The Mathematics Performance of Aboriginal Pupils for Computation and Word Problem Items in Using Academic and Community Languages

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Abstract

This comparative research study examined Grade Five Malaysian Aboriginal pupils' mathematical performance on 30 computation and 20 word problem items in the academic Malay language and community *Temiar* language. The items were constructed in the Malay language before adapting and audio recording into the *Temiar* language using experienced Mathematics teachers and native speakers. One test consisting of monolingual test items written in Malay language (MAL) and, another bilingual test with audio test items in *Temiar* language and written items in Malay language (BCL) were constructed. These two tests with identical content validity, were administered spirally among 237 pupils from eight schools in two states. Findings indicated that for computation and word problem items, pupils found the BCL test easier. They performed significantly better in computation items than in word problem items for both tests, with Cohen's d medium to high effect. The community language helped to alleviate the linguistics complications.

Keywords: aboriginal pupils, academic language, community language, mathematics, computation items, word problems

INTRODUCTION

In many parts of the world, Aboriginal students largely use their community language for communication (Meaney & Evans, 2013), resulting in low proficiency in the academic language used in classroom instruction (Sani & Idris, 2013). When mathematics is assessed in the academic language that students have limited proficiency in, the Aboriginal students' mathematical performance is greatly compromised (Sani & Idris, 2013). When non- Aboriginal students gain better score in mathematics when compared to their Aboriginal counterparts, it appears to suggest that the low mathematics scores obtained by the Aboriginal students' project their real differences in mathematical ability (Meaney, McMurchy-Pilkington, & Trinick, 2012), with lack of relation to another attributable factor, i.e., their language non-proficiency.

However, their disadvantaged position in education is not entirely a direct reflection of their poor cognitive ability, but also a manifestation of a myriad of factors at micro level such as low socioeconomic background, high absenteeism (Nicholas, 2000), and limited access to learning (Klenowski, 2009). At the macro level, perennial issues such as the conflict between the Western knowledge of the universal concepts and the devalued Indigenous cultural resources (Lee, 2015) such as their language, and the inability to capitalise on their cultural values to empower their learning (Miller & Armour, 2019) are evident. Williamson and Dalat (2007) explained the reason against indigenising universally accepted knowledge is to prevent the misaligned or "corrupted understandings of Indigenous knowledge" (p. 51). Even though their line of thoughts may have a basis, totally banning or not recognising some cultural resources of the Indigenous community such as language in the education system, puts the students in a disadvantaged situation when compared to their non-Indigenous counterpart and Trumbull and Nelson-Barber (2019) depicts such a situation as "cruel and educationally defensible" (p. 5). Conforming further,

Contribution to the literature

- The manuscript details a novel approach in testing the Indigenous pupils in Malaysia using the oral language approach, which adopts the *Temiar* language in orally translated audio scripted items, and written items in the Malay language. This is one of the first efforts undertaken for Indigenous pupils in a bilingual Immersion programme.
- The findings are of importance as it examines the use of undocumented community language in testing to reduce the variance contributed by the language of the test.
- The methodological approach can be duplicated to measure Indigenous learners' true mathematics with the removal of language as a secondary dimension.

Seagrim and Lendon (cited in Lancy, 1983, p. 54) emphasised that "the closer the home environment approaches the Western model, the more closely does performance approach the Western standard". Accordingly, this paper posits that the community language spoken among Aboriginal pupils is recognised and valued as an Aboriginal "curriculum genre" (Graham, 1986 as cited in Watson, 1988, p. 270) and testing principles.

These aforementioned factors may appear to be stand alone, but their joint forces contribute to the Aboriginal students' disengagement in learning, which is a significant predictor of success and academic excellence (Lee, 2014). Additionally, their readiness for school and learning mathematics was found to be at par with the non-Aboriginal students (Dockett & Perry, 2013) and the attributing factor that reverses the effects of readiness was found to be engagement towards learning (Young-Loveridge, 2011). Miller and Armour (2019) further clarified the negative effects of student engagement from the perspectives of behaviour (curriculum and co-curriculum participation), emotional (affection towards mathematics content) and cognitive engagement (ability and motivation to sustain the difficulty of grasping mathematical concepts and problem solving) that results in students' inactive participation in classroom learning, dislike for mathematics and demotivation.

One of the ways to engage Aboriginal students is by valuing and tapping on their cultural elements such as language (Edmonds-Wathen, 2015) that has been found to be a significant predictor for successful mathematical learning (Warren & Miller, 2013). Supporting further, Jorgensen, Grootenboer, Niesche, and Lerman (2010) highlighted that Aboriginal pupils are able to learn mathematics and that their performance in test is hindered more by the lack of social and educational factors favouring them than their cognitive ability. Literature has also established a close association between language and academic excellence since all assessments measure language skills (American Educational Research Association [AERA], American Psychological Association [APA] & National Council on Measurement in Education [NCME], 2014). With language being instrumental in any assessment, including mathematics, the academic language becomes a measure of the test construct among students who have limited proficiency in that language (August & McArthur, 1994). This testing practice invalidates the test results, as the scores do not capture the students' true mathematics ability. Alternatively, assessing students bilingually, i.e., both in the academic language and community language is necessary so that their limited proficiency in the academic language does interfere with their true performance (American Educational Research Association [AERA], American Psychological Association [APA] & National Council on Measurement in Education [NCME], 2014).

