Why do Disadvantaged Filipino Children Find Word Problems in English Difficult?

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Young Filipino students are expected to solve mathematical word problems in English, a language that many encounter only in schools. Using individual interviews of 17 Filipino children, we investigated why word problems in English are difficult and the extent to which the language interferes with performance. Results indicate that children could not solve word problems independently when these were given in English. However, appropriate interventions such as presenting problems in Filipino or narrating them led to improved performance. Implications for teaching are proposed.

In accordance with Philippine national policy, mathematics is taught in English. However, many children from poor families have little knowledge of English and it is recommended that instruction begin "with an assumption of zero knowledge" (Gonzales, 2006, p. 147). It is within this background that we investigated student performance in the domain of word problems that form an integral part of the Philippine mathematics curriculum (Department of Education Bureau of Elementary Education, 2003).

Word problems primarily serve as a means to apply computational skills. The curriculum documents are quite explicit about how children should solve word problems. Children should be able to state what is asked and what are given, identify word clues, and specify the correct operation to be used. For two-step problems, children are also asked for the "hidden question". These stringent requirements are evident not only in textbooks but also in standardised assessments (see Figure 1).

In a Grade Two class, there are 20 boys and 25 girls. How many pupils are there in all?

____ 24. What is asked in the problem?
a. number of pupils in all c. number of girls
b. number of boys d. number of class

____ 25. What are given in the problem?
a. 20 boys c. 20 boys and 25 girls
b. 25 girls d. 25 boys and 20 girls

____ 26. What operation will solve the problem?
a. addition b. subtraction c. multiplication d. division

____ 27. What is the correct number sentence?
a. 20 x 25 = N b. 25 ÷ 20 = N c. 25 + 20 = N d. 25 – 20 = N

____ 28. What is the correct answer?
a. 45 pupils b. 54 pupils c. 45 boys d. 45 girls

Figure 1. Word problem assessments for Grade 2 students from all public schools in one city

Filipino children find word problems difficult (Brawner et al., 1999), and the language factor is identified as one of the "what-else-is-new" reasons for student failure (Philippine Executive Report on the TIMSS, cited by Carteciano, 2005). Multiple studies have shown

L. Sparrow, B. Kissane, & C. Hurst (Eds.), *Shaping the future of mathematics education: Proceedings of the 33rd annual conference of the Mathematics Education Research Group of Australasia.* Fremantle: MERGA.

that Filipino children find word problems in English more difficult than those in Filipino (Bautista, Mitchelmore, & Mulligan, 2009; Bautista & Mulligan, 2010; Bernardo, 1999). It is also well-known that word problems in English are more difficult for children who are still in the process of learning English than for native English speakers (Martiniello, 2008).

Language is not the only challenge facing problem solvers. Some additive problem structures are more difficult than others (Carpenter & Moser, 1984). For example, the problem "There are 12 birds. Five are flying. How many are not flying?" is more difficult than "Julia has 12 books. She gave 5 books to Mark. How many books does Julia have now?" even though both can be answered by calculating 12 – 7. The first problem does not involve an explicit action, making it hard for children to relate the given quantities (Nunes & Bryant, 1996).

The disadvantages of written tests as a means of diagnosing children's difficulties is well established (Ellerton & Olson, 2005), especially when the language of the test is not the child's first language (Abedi, 2002). When children produce an error for short-answer questions, one can only hypothesise about the reasons for the error. Similarly, it is possible for students who do not have a firm grasp of the mathematical concepts involved in the problem to give correct answers. Thus, individual interviews are becoming increasingly utilised for mathematical assessments (Goldin, 2000).

The purpose of this paper is to describe an interview method for investigating the responses of young Filipino students to one-step addition and subtraction problems. Through the interviews, we aim to investigate (a) why Filipino children find word problems in English difficult, and (b) the extent to which the language and the related mathematical concepts explain these difficulties. The results from this study were intended to inform the design of an intervention as part of a larger research project.

Structure of the Interview Protocol

Analysing children's word problem difficulties through individual interviews is not new. Newman (1983) interviewed children to assess their initial errors when solving word problems, and proposed that word problem solvers should succeed in five intermediate stages: Reading, Comprehension, Transformation, Process Skills, and Encoding. The hierarchy provides a framework for identifying children's errors, allowing for the preparation of an appropriate teaching strategy.

