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The Research Digests

This Digest is one of a series of periodic digests produced by the Australian Council for Educational Research (ACER) for the Queensland College of Teachers.

Each digest focuses on a single topical issue, and provides a review of major messages from research on the issue. A key feature of the digests is an emphasis on what the research means for teachers and teaching. Over the course of several editions, a wide range of issues will be covered, so that teachers from different areas of schooling will find topics of relevance to their needs and interests.

Previous Issues

- 1 (Oct 2007) *Writing to learn*
- 2 (Apr 2008) *Managing student behaviour in the classroom*
- 3 (Oct 2008) *Using Data to Improve Learning*
- 4 (Apr 2009) *The use of ICT in schools in the digital age: what does the research say?*
- 5 (Aug 2009) *Talking to learn: Dialogue in the classroom*
- 6 (Feb 2010) *Successful professional learning*

Research Digest

Number 7

Language in the mathematics classroom

This Digest is focused on research studies about language in the mathematics classroom. A selection of websites is listed and a full reference list provided. Links to those references for which full-text online access is freely available are also included.

Introduction

The role of language in mathematics learning

2

The role of language in mathematics learning has been a matter of interest over many years.

For example, Pimm (1987) explored some of the language issues that arise in attempting to teach and learn mathematics in a school setting. This wide-ranging exploration covered the implications involved in using the metaphor of mathematics as a language, as well as aspects of classroom communication.

It also examined some common spoken interactions in mathematics classrooms.

In 2000, in Making Sense of Word Problems, Verschaffel, Greer, and de Corte reported research on students' unrealistic considerations when solving arithmetical word problems in school mathematics conditions.

A recent Australian review of numeracy teaching noted the significant role of language in mathematics learning. *The National Numeracy Review Report* (2008), commissioned by the Council of Australian Governments (COAG), synthesised evidence on effective numeracy teaching to support the goal of improving numeracy outcomes for Australian students. The report of the review acknowledged the significance of language in mathematics learning, and recommended:

That the language and literacies of mathematics be explicitly taught by all teachers of mathematics in recognition that language can provide a formidable barrier to both the understanding of mathematics concepts and to providing students access to assessment items aimed at eliciting mathematical understandings.

Research evidence about the role of language in numeracy learning was included in this report in the discussion of ways of supporting students' numeracy learning, although it was noted that there was a limited amount of research into language factors in mathematics education. Several issues relating to language and literacy were identified:

- ▶ the specialised symbols and expressions of mathematical language
- ▶ the use of everyday English terms that have different meanings in mathematics classrooms
- ▶ language-based factors in solving mathematical word problems
- ▶ communication in the mathematics classroom. (COAG, 2008)

This digest draws on recent research on these four issues.

It is important to note the difference between 'literacy in mathematics' and 'mathematical literacy'. This digest is concerned with literacy in mathematics, that is, how students access mathematics through language, and with the role that language plays in mathematics teaching and learning. The term 'mathematical literacy' uses literacy in the sense of an aptitude, as in PISA, the Programme for International Student Assessment. The PISA framework defines mathematical literacy as: ...

an individual's capacity to identify and understand the role that mathematics plays in the world, to make well-founded judgements and to use and engage with mathematics in ways that meet the needs of that individual's life as a constructive, concerned and reflective citizen. (Thomson, Cresswell & De Bortoli, 2004) ■



Teachers as content experts

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For many children, mathematics is seen as a 'foreign language'; the symbols and expressions provide a formidable barrier to understanding of mathematical concepts. (COAG, 2008)



Schleppegrell (2007) conducted a review of research by applied linguists and mathematics educators that highlighted the pedagogical challenges of mathematics. The review notes that since at least the mid-1980s researchers have been pointing to ways that language is implicated in the teaching of mathematics. A key influence has been the discussion by M.A.K. Halliday (1978) of the 'mathematical register'. Halliday pointed out that counting, measuring, and other 'everyday' ways of doing mathematics draw on 'everyday' language, but that the kinds of mathematics that students need to develop through schooling use language in new ways to serve new functions (in Schleppegrell, 2007). A summary of key linguistic features of the mathematics register is indicative of the different aspects of language involved.