Recognising the important role of language as a vital element of cultural validity, Warren and Miller (2016) advocate the use of oral language approach as an effective pedagogy for Aboriginal students. The main benefit of the oral language approach is that it removes or reduces the reading difficulty that affects their ability to understand the mathematical problems in a language that they have limited proficiency in (Videnovic, 2017).

Accordingly, the rationale for carrying out the current study is to provide equal opportunity for the Aboriginal children to handle the procedural aspects of mathematics as well as for them to solve mathematics word problems. At the same time, they could be assisted to better understand the content and meaning within the word problem items and hence, could better comprehend what the problems are actually asking them to do when the content is assessed using their everyday language spoken in their communities. The assumptions made are based on the literature whereby language plays a significant role in assisting pupils to understand and comprehend the content embedded within the mathematics word problem items.

While Warren and Miller (2016) advocate the oral language approach in teaching and learning, this study proposes the oral language approach in testing. As Gee (2003, p. 28) highlighted, "If two children are being assessed on something that they have not had equivalent opportunities to learn the assessment is unjust". The oral language approach is aptly suitable with the Aboriginal pupils whose learning styles are non-verbal (Deyhle & Swisher, 1997) and oral-based, whereby they learn through watching, observing and listening (Goulet, 2001; Williams & Tanaka, 2007). Therefore, in pursuit of

developing a fair assessment for Aboriginal pupils, this study adopts a novel oral language approach driven by testing and examines the Aboriginal pupils' performance in mathematics for computation and word problem items using a bilingual model of written academic language and oral community language.

Problem Statement

Many Aboriginal students are challenged when learning Mathematics (Bucknall, 1995; Howard, 1995) and four major factors, namely: (i) language, (ii) assessment, (iii) learning style, and (iv) relevance of the mathematical activities have been identified to impact their learning of mathematics (Warren, Cooper, & Baturo, 2004). Of interest to the context of this study are language and assessment. Aboriginal pupils come to school with some form of understanding in mathematics, but there is a longstanding gap between their mathematical knowledge and the Western mathematics taught in schools, mainly because of the mismatch between the community language and academic language (Warren & Miller, 2013). And in order to succeed in schools, they have to learn to read and write in a foreign language (academic language) that is not their familiar native or home language (community language). Furthermore, to be rated as performing well academically, they need to read and write their responses during examinations in the same unfamiliar academic language.

The reality is that the linguistics nature of the language of the test is capable of augmenting the complexity of any assessment tasks (Clark-Gareca, 2016), even more among the Aboriginal pupils, who face the risk of an unfamiliar academic language. Therefore, with their limited linguistics proficiency in the academic language, assessing their mathematical content knowledge in their dominant community language may remove the secondary dimension introduced by the language, thus allowing only the primary dimension (Mathematics content) to be assessed.

According to AERA et al. (2014), assessing students in their dominant language gives accurate measure of their true ability as they are not impeded by their linguistic disability and the test score are not masked by any unintended test construct. As such, the test scores are free from any construct irrelevant variance and can be validly interpreted as their true performance. Since for mathematics assessment, language should not interfere with the test construct (mathematical ability, skill or knowledge) that is intended to be measured, this raises an important validity issue, which is how accurately do the mathematics scores reflect the Aboriginal pupils' true mathematical achievement when they are assessed in an academic language that they have difficulty understanding? When two constructs like language and mathematical ability are so closely related, how much of the mathematics test scores is a valid measure of the students' mathematical ability and how much of that composite score is due to their language ability? One testing intervention that can address this infidelity for a fair assessment is by testing the Aboriginal students in their community language that they demonstrate proficiency in.

Language becomes a more profound challenge for students when solving word problem items than computation items, especially since they need to negotiate the meanings of the more linguistically loaded word problem items (Haag et al., 2013). Studies have proven that students who can competently solve arithmetic computation do not necessarily display the same level of competency when solving word problem items (Oviedo, 2005; Valentin & Lim, 2004). Oviedo (2005) argued that this complication arises as there is a conflict between the understanding of the text of the word problem items, the context in which the items are placed and the problem-solving strategies that are needed for solving them. She conceded that student's language proficiency is necessary to unpack the language into mathematical symbols for them to understand the text of the word problem items before they are able to process them into mathematical concepts and solve using the appropriate mathematical operations.

Therefore, putting all these issues into context, it raises the need to test Aboriginal pupils in their community language, alongside the academic language. This bilingual testing model is deemed necessary as a futuristic measure to prepare their smooth immersion into their mainstream learning environment after completing their primary education. The reality is that assessing pupils in their community and academic languages could be the answer for the Aboriginal pupils to gain equal access to an inclusive education.

Research Aim

The main aim of the study is examine the Aboriginal pupils' mathematical performance on the computation and word problem items in academic and community languages. As such, one test consists of a test book with test items written in the academic language (AL), which is *Bahasa Malaysia* or the Malay Language. Another test consists of the combination of the same test book with items written in the academic language, and is accompanied by the audio form of the orally translated items in the community language (CL), which is the *Temiar* language. The two test books are acronymic to MAL, indicating monolingual (M) test items in academic language (AL), while the other test as BCL to indicate bilingual (B) test items written in the academic language, with the audio form of the test items in the community language (CL). Specifically, the research objectives are to:

1) examine the Aboriginal pupils' mathematics performance for computation items in monolingual academic language and bilingual community language.