Newman acknowledged that the method was designed to identify children's initial errors. However, other errors may occur after the initial error. For instance, a child who initially miscomprehends a problem may subsequently execute some calculation inaccurately. These errors were not of primary concern in the Newman method. Nevertheless, Newman proposed modifications that allow for researchers to determine whether children may produce subsequent errors by providing assistance in the initial stages. For example, for a child who commits a Reading error, the interviewer may read the problem aloud and see whether the child can now proceed with a solution.

The value of Newman's modification became evident after we have analysed our pilot interviews with seven Filipino children (Bautista, Mulligan, & Mitchelmore, in press). The pilot data revealed that children with the same initial error (e.g., Reading) may consequently follow different solution paths after some help. Thus, we shifted the focus from identifying initial errors to investigating "intentional actions" (Jacobs & Ambrose, 2008, p. 261) which could give students more opportunities to reveal their mathematical abilities. Our pilot interviews also revealed that the interview design should allow for the systematic use of two language versions of each problem.

We now describe the interview method in detail. It employs six tasks taken from Carpenter and Moser's (1984) word problem classification (Table 1). English and Filipino versions of each task were prepared and checked by reverse translation.

Table 1
Word Problem Tasks Used in this Study

Problem Type	Sample Problem
Join (addition)	Alvin had 3 coins. Then Jun gave him 8 more coins. How many coins does Alvin have now?
Separate (subtraction)	Dora has 11 mangoes. Then Dora gave 6 mangoes to Kevin. How many mangoes does Dora have now?
Join (missing addend)	Jolina had 7 pencils. Then Alma gave her some more pencils. Now Jolina has 12 pencils. How many pencils did Alma give her?
Combine (addition)	Tess has 5 hats. Rodel has 8 hats. How many hats do they have altogether?
Combine (subtraction)	Jimmy and Mia have 11 marbles altogether. Jimmy has 4 marbles. How many marbles does Mia have?
Compare	Rica has 12 books. Luis has 7 books. How many more books does Rica have than Luis?

Following Newman (1983), the English problem was first presented to the child, who was asked to read the problem aloud. When no response or an incorrect response was given, the interviewer attempted to determine whether the child had any difficulties in comprehending what had been read. The child was asked for any word or phrase that was not understood, or what was being asked in the problem. Alternatively, the child may have been asked to retell the problem (cf. Hershkovitz & Nesher, 2001) as a means of understanding the child's interpretation of the text.

The Filipino version was presented next. If this procedure did not help, the problem was read aloud to the child by the interviewer. Again, if reading aloud did not help the child, the interviewer retold the problem to the child as if it were a story (in Filipino), utilising questions about the text along the way, to facilitate comprehension. The following dialogue illustrates the interviewer's (*I*) intervention when the child (*C*) could not manage to retell the situation described by the Separation problem:

I: *O, may 11 na mangga si Dora ha* [Dora has 11 mangoes]. *Tapos, ito makinig ka, ilan ulit yung mangga ni Dora* [Then, listen here, how many mangoes does she have again]?
C: Eleven.
I: *Binigyan ni Dora si Kevin* [Dora gave Kevin]*; namigay si Dora ng anim na mangga* [Dora gave Kevin six mangoes]. *O, kanina ilan yung mangga ni Dora* [How many mangoes did Dora have a while ago]?
C: Eleven.
I: *O, tapos namigay siya ng* [Then how many did she give]?
C: *Anim* [Six].
I: *Ilan na ang mangga ni Dora ngayon* [How many mangoes does Dora have now]?

Some children still failed to produce correct answers even after the text was narrated to them in this manner. To further understand the cause of their difficulties, the interviewer gave one or more of the following interventions: (a) reading the problem line by line and pausing to allow the child to represent each statement using blocks, (b) presenting a concrete modelling task, or (c) rewording the problem. The concrete modelling task was one that matched the problem's mathematical structure (cf. Wright, Martland, & Stafford, 2000). In the Separation Problem, for example, the corresponding task was to briefly display, then screen, 11 counters. Without allowing the child to see, six counters were then removed from this set. The interviewer said (in Filipino), *There were 11 counters, but then I took away 6 counters. How many counters are there now?*

For Combine (subtraction) and Compare problems, a reworded version was presented because rewording has been found to facilitate problem solution (Bernardo, 1999; Jacobs & Ambrose, 2008). For example, the reworded version for the Compare problem was: "Rica has 12 books. Luis has 7 books. How many more books does Luis need so that he and Rica would have the same number of books?"

