconds while the total number of ICR for each school group was expressed as a percentage out of the 'Total number of sub-tasks per task group. It is possible for a student to score 0% (i.e. all correct responses per task group) or 100% for all incorrect responses per task group. On average each interview session took 30 minutes for each participant. Based on cognitive efficiency theory (CET), the shorter the reaction times the higher is the cognitive efficiency level (Erickson, Chase & Falcon; 1980; Groen & Resnick, 1977). Likewise, the fewer mistakes the higher is the competency level in mathematics. Thus, in assessing early number knowledge, reaction times and total number of mistakes measured children's cognitive efficiency level (CEL) and mathematics competency level (MCL) respectively.

Results and Discussion

In order to measure the influence of Indigenous languages and traditional counting systems on children's performances on early number assessment, all final group means for both Correct Reaction Times (CRT) and Incorrect Responses (ICR) were converted to standardized scores (see Table 3, 4, & 5). This is necessary to compare measures from different distributions (Greer, 1980; Zeller & Carmines, 1978) comprising of CRT and ICR measuring children's cognitive efficiency level (CEL) and mathematics competency level (MCL) respectively.

Table 3: *Overall standardised mean scores for correct reaction times (CRT)* **-** *All Tasks*

Standardised TENA Scores for "Correct reaction times" (CRT) in seconds											
CEL Sch Rank	LFI Based School Group	NT:A No. ID X/9 z-sco	NT:B FNWS X/7 z-sco	NT:C BNWS X/7 z-sco	NT:D Subtise X/6 z-sco	NT:E Count X/3 z-sco	NT:F ADD X/3 z-sco	NT:G Subtra X/3 z-sco	NT:H Multpy X/2 z-sco	Mean z-sco CRT x/40	Final Mean z-sco CRT
1	PE (N=18)	-1.94	-1.51	-0.36	-1.48	-1.86	-1.75	-1.02	-0.03	-1.24	-1.87
2	VE (N=9)	-0.02	0.46	-1.53	0.75	-0.35	0.98	-0.95	-0.26	-0.12	-0.17
3	VO (N=35)	0.37	0.52	1.06	-0.48	0.49	-0.01	-0.47	-0.18	0.16	0.24
4	PO (N=18)	0.56	-0.45	0.90	-0.15	0.92	-0.06	0.68	-0.62	0.22	0.33
5	EO (N=9)	0.88	-0.42	-0.59	1.41	0.36	-0.12	1.52	-0.86	0.27	0.41
6	VP (N=36)	0.17	1.37	0.51	-0.03	0.44	0.98	0.24	1.95	0.70	1.06
	Mean	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Stdev	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.66	1.00

An analysis of children's overall mean performances on all 8 numerical tasks indicate a greater variation in performance differences between each category of school children (see Table 3 & 4). Based on the overall standardized scores for CRT (See Table 3), the final CEL ranking indicates that PE group has the lowest standardized score of -1.87 followed by the VE group with standardized score of -0.17. Based on cognitive efficiency theory, this means that students attending PE schools have the highest CEL. On the other hand, the VP schools, on average, have the lowest CEL having to score the highest overall standardized score of 1.06.

In terms of children's overall mathematics competency level (MCL), the PE schools scored the lowest standardised score of -1.34 followed closely in second spot by VO schools with a score of -1.18 (see Table 4). This means that on average, students in PE schools scored fewer incorrect responses (ICR) on all 8 task groups compared to those in other school groups. According to theory of automaticity in mathematics (Groen & Parkman, 1972; Hasselbring, Goin & Bransford, 1987; Wheatley & Wegner, 2001), having fewer ICR means higher competency level in mathematics for students attending

PE schools. In contrast, children attending VE schools had the lowest MCL as indicated by their highest standardised score of 0.98 when compared with other school groups.

Table 4: *Overall standardised mean scores for incorrect responses (ICR) – All Tasks*

Standardised TENA Scores for "Incorrect responses" (ICR) expressed in percentage – All Tasks											
MCL Rank	LFI Based School Group	NT:A NO. ID X/9 z-sco	NT:B FNWS X/7 z-sco	NT:C BNWS X/7 z-sco	NT:D Sbitise X/6 z-sco	NT:E Count X/3 z-sco	NT:F Add X/3 z-sco	NT:G Sbtract X/3 z-sco	NT:H Multip X/2 z-sco	Mean ICR z-sco x/40	Final z-sco ICR %
1	PE (N=18)	-1.50	-1.23	-0.46	-1.18	-0.26	0.26	-1.18	-0.96	-6.50	-1.34
2	VO (N=35)	1.23	0.92	-1.47	-1.13	-1.07	-1.86	-1.16	-1.15	-5.69	-1.18
3	EO (N=9)	-0.25	0.26	-0.60	0.70	0.42	-0.12	1.31	-0.11	1.61	0.33
4	PO (N=18)	1.02	0.26	0.52	-0.24	-0.60	0.07	0.07	1.30	2.39	0.49
5	VP (N=36)	-0.25	1.00	0.93	0.79	-0.26	0.64	0.69	-0.11	3.43	0.71
6	VE (N=9)	-0.25	-1.23	1.07	1.07	1.78	1.02	0.27	1.02	4.76	0.98
	Mean	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Stdev	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	4.85	1.00