2) examine the Aboriginal pupils' mathematics performance for word problem items in monolingual academic language and bilingual community language.

3) examine the Aboriginal pupils' mathematics performance for word problem and computation items in monolingual academic language .

4) examine the Aboriginal pupils' mathematics performance for word problem and computation items in bilingual community language.

LITERATURE REVIEW

Academic Language and Community Language in Mathematics

Cummins's (1979, 1984) early work in bilingualism laid the groundwork for further research into the significance of language in mathematics learning (See Cathcart, 1980, 1982; Dawe, 1983; Harris, 1989; Hernandez, 1983). Many studies have since ensued with different learner's background and status. It is discovered that language barrier can put learners at a 15% disadvantage in Mathematics as mathematical word problems differ from day-to-day English on vocabulary, sentence and text level (Adoniou & Yi, 2014). Smith's (2017) research into low mathematical competency scores of freshmen who speak the Jamaican dialect (JD) when compared to students who speak Standard English (SE) shows the magnitude of an unfamiliar language as the medium of instruction on mathematical learning. Although SE is the official language of the country, most students were considered to be English language learners. The study revealed significant improvement among students who spoke JD and received instructions in their vernacular language of choice. This finding highlights the decisive impact of the students' community language for instructional delivery on their understanding of mathematical concepts.

A research along a similar vein, Fredua-Kwarteng and Ahia (2015) explore the effectiveness of learning Mathematics in English at basic schools in Ghana. Using their own personal reflections and narratives, the researchers reported that using English when the students have Ghanaian language as their mother tongue was a stumbling block to the development of their mathematics proficiency. The students encountered great difficulty in i) explaining, communicating and justifying themselves mathematically, ii) mathematical problem-solving, ii) participating actively in the classroom. It was found that pupils who performed poorly in Mathematics struggled with the language rather than the subject or the mathematical concepts themselves.

Language is an "essential component of the building of mathematical meanings from experiences" (Frid, 1993, p. 38) and the skills are the "vehicles through which students learn, apply, and are tested on math concepts and skills" (Spanos et al., 1988, p. 222). Within the context of mathematics, language goes beyond communication in mathematics classroom and is the key that transforms the conversation language into cognition. While the Aboriginal pupils may be able to learn the conversational academic language at an accelerated rate, this is not the case for mathematics register (Cummins, 1996).

Further exacerbating the issue is the context of the Indigenous students. The school mathematics is constructed in a social context governed by rules that reflect the social and cultural rules of the wider society. However, school mathematics, though taught within social and cultural practices, may not acknowledge the mathematics of the students' cultural origins (Howard & Perry, 2005). Evidently as Dandy et al. (2015) observed in their study among Indigenous, Asians and Anglo students in Australia, Asian students had better performance compared to the Anglo and Indigenous students probably because of the examination culture found among Asian students (Wong, 2002). The Indigenous students lagged most behind particularly in numerical-related subjects, when compared to their peers. On the contrary, Rubie-Davies and Petersons (2016) found that the local Māori Aboriginal students' academic capabilities were better compared to their European peers.

Aboriginal Pupils Differentiated Performance in Word Problem and Computation Items

Mathematical problems can be presented in computation form or as a word problem item and each poses its own challenges to Indigenous students. Word problem items carry real world like problems placed in a context and this fundamental element is absent in computation items (Nesher & Katriel, 1977). According to Schmidt and Weiser (1995), word problem items are arithmetic problems presented in a non-mathematical context that stretch beyond mere verbalisation of number sentences. Randall (2008) summarised word problem item as an item set in a real-world context where there are the mathematical quantities with one or more known quantities and one or many unknown quantities that will be required to be found through a combination of either addition, subtraction, multiplication or division mathematical operations. Word problem should not be confused with computation mathematical items that have language loading as the latter includes language from a simple

statement to a combination of multiple language features (Abedi et al., 2006).

Illustrating further, word problems items are divided into two main categories: standard and non-standard (Fairclough, 2002). The former types of problems are probably those encountered most often by pupils. These problems "require the pupil to apply a computation such as addition or multiplication in a context" (Farrugia, 2003, p. 76). Although a variety of word problem items have been identified, it is evident that language plays a crucial role in all of them. As indicated by Sepeng and Madzorera (2014), "the difficult part of solving mathematical word problem items appears to be the process of understanding a problem and deciding what operation(s) need(s) to be performed" (p. 217). Thus, solving word problem items includes a number of cognitive and linguistic processes including comprehension processes (Banks, Jeddeeni, & Walker, 2016; Martiniello, 2008; Zhang & Lin, 2015). These complex processes have given rise to an interest in the ways in which language may influence an individual's mathematical performance. This interest has been accentuated through a number of studies (Andon, Thompson, & Becker, 2012; William et al., 2009), which have illustrated that pupils who are not fluent in a language, may perform more poorly than their more fluent peers.