We do not assert that the concrete modelling tasks or the reworded versions required the same level of thinking as the original problems. However, because our aim was to determine obstacles to solving word problems, we wanted to provide as many aids as possible in order to identify the strategy that enabled the child to solve the word problem. The strategy of providing aids was in accordance with Goldin's (2000) procedure for constructing scripts for task-based interviews. He asserted that these pre-planned aids allow the researcher to delve deeper into children's thinking than would have been possible had no aids been available. The enabling strategies for making word problems accessible to students are summarised in Table 2. Minor computational errors that were corrected after children had been asked to repeat or explain their solution were recorded as correct.

Table 2
Levels of Enabling Strategies for Correct Solution

Description
Incorrect – child fails to solve the problem
Concrete – child solves the corresponding concrete modelling task
Reworded – child solves the reworded problem
Narrated – child solves the problem when the interviewer tells the problem as if it were a story or when the interviewer corrects the child's initial misinterpretation of the problem
Read aloud – child solves the problem when the interviewer reads it aloud in Filipino
Filipino – child solves the Filipino problem independently (not read aloud by interviewer)
English – child solves the English problem independently (not read aloud by interviewer)

Interview Results

The interviews reported here were conducted with 17 Filipino Grade 2 students (11 girls, 6 boys; mean age: 7 years 10 months) who voluntarily participated in a parish-based, out-of-school tutorial program. All the children were from public schools drawn from the poorer areas of Metropolitan Manila.

For purposes of analysis, the Join (addition), Separate (subtraction), and Combine (addition) problems (see Table 1) were grouped together and labelled "Easy Problems"

because previous findings (Okamoto, 1996; Riley, Greeno, & Heller, 1983) indicate that children are generally more successful with these problems than with the rest. The remaining problems in Table 1 were grouped together and labelled 'Difficult Problems'.

The 17 children's responses are summarised in Figure 2. The graph shows the point at which a correct solution was produced. For easy problems, most responses were correct. However, most of these correct answers required some form of assistance from the interviewer. These aids were less successful for the difficult problems where almost half of the responses were incorrect. Although reading word problems aloud facilitated problem solution for easy problems, it did not seem to have helped for more difficult problems.

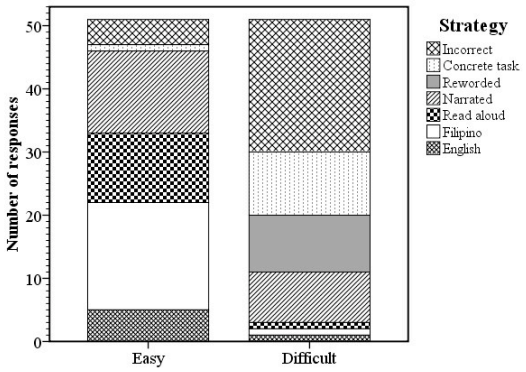

Figure 2. Enabling strategies for easy and difficult problems

The results also show the expected poor performance in solving problems written in English, and the interview protocols reveal several possible reasons. Some children could only read one syllable at a time, and most had not mastered the conventions of written English (e.g. reading "now" as "no"). Also, many children knew only the most basic words. When Dina[7] was asked what "Alvin had 3 coins" meant, she replied, "*Pera* [money]". She was only able to pick out one word that she understood. Under these circumstances, it was unlikely that she could have understood the meaning of the entire sentence. Eleven other children just shook their heads when asked whether they understood the same statement. To place ourselves in these children's shoes, solving the relatively simple Join (addition) problem in Spanish requires understanding the sentence, "Alvin tuvo tres monedas" which a non-Spanish speaker would find difficult, if not impossible, to comprehend.

The inability to understand simple English sentences did not prevent some children from producing correct answers, although it is questionable whether the correct answers reflected mathematical understanding. For example, after reading the Join (addition) problem (see Table 1), Maria added the two given numbers silently and said, "Eleven", which was the correct answer. However, when asked subsequently about what happened in the problem and what "gave" meant, she could not respond. When the Filipino version was presented, she smiled and said, "*Sabi na nga ba, dagdag 'yan eh!* [I told you, it's addition!]". It was only then when she understood the basis for her own method.

Not only did children have problems with English vocabulary but they also had difficulties with the syntax of the English language. For example, Sheryl knew what "gave" meant in "Alvin had 3 coins. Then Jun gave him 8 more coins", but she thought

[7] All children's names are pseudonyms.

that Alvin was the giver. There were also many instances where children said they did not understand the word "does" in the sentence "How many coins does Alvin have now?"