Features of the classroom mathematics register

Multiple semiotic register

- ▶ mathematics symbolic notation
- ▶ oral language
- ▶ written language
- ▶ graphs and visual displays

Grammatical patterns

- ▶ technical vocabulary
- ▶ dense noun phrases
- ▶ 'being' and 'having' verbs
- ▶ conjunctions with technical meaning
- ▶ implicit logical relationships (Schleppegrell, 2007)

Schleppegrell's review identifies research that suggests the important role that teachers play in helping students to use language effectively, and the need for explicit teaching of language in mathematics. For example, O'Halloran (2000) recommends that

teachers use oral language to unpack and explain the meanings in mathematics symbolism as a way of using the multi-semiotic nature of mathematics to help students draw on the different meaning making modes for understanding. Explicitly focusing students' attention on the linguistic features can help students explore and clarify the technical meanings.

Other research identified by Schleppegrell suggests that



there are various strategies that teachers can use to support students to move from the everyday language into the mathematics register

... by helping students recognise and use technical language rather than informal language when they are defining and explaining concepts; by working to develop connections between the everyday meanings of words and their mathematical meanings, especially for ambiguous terms, homonyms and similar-sounding words; and by explicitly evaluating students' ability to use technical language appropriately. One way to evaluate this ability is by having students talk about mathematics as they solve problems, encouraging them to articulate patterns and generalisations.
(Adams, 2003)

The 'mathematical register' is *unique to mathematics, is highly formalised and includes symbols, pictures, words and numbers* (Kotsopoulos, 2007). A study that analysed transcripts from a Year 9 classroom demonstrated how the mathematical register can sound like a foreign language to students. The analysis showed that sixty words identified as belonging to the mathematical register were used more than 1500 times in 300 minutes of classroom transcription. In the following extract from a lesson on the order of operations, words belonging to the mathematical register are italicised:

Teacher: This is our last topic in *algebra*, and it's actually not going to be very different from the stuff you've already done. ... Do this topic, do the review exercises, and finish the morning with our review. *Adding and subtracting polynomials*. All right. Again, a lot of time I find people look at a question like that and they go home and say, "Look at all those terms, look at all those *positives* and *negatives*, look at all those exponents. I can't do that." ... But all it would take is for them to take two seconds and look at it and realise, "Wait a minute, what's the operation that I'm being asked to *perform* here? What's the *operation* I'm being asked to *perform*? And how can I rely on prior knowledge?" Watch. What's the *operation* here? [long pause; the Teacher calls on a student whose hand is up]

Evan: *Division. Brackets, basically, multiplication.*

Teacher: I don't think so.

Evan: *Addition?* What was that question again?

Teacher: You've got four choices. What is the *operation* here?

Evan: [shrugs]

Teacher: I don't think so. To look at it, you've got a set of brackets, but the important part is what's in between them. It's *positive*, so you're being asked to add this *polynomial*. What kind of *polynomial* is this? A *trinomial*... (Kotsopoulos, 2007)

This analysis led to the conclusion that to become proficient in mathematics, *students need to participate in mathematical discussions and conversations in classrooms. This participation, in turn, will allow teachers to understand better whether students are making appropriate conceptual connections between words and their mathematical meanings* (Kotsopoulos, 2007).

Zevenbergen (2001) discussed the forms of literacy associated with reading and interpreting mathematical texts, and identified several specific literacy demands:

- ▶ words used in a mathematics specific way, including terms such as *tessellation*, and words that exist in school mathematics and also in the world beyond school
- ▶ spatial terminology (for example, above, horizontal)
- ▶ the concise and precise expression in mathematics that can involve significant lexical density
- ▶ word problems that create complexity through the semantic structuring of the questions rather than the mathematics.

One aspect of language that can cause confusion is the ambiguity of words that are different in meaning between the context beyond school and the mathematics classroom. Zevenbergen cites this example from a middle years classroom:

T: *Can you calculate the volume of this box?*

S: *um .. [pause] .. no [has a puzzled look]*

T: *Do you know what volume is?*

S: *Yes, it is the button on the TV.*

Complexity of working with words used in mathematics that have multiple meanings.

Words can have different meanings depending on the context in which they are used, as is evident in the case above. Zevenbergen provides the following list, indicating the ambiguity in meaning between the context beyond school, and the context of the mathematics classroom:

angle average base below cardinal change
common degree difference face figure improper
leaves left make mean model natural
odd parallel point power product proper
rational real record right root sign
similar square table times unit volume

Adams, Thangata & King (2005) report on research highlighting the complexity of working with words used in mathematics that have multiple meanings. Mathematical language includes many words that sound the same as words with other meanings (or homophones), and many words that have the same spelling as everyday words, but have different meanings as mathematical terms. Table 1 provides examples of some of these words.