Note: FNWS = Forward number word sequence BNWS = Backward number word sequence

A 3-group comparison of final standardised scores for VO, PO, and EO schools reveals that children in VO schools performed better than those in PO and EO schools in both CEL and MCL (see Table 3 & 4). This is further confirmed by their overall performance score for combined CRT and ICR (see Table 5) where VO group has lowest standardised score of -0.517, EO Group has 0.413 and PO group has 0.449. Although all 3 school groups used the same CMS, the better overall performance by children in VO school group indicate that children who learn early number knowledge in their own language are not disadvantaged compared to those taught in Pidgin or English only. This is despite all schools in VO group classified as rural schools compared to PO and EO schools which are mainly located in and around major urban centres hence often have greater access to basic Government services.

Table 5: *Standardised scores for combined CRT and ICR for VO, PO, and EO schools*

Final Ranking Combine CRT & ICR	LFI Based School Group	Final Combine z-scores CRT (sec)	Final Combine z-Score ICR (%)	Combine Mean z-score CRT & ICR	**Final Mean z-score** CRT & ICR
1	PE (N=18)	-1.873	-1.342	-1.608	**-1.785**
2	VO (N=35)	0.243	-1.175	-0.466	**-0.517**
3	EO (N=9)	0.412	0.332	0.372	**0.413**
4	VE (N=9)	-0.173	0.982	0.405	**0.449**
5	PO (N=18)	0.333	0.493	0.413	**0.459**
6	VP (N=36)	1.059	0.708	0.884	**0.981**
	Mean	0.000	0.000	0.000	0.000
	Stdev	1.000	1.000	0.901	1.000

The main difference between VO, PO, and EO schools is in terms of language of formal instruction (LFI). The children in VO schools spend at least 80% of their classroom time learning to read and write in their own mother tongue unlike those in PO and EO schools who do not have any opportunity at all to learn their own language. Having to learn in their own language automatically gives children in VO schools the opportunity to count

and perform basic number operations using their own traditional counting systems. It is also highly possible that the higher performance by children in VO schools is due to longer length of time spent by children in leaning early number knowledge embedded in the counting number words of respective traditional counting systems that are meaningfully expressed in their own mother tongue. This is obviously an advantage that is not enjoyed by children attending PO and EO schools. Moreover, the traditional digit-tally counting systems (e.g. Kâte), automatically reinforce the idea of *composite units* in meaningfully assist children to construct larger numbers through the use of cyclic pattern numerals (i.e. 2, 5, 20) that are physically expressed through the use of fingers and toes, and hands and feet. The physical use of hands and feet, which is part and parcel of all digit-tally counting systems of PNG, also automatically reinforces the cognitive processes and skills associated with early number learning. Thus, through more practice, it is natural for individuals to become efficient in performing basic number tasks (Wheatley & Wegner, 2001) such as those that are reported in this study.
The above observations are in line with the underlying assumptions of CET which assumes that people very often seek to perform regularly encountered tasks in as quick and easy a manner as possible suggesting the smoothing out of performances through dropping of 'extra actions' that are no longer considered necessary by the skilled performer (Groen & Parkman, 1972; Groen & Resnick, 1977). Moreover, they are also in line with theoretical assumptions of Automaticity in mathematics which suggests that as basic skills are practiced more, their execution requires less cognitive processing capacity thus becomes automatic (Hasselbring, Goin & Bransford, 1987; Bransford & Vye, 1989). Thus, an individual's ability to succeed in higher level cognitive skills is directly related to his/her efficiency in executing lower level cognitive processes. In contrast, the irregular counting words in Pidgin and English, coupled with their lack of relevant physical support such as the use of hands and feet, to fully assist school children in PO and EO schools to perform efficiently on early number assessment. While the above characteristics are an integral part of the majority of all traditional counting systems in PNG, in terms of children's early number development, they form important numerical and linguistic foundation for meaningful and effective learning of school mathematics in elementary schools. Moreover, they also provide the relevant contextual meanings associated with formal mathematical concepts taught in schools thus providing the important linkage between formal school mathematics and its everyday application such as those found in the traditional counting systems of Papua New Guinea.

Conclusion

The results obtained so far indicate that children learning to read and write, and count in their own language performed better than those learning early number knowledge in Pidgin or English only. Though the study is limited to investigating the influence of children's own mother tongue on formal number development from only three provinces, in the context of implementing the new elementary CMS, the results are significant in that they provide further support for use of children's own language and traditional counting systems in teaching formal school mathematics. The result is contrary to negative views held by parents and critics of the curriculum reform in PNG. While the preliminary results suggest possible reasons why students taught in their own language will perform well during formal learning of school mathematics, further research covering all regions of PNG is needed to confirm this, and to find out how best to assist elementary teachers to take advantage of the prerequisite number concepts found in the respective traditional counting systems of PNG in effectively teach school mathematics.

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