Presenting problems in Filipino offered some help, but several children needed to have the text narrated to them, especially for the more difficult problems. In particular, probing questions showed that children interpreted "Then Alma gave her some more pencils. Now Jolina has 12 pencils" as "Alma gave 12 pencils," even when the text was presented in Filipino. The situation had to be clarified to them before a correct strategy was selected. This aid worked in some instances. For example, after Monica read the Filipino version of this problem, she immediately answered, "Twelve". The interviewer said that the text did not mention the exact number of pencils given, but only that Alma gave Jolina some pencils and "*kaya ngayon, 12 na daw ang lapis ni Jolina*. [so now, Jolina already has 12 pencils]". After hearing the narration, Monica used her fingers to silently count up from seven and gave the correct answer.

After the problem had been clarified, the children displayed a wide range of mathematical strategies. Jessa solved the problem above in a different way. She formed a set of seven red blocks and joined nine green blocks to this set. She then started to count all the blocks, starting with the red ones. Upon reaching 12, she removed the excess blocks and counted the number of green blocks.

We also observed that besides understanding the problem context, children also needed to understand that addition and subtraction are more than joining sets or breaking them apart. For example, most of the children responded to the Compare problem by adding the two given numbers or saying the larger number. They had no appropriate strategy to deal with this mathematical structure, even after the problem was explained to them.

Discussion

Most of the children in this study could not solve word problems when they were presented solely in written English. This result confirms the assertion we made at the outset that written assessments may fail to give a complete picture of Filipino children's abilities. The pre-planned aids presented during the interviews minimised interference from deficiencies in reading and English language competence. The interview allowed the children to demonstrate their mathematical knowledge, even when the language initially impeded problem solution. Thus, we found that like the children from Carpenter and Moser's (1984) study, the children from our study also found some problem structures easier than others and displayed a wide range of strategies for solving word problems.

Results indicate that the children's difficulties with the English language are not comparable with those reported in the literature. Much of the research on difficulties of second language learners focuses on academic English and the highly specialised language of mathematics (Bielenberg & Fillmore, 2005; Schleppegrell, 2007). However, the needs of the children in this study are much more basic. They have not even acquired the English language skills necessary for daily social interactions, and the interviews themselves had to be in Filipino in order for meaningful communication to take place. Thus, the problem's semantic structure remains concealed and cannot form the basis for an appropriate strategy.

The children's unfamiliarity with English may prevent them from going through the recommended problem solving steps illustrated in Figure 1. It is conceivable that the guide questions were intended to help children capture relevant information from the text. However, children with very low levels of English proficiency and decoding skills are unlikely to benefit from such questions. The only way for them to solve these questions is if they were taught superficial strategies. For example, to determine what is being asked,

one should simply change "how many" in "How many pupils are there in all?" to "the number of". These kinds of strategies may work but they encourage low-level thinking and do not contribute to meaningful sense making.

Implications for Teaching and Curriculum

The results from this study have clear indications for teaching. First, because many children could not understand everyday English words, plenty of time should be set aside for helping children understand the problem situation. Helping children make sense of the situation before applying a mathematical strategy will prevent the development of short-cut solutions not based on the problem text. Second, the interviews demonstrated effective interventions that make word problems more accessible for students. Teachers may narrate problems and guide children towards understanding, and support the discussion with concrete tasks. These aids often lead children to execute appropriate strategies.

A third implication is that it is important to develop children's understanding of the various addition and subtraction structures illustrated in Table 1. Because students' language difficulties may mask their gaps in mathematical knowledge, it may be tempting to focus primarily on language issues. It is also important to encourage them to model the relations in the problems using representations which make sense to them, whether these be physical objects, drawings, counting sequences, or number sentences.

We also propose that the problem solving process outlined in Philippine curriculum documents be seriously re-examined. This study showed how difficult it was for children to understand common English words. The proposed intermediate questions illustrated in Figure 1 contain more specialised language than that used in basic social interactions. Linguistically, they are even more complex than the original word problem, and it is highly unlikely that the questions would contribute to better comprehension. Instead, we suggest that questioning should be more conversational. These questions should pertain to the particular problem being solved and help children develop a qualitative understanding of the relationships between the given quantities.

Finally, the research reported here must be interpreted in the context of a developing country with limited educational resources (Senate of the Philippines, 2009, January 27), and where educational reform is challenging but possible (Nebres, 2009).

Acknowledgment

Special thanks are due to Assoc. Prof. Michael Mitchelmore for providing valuable comments and suggestions on earlier drafts of this paper.

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