Zerafa (2016) studied the influence of language on solving word problem item in Malta among pupils whose first language is Maltese. The study was carried out with 30 pupils in Grade 3 (aged 8 to 9). The findings indicated that the pupils found word problem items more challenging than non-verbal computation items presumably due to the language demand. Moreover, they understood and recalled word problem items better and solved them using correct operations when they were written in their first language. They also managed to solve quickly since there was no need to translate the word problem items as they were already proficient in that language.

Apart from language, tapping on the Indigenous culture promotes Aboriginal pupils' successful learning in mathematics. Treacy, Frid, and Jacob (2014) emphasized the overlooked general truth; that Indigenous cultures have distinctly different world views and social practices, which directly impact on their channel of knowledge acquisition. In this study, the researchers were interested in the strategies used by the Australian Aboriginal students in doing counting and subitizing. Although there is still need for more in-depth research to reach a definitive conclusion, findings from the study suggests that indigenous cultures have an effect on students' approach in Mathematics. This is because the Aboriginal students in the study exhibited tendency to estimate when the task allowed it, which was in reflection of their own culture that only had numbers up till four.

However, Fredua-Kwarteng and Ahia (2015) offered an interesting insight in their study on Ghanaian basic school students. They discovered that the teachers preferred using numerical and routine problems, and the students also responded positively towards these problem types, stating that "[the students'] confident level with word problems drops as they move up the grade level when mathematical problem-solving becomes more complicated as a result of the abstract nature of the English language" (Fredua-Kwarteng & Ahia, 2015, p. 130). It would seem though that in this context the problem lies with the language rather than the question type, as word problems require students to process both the linguistic and mathematical aspect of the problem, a feature that is absent or not as prominent in a numerical problems.

Local Aboriginal students in Malaysia also exhibited similar qualities to the findings by Fredua-Kwarteng and Ahia (2015). In a study conducted by Zaleha, Tan, and Nur (2020) among Aboriginal students in Malaysia, the students scored better when they were tested on mathematical operations, and most encountered difficulties with word problems, which required literacy skills such interpreting the situation and applying the correct procedure. Although the students also demonstrated difficulties in certain mathematical operations such as multiplication, word problems posed a bigger problem to their ability to obtain the correct answers. To further reinforce this argument, Zaleha, Tan, and Nur (2020) also conducted oral tests with the same item sets, which yielded higher correct mean than the written test in all the topics.

Matang and Owens (2014) conducted a study that combined all the key elements associated with this current paper. The study involved elementary school students being taught early number knowledge (as stipulated in the country's syllabus) in the student's mother tongue, *Tok Ples* and their traditional counting systems and, comparing its efficiency to using English or the lingua franca, *Tok Pisin*. The instrument employed in the study consisted of basic arithmetic concepts such as numerical identification, number word sequence, subitizing, and counting, and the students were divided into groups based on the language of instructions. It was discovered that having the opportunity to learn in their own language gave the children a boost in performing early arithmetic tasks as well as answering numeric and arithmetic questions as they got to utilize a counting system that they were familiar with to perform basic number operations. Matang and Owens (2014) also argued that traditional digit-tally counting systems can "reinforce the idea of composite units [for children] to construct larger numbers through the use of cyclic pattern numerals… [and] reinforces the cognitive processes and skills associated with early number learning" (p. 549).

Cultural Validity

Recognising assessment as a cultural tool matters in Mathematics, even though Mathematics is perceived to have more symbols and less language. Universally truth-based mathematical concepts such as arithmetic operations and Pythagorean Theorem would remain the same across different cultures (Seah, 2005). However, even though the mathematical tasks remained the same, it did matter who was 'doing' Mathematics as the students' cultural background have a profound impact on their cognitive skills (Ladson-Billings, 1997). Guberman (1999) further pointed out that mathematical knowledge varies across cultures and as affirmed by Saxe (1991), children's development of mathematical knowledge is reflected by the cultural activities that they participated in, which directly influences the number system and algorithms used. These mathematical tools are developed over time and the mathematical knowledge that is acquired is the result of their cultural background interacting with these tools. An example is the number system that varies across time and place. For example, Klein and Starkey (1988) provided an example of how the number system is developed among Oksapmin children of Papua New Guinea, who count by using a number system that refers to 27 body parts and that lacked the base structure.

Language being an integral component of any culture is an important mechanism that facilitates the cognitive skills required in mathematical thinking (Steele, 2001). Steele (2001) clarified that the mathematical language, which is fed by the culture of the society, forms the mathematical concepts that underlie the students' individual thoughts. The acquisition of the mathematical knowledge does not solely depend on the development of cognition but also on the cultural setting where the individuals acquire numerical proficiency within their culture and are able to learn, understand and perform mathematical operations on numbers (Goodnow, Miller, & Kessel, 1995). Accordingly Warren, Cooper, and Baturo (2004) reinforced that successful learning in mathematics among Aboriginal pupils needs to encompass elements in their culture such as language.

THEORETICAL FRAMEWORK

Cummins' Theory of Second Language Acquisition (1979)

Cummins' Theory of Second Language Acquisition (1979) presents two continua that underlie students' language proficiency. At one end there is the Basic Interpersonal Communication Skills (BICS), which is the students' familiar home language (community language) that they bring to school and at the other end is the Cognitive Academic Language Proficiency (CALP), which is the academic language of the subjects in school such as the mathematics register. While BICS can be developed within two years of second language learning, CALP needs five to seven years and is dependent on factors like the level of exposure to the native language and the students' age (Collier, 1987).