Table 1: Mathematical words and homophonic partner

Mathematical term	Homophonic partner
arc	ark
chord	cord
mode	mowed
pi	pie
plane	plain
serial	cereal
sine	sign
sum	some

Adapted from Adams, Thanagata & King, 2005

These researchers suggest several key considerations in helping students deal with mathematical vocabulary, for example:

- ▶ it is essential that students have the opportunity to see, hear, say and write mathematical vocabulary in context
- ▶ students at all levels need opportunities to define mathematical terms in ways that make sense to them
- ▶ support students' development of visual skills by encouraging them to use pictures and diagrams to help understand mathematical language (Adams, Thanagata & King, 2005).

A further difficulty is found in the words used for the four main mathematical operations. Tout (1991) notes how analysis of words and phrases used for the operations of addition, subtraction, multiplication and division indicates how complicated it is for adults to solve problems and interpret real life situations. He offers the following examples:

Terms can overlap between different operations. For example, the phrase 'how many' is commonly used to indicate division as in 'how many fives in 25?' But what about 'how many are there between 5 and 25? Or 'how many are five 25s?' 'How many' can be used for any operation, but many students recognise it as division.

Another complication is the multitude of different words used for the one operation. Taking subtraction as an example, the common words used would include: from, minus, take away, and subtract. But what about: difference between, less, reduce, remove, decrease, discount, take off, and various other phrases that call for the use of subtraction? (Tout, 1991) ■

Everyday words in mathematics

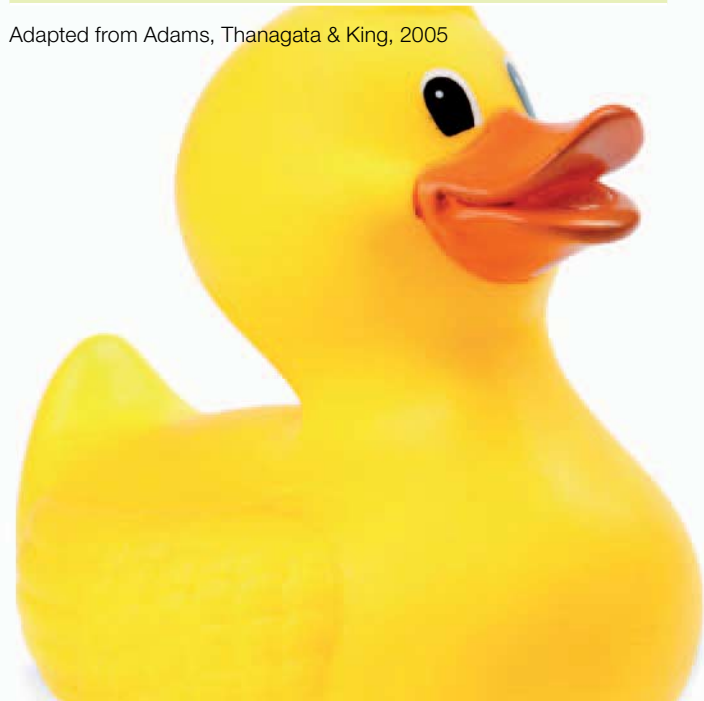
Mathematics is like a language, although technically it is not a natural or informal human language, but a formal, that is, artificially constructed language. Importantly, we use our natural everyday language to teach the formal language of mathematics. Sometimes we encounter problems when the technical words we use, as formal parts of mathematics, conflict with an everyday understanding or use of the same word, or related words (Gough, 2007).

Mathematics uses many words in the English language that are already familiar to students in their everyday lives. Words such as 'change' have a specific mathematical meaning, but as they also have an everyday meaning, they are ambiguous in mathematics classrooms. Some examples are provided in Table 2. Students need to be taught new meanings for these already familiar words.

Table 2: Mathematical words and their everyday usage

Mathematical term	Everyday usage
angle	point of view
concrete	hard substance used in paving
figure	shape of an object
odd	strange
order	place a request
property	belonging to someone
rational	sane
volume	sound level

Adapted from Adams, Thanagata & King, 2005



A research project (Landsell, 1999) tracked the progress of 5-year old children as they acquired new mathematical concepts in the classroom, and investigated their learning of new meanings of familiar words, or new words for the concepts. In the following transcript the teacher is introducing the word 'change' with the mathematical meaning of 'money left over'.