In the general context of language proficiency among students with limited language proficiency, Cummins' BICS and CALP framework is crucial as it highlights several issues. Context-rich communication that is embedded with social cues expedites the mastery of community language than the academic language. And, since schools are more focused on cognitively demanding but contextually reduced communication, students are to some degree deprived of a meaningful development of the academic language that is much needed for academic performance.

Word Problem Model

Kintsch and Greeno (1985) proposed the Word Problem Model, which consists of two sets of structures. They are the textual information of the word problem and the abstract problem model itself. The knowledge from the text is used in unison with the set of strategies to represent the mathematical problem. This representation has two facets, which are the text from the textual input and the problem model that holds the necessary information from the text for successful solution. In order to solve a mathematical problem, the model distinguishes three different types of knowledge. The first for translating the mathematical text into propositions, the second as mathematical relations for building the problem model, and finally, knowledge that involves the relevant mathematical skills and operations for solving.

Based on Kintsch and Greeno's Word Problem Model (1985), in order to solve a mathematical problem students rely on their knowledge of the mathematical language and the language of the text to obtain the textual mathematical information and build a conceptual representation before deciding on the suitable mathematical operations. Therefore, a successful mathematical solution is influenced by the students' language proficiencies as well as their competency in the mathematical skills.

METHODOLOGY

Instrument

Two instruments were used in this study that had items written in: i) monolingual academic language ii) bilingual community language. The test book in monolingual academic language was developed in three stages. Stage One involved constructing 30 computation and 20 word problem items from seven topics (computation, addition, subtraction, multiplication, division, decimal and fraction) in the Malay language (ML), which is the academic language. Content validity

Table 1. Test Item Composition

Domain	Computation Items	Word Problem Items	Total (%)
Knowledge	13	5	18 (36%)
Application	11	10	21 (42%)
Reasoning	6	5	11 (22%)
Total	30	20	50 (100%)

was established by mapping the items to the Grade 5 syllabus with the construct of a Test Specification Table. Computation items either had only numerals or minimum language load. A total of 28 items used fewer than 8 words, while two items were constructed with two simple sentences that had fewer than 15 words. Word problem items were linguistically denser and had real-life setting.

Table 1 shows the composition for the 30 computation and 20 word problem items for the test books. These 30 computation items and 20 word problem items in ML composed the monolingual academic language (MAL). Stage 2 involved preparing in advance a printed audio script for the test items in the *Temiar* language (TL), which is the community language spoken by the Aboriginal pupils. The items were adapted to culturally fit the *Aboriginal* community and were translated by two native speakers of TL and three mathematics senior teacher experts, who were teaching Grade 5. Stage 3 involved audio recording all the items into TL using a native speaker of TL. The recordings were played back to check its quality. Each item was recorded on a separate track and saved accordingly. The 30 computation items and 20 word problem items written in ML and audio recorded in TL formed the test in bilingual community language (BCL). At the end of the test development process, there were four test books; computation items (MAL and BCL) and word problem items (MAL and BCL) that were equivalent in terms of the content and mathematical skills that were to be assessed.

Procedure

This comparative research study used the random equivalent design in order to equalize the effect of test booklet difficulty and student ability by balancing out the order effect of answering different language versions of test items. By spirally administering the tests in MAL and BCL, pupils were randomly assigned into two language versions tests for one and a half hours in eight schools in two states in Malaysia among 237 Year Five Aboriginal pupils. By assigning the tests in this way, the groups of test takers who took the tests would be similar and thus, equalising their experience of taking either one test (Livingston, 2004).

In one classroom, pupils who sat for the MAL test were given the printed test books with the written items in ML. In another classroom, pupils who sat for the BCL test were given the printed test books with the same written items in ML for their reference, and

simultaneously the oral recordings in TL were played before they attempted the items. The printed test books were given so that the pupils could refer to the items as the audio recordings were played; without having to memorise the content of the test items. As such, by having the written items in front of them, the pupils were able to refer to them and simultaneously listened to the recordings in their native language. This precaution ensured that only their ability to solve the mathematics content was assessed and not the ability to memorise items. For both language versions, computation items and word problem items were administered back-to-back, with a 20 minute break between the two administrations.

Data Analysis

Data analysis involved computing first the item difficulty before proceeding to inferential statistics (t-test and Cohen's *d* effect size) to determine if there were any practical significant differences in the mathematics performance of the pupils sitting for the two tests for the computation and word problem items. Independent samples t-test was used to compare scores on the same variable but for two different groups of cases. Each group was tested independently to view the significance between the two groups of cases. The independent sample t-test analysis has two main parts; Levene's test for the assumption of equal variances and the t-test for equality of means (Leech, Barret & Morgan, 2008). In addition, to independent samples t-test, Cohen's *d* effect size was also computed to determine the practical significance by calculating the mean difference between the two groups, and then dividing the result by the *pooled* standard deviation. The formula is as displayed below

Cohen's $d = (M_2 - M_1) / SD_{pooled}$, where: $SD_{pooled} = \sqrt{((SD_1^2 + SD_2^2)/2)}$