T: You could buy it, couldn't you? Go on, then, you buy it. That's it ... Right, you've taken the penny off, OK? And you'd have one penny left, wouldn't you? One penny change. So that would be nice. ...

R: Mmmmm.

T: What about the duck, that's 5 p – Could you buy the duck?

R: Yes.

T: Yes, and what would happen if you did that?

R: I would have ... I'd have two pennies change. The next day the teacher asked R whether her 10 p could buy an item worth 7 p:

R: Er, I could buy it because I've got 10 p change then I would have three pennies.

T: Right, you've got 10 p and you have three pennies change, that's quite right, well done!

The student demonstrated confusion with the terminology rather than the mathematical concept, and the teacher corrected her use of language and confirmed her calculation.

A week later, R was more confident when talking about change. In this game, the teacher had 10 p to spend on items worth less than 10 p:

R: You could buy the 8 p one.

T: Would I have any left?

R: Yes, you would have some change. And you could buy the 7 p one, the 5 p one, and the 1 p one. ■

Mathematical problem solving

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The justification of applied word problems is to attempt to make greater links to the world beyond school. ... What is central is that this contextualising process increases the literacy demands in school mathematics. (Zevenbergen, 2001)

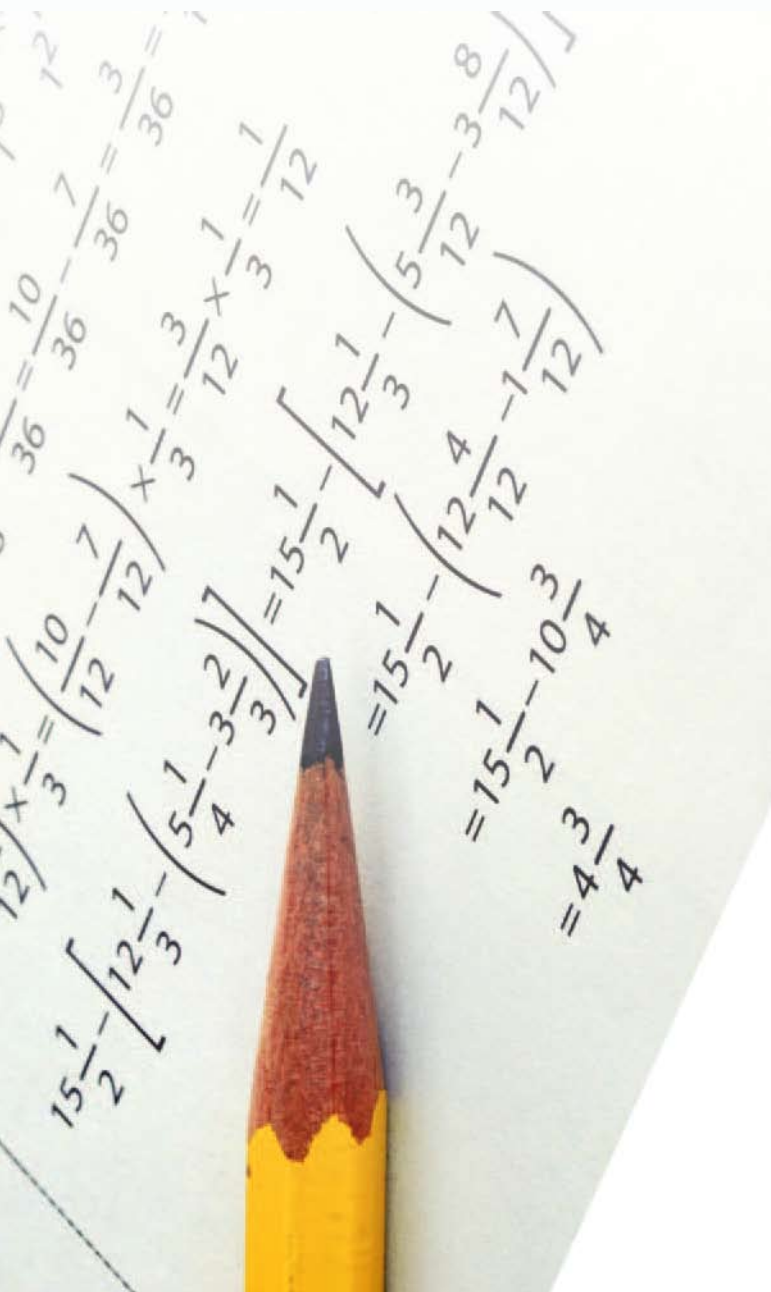
Language is implicated in teaching and learning mathematics in many ways. An aspect of particular interest is the use of word problems and highly contextualised tasks that involve high levels of language use. The *National Numeracy Review Report* (COAG, 2008) refers to Newman's examination of the errors made by students as they solved worded mathematics problems. There were seven categories of error which were related to the sequencing associated with problem solution: reading, comprehension, transformation, process skills, encoding, carelessness, and lack of motivation (Newman, 1977). Later research confirmed these findings.

Zevenbergen (2001) notes the significant body of research undertaken on word problems. Three main types of problems have been recognised:

Change questions	These questions involve a dynamic process in which there is an event that alters the value of the quantity.	Example: 'Michael had 5 apples. Kelly gave him two more apples: how many apples does Michael have now?'
Combine questions	These relate to static situations where there are two amounts. These are considered either as separate entities or in relation to each other.	Example: 'Steven has 4 oranges; Michelle has 2 oranges; how many oranges do they have altogether?'
Compare questions	These involve the comparison of two amounts and the difference between them.	Example: 'Stephanie has 5 oranges; Alice has 2 more oranges than Stephanie; how many oranges does Alice have?'

In each case, the arithmetic is very simple, but Zevenbergen highlights the level of complexity related to the semantic structure of the problems.

The *National Numeracy Review Report* (COAG, 2008) notes language factors specific to mathematics, citing the work of DiGisi and Fleming (2005) who described three types of vocabulary that students needed to be able to solve word problems: mathematics vocabulary, procedural vocabulary, and descriptive vocabulary.



Research on reading provides insights into effective methods of teaching vocabulary, and this can be utilised in mathematics classrooms, in order to develop students' ability to understand and use specific mathematics terms, and ambiguous, multiple meaning words used in specific ways in mathematics. Pierce & Fontaine (2009) point out that:

The principles of robust vocabulary instruction recommended for the language arts can be successfully applied to the domain of mathematics. Math vocabulary instruction should follow the recommendations of Isabel Beck¹ and her colleagues by offering student-friendly definitions of math terms, encouraging deep processing of word meanings, providing extended opportunities to encounter words, and enriching the verbal environment of the math classroom.

Pierce and Fontaine distinguish between 'technical vocabulary words', such as *number sentence*, *rectangle*, *fraction*; words that have a precise mathematical meaning that must be taught explicitly; and 'subtechnical vocabulary words' that have a common meaning, but also have a mathematical denotation that must be taught. The word *true* is one example of a subtechnical vocabulary word, that in everyday language means *accurate*, *the opposite of false*, but has a technical definition in mathematics problems of a *number sentence where the value to the left of the equal sign is the same as the value to the right*. Pierce and Fontaine offer the following vignette of how a teacher might help students to learn the word *true* in the mathematical context.

Mrs Lewis started the lesson by asking her students to come up with a student-friendly definition of the word true. After some discussion, the class decided on the following: something that really happened, or a fact, the opposite of false. Mrs Lewis reminded the class that most words have several meanings, dependent on the situation in which the word is used. Then she introduced a second meaning of true: 'a word used to describe a number sentence where the value to the left of the equal sign is the same as the value on the right of the equal sign'. Together the class brainstormed examples of number sentences that were true

The word *true* is one example of a subtechnical vocabulary word, that in everyday language means accurate, the opposite of false, but has a technical definition in mathematics problems of a *number sentence where the value to the left of the equal sign is the same as the value to the right*.

(e.g., $4 + 3 = 7$, $5 \times 4 = 2 \times 10$) and number sentences that were not true (e.g., $1 + 2 = 5$, $3 \times 4 = 7$). The students then wrote the term, its everyday meaning, and its math definition in their math glossaries, while the teacher recorded it on their math word wall. (Pierce & Fontaine, 2009)

Kabasakalian (2007) conducted a study that explored the use of a protocol for enabling students who are not skilled readers to approach problem solving tasks. The study introduced the protocol as a tool for staff development about word problems, and linked this to the potential usefulness of the protocol as a tool for students. A qualitative research design was used to investigate the ways in which the tool could be used by teachers in study groups, and then directly with students in the classroom. A starting point for the research was the literature on the value of learning mathematics through problem solving. There is evidence that although middle school students find mathematics problems very challenging, good word problems embed within themselves a number of different mathematical ideas, and therefore can serve as a powerful way to explore mathematics concepts and form connections among them.