Cohen (1962) suggested that *d*=0.2 be considered a 'small' effect size, 0.5 represents a 'medium' effect size and 0.8 a 'large' effect size and that a *d* of 0.5 suggests that the means of the two groups differ by half a standard deviation. This also means that if the means of the two groups do not differ by 0.2 standard deviations or more, the difference is considered trivial, even if it is statistically significant. However, Cohen (1977) cautioned on the stringent compliance of these classifications and maintained that they should only serve as "a conventional frame of reference which is recommended when no other basis is available" (Cohen, 1977, p. 25). Agreeing further to Cohen's argument, Ellis (2010) highlighted that these cut-off scores are

Table 2. Average Item Difficulty and Discrimination Indices for MAL and BCL Tests

Test	Items	p	Average of p	D	Average of D
Monoliongual Academic Language	Computation	0.32	0.31	0.17	0.14
	Word Problem	0.29		0.10	
Bilingual Community Language	Computation	0.39	0.37	0.21	0.34
	Word Problem	0.34		0.23	

Table 3. Range of Item Difficulty Index for MAL and BCL Tests

	Monolingual Academic Language		Bilingual Community Language	
	Min	Max	Min	Max
Computation Items	0.17	0.56	0.17	0.76
Word Problem Items	0.14	0.46	0.13	0.61

Table 4. Difference in Mathematics Performance for Computation Items between MAL and BCL test

Computation Items	N	Mean	SD	df	t	p
Monolingual Academic Language	114	31.60	13.83	220	-3.53	0.00*
Bilingual Community Language	108	38.10	13.65			

*p< .05

"controversial" (p. 40). Even then, these cut-off values have been widely and stringently used. On the off-set, Cummings and Calin-Jageman (2017) also proposed another prevailing benchmark for average effect size in education research: a Cohen's *d* value of 0.2 is illustrated as small, 0.4 as medium and 0.6 as large.

In this study, t-test was conducted on two cases; computation and word problem items. The data was first screened for outliers. Responses were only removed for pupils who had selected more than one option and left many items unanswered. As such, the number of respondents for each test book was different; MAL computation (114), BCL computation (108), MAL word problem (116) and BCL word problem (104).

RESULTS

The results are presented according to the research questions posed in this paper. However, before studying each research question in detail, item analysis was conducted on both types of test items for the two tests in order to study the average of the item difficulty and item discrimination indices. Table 2 presents the results.

The average mathematics score for the MAL test and BCL test shows that the BCL test is more valid compared to the MAL test. Table 2 shows that BCL that used the community language test is slightly easier than the MAL test that used the academic language. However, the BCL test is more able to discriminate compared to the MAL test. Overall, the BCL is easier than the MAL test and the BCL also has better discriminating power (acceptable discrimination) than the MAL test (poor discrimination).

Scrutinising further the minimum and maximum difficulty index for the two types of test items also corroborate the initial conclusion that the test items in the community language is easier than the test items written in the academic language. As exhibited in Table 3, the Aboriginal pupils found the test items in their community language easier (comp= 0.76, WP= 0.61) than in the academic language (comp= 0.56, WP= 0.46) for both types of computation and word problem items. And as expected, they found the computation items (MAL=0.56, BCL=0.76) easier than the word problem items (MAL=0.46, BCL=0.61) in both tests and the computation items in the community language (0.76) was still easier than in the academic language (0.56).

The subsequent sections will present results guided by the research questions.

RQ1: How Differently *Aboriginal* Pupils Performed for the Computation Items in Monolingual Academic Language and Bilingual Community Language?

Levene's test was not statistically significant (p >.05). This shows that the tests assumed equal variances in the mathematics performance between the MAL test and BCL test for the computation items. The independent sample t-test was statistically significant, (t (220) = -3.53, p<.05) for the computation items between MAL test and BCL test as exhibited in Table 4. Therefore, H_0 was rejected to suggest that there is a difference in the pupils' mathematics performance for computation items between MAL test and BCL test. The mean score for the BCL test is 38.10, which is higher than the mean score for the MAL test (31.60). As such, for computation items Aboriginal pupils who sat for the BCL test, on average, scored 6.5 units marks more than students who sat for the MAL test (d=.5). Furthermore, Cohen's d = (38.1 - 31.6) / 13.740295 = 0.5 (medium effect). As shown, the calculation for the effect size is 0.5, indicating a moderate to high practical significance. Therefore, *Aboriginal* pupils performed better in the BCL test when compared to the MAL test.

Table 5. Difference in Mathematics Performance for Word Problem Items in MAL Test and BCL Test

Word Problem Items	N	Mean	SD	df	t	*p*
Monolingual Academic Language	116	25.56	11.00	218	3.04	0.00*
Bilingual Community Language	104	30.63	13.68			

*p< .05

Table 6. Difference in Mathematics Performance between Computation and Word Problem Items for MAL Test

Monolingual Academic Language	N	Mean	SD	df	t	*p*
Computation Items	114	31.60	13.83	228	2.15	0.03*
Word Problem Items	116	25.56	11.00			

*p< .05

Table 7. Difference in the Mathematics Performance between Computation and Word Problem Items for BCL test

Bilingual Community Language	N	Mean	SD	df	t	*p*
Computation Items	108	38.10	13.65	210	-3.98	0.00*
Word Problem Items	104	30.63	13.68			

*p< .05

RQ2: How Differently Aboriginal Pupils Performed for Word Problem Items in Monolingual Academic Language and Bilingual Community Language?

The Levene's test was not statistically different (p >.05). This shows that the test assumed equal variances in the mathematics performance for the word problem items in the MAL test and BCL test. Table 5 shows that the independent samples t–test was statistically significant, (t (218) = 3.04, p<.05) and as such H_0 was rejected. There was a difference in the mathematics performance for the word problem items between MAL test (*M* = 25.56, *SD* = 11.00) and BCL test (*M* = 30.63, *SD* = 13.68). Among the fifth graders Indigenous pupils, they scored better by 5 scores in the mathematics BCL test when compared to the MAL test. Furthermore, Cohen's *d* = (30.63- 25.56) / 12.412542 = 0.41 indicate a moderate to high practical significance (Cummings & Calin-Jageman, 2017).

RQ3: How Differently *Aboriginal* Pupils Performed for Word Problem and Computation Items in Monolingual Academic Language?

The Levene's test was not statistically significant difference (p >.05), and thus the test assumed equal variances in the Aboriginal pupils' mathematics performance between computation and word problem items for the MAL test. The independent sample t–test was statistically significant (t (228) = 2.15, p<.05) between the computation and word problem items for the MAL test as displayed in Table 6. This test rejects H_0 to suggest that there is a significant difference in the pupils' mathematics performance between computation (*M* = 31.60, *SD* = 13.83) and word problem (*M* = 25.56, *SD* = 11.00) items for the MAL test. The higher mean score for the mathematics computation items suggests that the *Aboriginal* pupils performed better by six unit scores in the computation items when compared to the word problem items for the MAL test. Additionally,

Cohen's *d* = (25.56 - 31.6) / 12.495377 = = 0.5 also suggests moderate to high practical significance.

RQ4: How Differently *Aboriginal* Pupils Performed for Word Problem and Computation Items in the Bilingual Community Language?

The Levene's test, which was also not statistically significant (p >.05), suggests that the BCL test assumed equal variances for the Aboriginal pupils' mathematics performance between computation and word problem items. As indicated by Table 7, the independent sample t–test was statistically significant (t (210) = -3.98, p<.05). This test rejects H_0 to suggest that there is a difference in the mathematics performance between computation (*M* = 38.10, *SD* = 13.65) and word problem (*M* = 30.63, *SD* = 13.68) items for the BCL test. The higher mean for the mathematics computation items than the word problem items indicate that the *Aboriginal* pupils scored 7.5 unit scores higher in the computation items when compared to the word problem items for the BCL test. Substantiating further, Cohen's *d* = (30.63 - 38.1) / 13.665008 = 0.55 illustrates a moderate to high practical significance.

DISCUSSION

The average mathematics score between the tests assessed in the academic language and community language shows that the test items in the community language were easier and was more able to discriminate the *Aboriginal* pupils compared to the test items in the academic language. Similar to past studies on non-Aboriginal pupils (Andon, Thompson, & Becker, 2012; Fredua-Kwarteng & Ahia, 2015; Oviedo, 2005; William et al., 2009; Valentin & Lim, 2004; Zerafa 2016), the findings of this study also confirm that mathematically competent Aboriginal pupils do not demonstrate equal amount of proficiency for computation and word problem items due to the element of language embedded

more densely in word problem items. The findings also indicate that there was a difference in the pupils' mathematics performance for the computation items between the academic and community languages and that the mean score for the computation items assessed in the community language is significantly higher than the mean score for the computation items in the academic language with moderate effect. Therefore, it can be concluded that in solving the computation items, the mathematics items in the community language is found to be easier for the *Aboriginal* pupils when compared to using academic language, with discernible practical significance.

For the word problem items, there is a difference in the mathematics performance between the two tests that used the academic and community languages. The higher mean score for the word problem items assessed in the community language compared to the academic language suggests that the *Aboriginal* pupils found the word problem items easier in the community language when compared to the academic language, and that, the use of the community language alleviates their linguistics complications. The medium effect size also warded off the possibility that the significance is trivial.

In inspecting the utility of the MAL test, there is a difference in the mathematics performance between computation and word problem items between MAL test and BCL test. For the MAL test, the higher performance for computation items than in the word problem items, suggests that the *Aboriginal* primary pupils performed better in computation items when compared to word problem items. In the case of the BCL test, there is also a difference in the mathematics performance between computation and word problem items. Just like the MAL test, the *Aboriginal* primary pupils performed better in the computation items than in the word problem items for the BCL test as well. The mathematics BCL test was easier for the *Aboriginal* primary pupils compared to the MAL test for both computation and word problem items. And the computation items were easier than the word problem items in both tests with a moderate effect size recorded. In line with this finding, the effectiveness of using native (community) language is evident among Indigenous students who attended schools that used their native language (Quechua) than non-native language (Spanish) as the language of instruction. The language support provided by the native language as the academic language is significant to the extent the use of native language among the Indigenous students has been recommended as an alternative to reduce the achievement gap among Indigenous students and mainstream students (Hynsjo & Damon, 2016), since Indigenous students perform better when native language is used.

Since a fair and valid assessment is the result of equal access to learning, it is crucial to discuss the association of community language to learning mathematics. The advantage of using students' native (community) language in alleviating the construct irrelevant-variance of linguistics difficulty has been studied much earlier by Bernardo (2002), even though his sample consisted of non-Aboriginal students. Similar to the findings of this study among Aboriginal pupils, in his study among speakers with different native languages, the academic language (English) aggravated their ability to understand the mathematics items due to the language adopted. However, switching the language of the test to their community language allowed them to easily solve the mathematics word problems items as supported in Cummins' Theory of Second Language Acquisition (1979). The point that is being driven home here is that community language supports the mathematical performance among students with limited proficiency in the academic language, for general student population and especially for Aboriginal students. The mixed use of Aboriginal students' community language conversed in their social setting consolidates the understanding of mathematics when language is switched into a second language; their academic language.

The linguistics support is further reinforced when the test items are presented in oral form as revealed in the study by Zaleha, Tan, and Nur (2020). In particular, oral language approach in testing compensates the absence of the written form for the majority of Aboriginal community languages worldwide. Thus, with the removal of language as a construct irrelevant variance in mathematics tests, a promising alternative for a valid measure of Aboriginal pupils' mathematics achievement presents itself. Additionally, the use of oral language promotes successful learning at a very early stage of mathematics learning among younger Aboriginal pupils, who will otherwise lag drastically behind should a less proficient language used in teaching, learning and assessing them.

As a further matter, Aboriginal pupils encounter unbiased opportunity to exhibit their performance in mathematics when cultural elements such as language are infused (Edmonds-Wathen, 2015, Warren & Miller, 2013) because linguistics complications are a potential threat that magnifies learning difficulties in Mathematics (Clark-Gareca, 2016) and invalidates true mathematics scores. Associating the culture of Aboriginal pupils into mathematics provides additional solid foundation for scaffolding their learning in mathematics since mathematics is made more meaningful to them. As Jorgensen et al. (2010) advocated, it is the lack of association to the Aboriginal culture that interferes more with their meaningful mathematics learning and not so much due to the common belief of their poor cognitive ability. In the current era of educational reforms that support equity in education and Education for All, mathematics education that severs culture, in particular language, from the Aboriginal education process is

detrimental to their rights for equal access to learning and should be acknowledged as a practice that invalidates mathematics assessment.

Implications and Future Study

Oral language approach in language acquisition and language testing has been vastly researched on resulting in abundant literature in related areas. However, very little is studied on testing Aboriginal pupils for Mathematics. Therefore, the policy implications posits the adoption of oral language approach in testing for Aboriginal pupils as a valid test accommodation for them. In the move to "level the playing field" (Sireci et al., 2005, p. 457) for mathematics assessments, the oral language approach significantly reduces or removes the influence of language as a construct irrelevant variance. The removal of language as a secondary dimension results in only mathematics ability to be assessed as a primary dimension (Shealy & Stout, 1993). Furthermore, there is a dearth of written form of Aboriginal languages documented worldwide, adopting oral language approach in testing (and bilingual testing in the bargain) largely benefits Aboriginal pupils in the global pursuit towards equity and fairness in testing.

Yet another underlying principle in education is assessment drives learning and, purposeful assessment designs teaching and affects learning. Accordingly, the practical implication of this study would revolve around pedagogical matters when implementing mathematics teaching and learning activities in order for the pupils to experience a fair and valid mathematics test. During mathematics lessons delivery, it would be more beneficial for the Aboriginal students if mathematics teachers who are teaching especially the younger *Aboriginal* pupils, to codeswitch between the community and academic languages. Their ability to speak and understand the *Aboriginal* community language will facilitate and expedite pupils' understanding of mathematics at the early stages of learning. In this context, teachers' proficiency of the mathematics vocabulary in the native language, which we are referring to as mathematical native vocabulary knowledge (MNVK) is as important as being proficient in the mathematical content knowledge. When mathematics lessons are customised with their community language, they are more meaningfully engaged in class. This will help to ensure that the *Aboriginal* pupils are able to grasp and construct basic mathematics concepts.

CONCLUSION

The use of community language in mathematics test has the potential to fairly assess Aboriginal pupils is further for both computation and word problem items. In these two types of items, the bilingual community language test was easier than the monolingual academic language test. When comparing the Aboriginal pupils' performance in these two tests, they scored better in the computation items than in the heavily language-loaded word problem items. This confirms that the use of community language provides a more valid measure of Aboriginal pupils' mathematics ability, and thus signals the use of community language in oral form as a reliable and fair test accommodation for Aboriginal pupils. The bilingual community language (BCL) test as a test accommodation advocated in this study is a promising alternative testing that can enhance the cultural validity of the Aboriginal pupils, putting them at par with the mainstream students in providing equal access to education, in line with the UNESCO's Education for All. Future studies can be directed at a qualitative studies that employs the utility of computer delivered oral mathematics assessment, as a precautionary step during the prohibition of face to face testing administrations such as at present COVID-19 pandemic. The qualitative observations can also shed light on the extent the use of community language averts the learning difficulties in mathematics among Aboriginal pupils.

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