The steps in the teacher professional development workshops started with the distribution of a mathematics problem to the group. Instructions given by the facilitator to participants were as follows:

1. *Write what you think the students would find difficult about this problem.*
2. *Now write anything that's in the problem, anything at all.*

1 Beck, I., McKeown, M.G., & Kucan, L. (2002). *Bringing words to life: Robust vocabulary development*. New York. Guilford.

Comment: The crucial role of professional learning

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3. *Discussion about the meaning of the text was generated by these steps. The next steps were as follows:*
 4. *Tell us the story of the problem.*
 5. *Work with a partner to solve the problem; write solutions or attempts on a problem sheet.*
 6. *Present your small group's strategies and solution to the large group. (Kabasakalian, 2007)*

The protocol enabled the teachers to reflect on the mathematics as their students might.

It provides an approach to mathematics problem solving for teachers of students with undeveloped reading and analytical abilities. Teachers who transfer this protocol for their students' use will enable those students in developing important thinking, reading, analytical and mathematical skills – skills that will greatly enhance their life prospects. (Kabasakalian, 2007)

Word problems can present comprehension difficulties for students who are English Language Learners (ELLs). A study exploring the nature of linguistic difficulty in maths word problems used differential items functioning procedures to identify items that were more difficult for ELLs than English speaking students of comparable proficiency in mathematics (Martiniello, 2008). The analysis indicated that the most linguistically complex items were those that contained *complicated grammatical structures that were central to comprehending the item, along with mostly low-frequency, nonmathematical vocabulary terms whose meanings were central for comprehending the item and could not be derived from the context.*

Think-aloud protocols were used with a sample of ELLs who came from homes where the primary language was Spanish.

In the interview sessions, the students were asked to read the item, and explain what the item was asking them to do. The linguistic features of items that showed evidence of causing difficulty for ELLs were examined. Some of the characteristics that hindered reading comprehension were found to relate to syntax and vocabulary.

Characteristics of syntax included:

- ▶ Multiple clauses. Item sentences have multiclausal complex structures with embedded adverbial and relative clauses, which are more difficult to understand than other types of clauses.
- ▶ Long noun phrases. Long phrases with embedded noun and prepositional phrases lead to comprehension difficulties.
- ▶ Limited syntactic transparency in the text, such as a lack of clear relationship between the syntactic units. (Martiniello, 2008)

This research has implications for test developers, but also for teachers.

It confirms how important language skills are for understanding and solving mathematical problems in large-scale assessments. Thus, the teaching of mathematics to ELLs can no longer be perceived as separate from the teaching of language. Research on teachers' perceptions has found some contradictions in the way teachers conceive of maths instruction (as free from language) and the kinds of maths assessments they use in their classrooms (with great language demands). Teachers must provide sustained linguistic scaffolding for ELLs while encouraging the development of their mathematical meaning-making skills. (Martiniello, 2008) ■



Communicating in the mathematics classroom: Learners of English as an additional language

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Ellerton and Clements (1991) drew attention to the wide range of social, cognitive, cultural and linguistic factors that relate to communication in the mathematics classroom. They considered a number of aspects, including the ways in which the language of teachers impacts on mathematics learning. Their analysis of the language of resources used in mathematics classrooms led to the conclusion that it is essential that teachers train their students to read mathematics.

When the language of instruction is English, students who learn English as an additional language are likely to experience language-related difficulties in mathematics. An overview of research into classrooms that promote teaching and learning mathematics with understanding highlighted the equity issues involved for ELLs. Borgioli (2008) drew on both mathematics and second language acquisition research, focusing on ways that teachers can support ELLs to learn mathematics and become more proficient in English.

When ELLs students cannot understand the language of mathematics because of language barriers, teachers need to use a variety of strategies to help with students' language acquisition, and enhance their mathematical learning. Brown, Cady & Taylor (2009) illustrate the nature of the problem through this example.

For example, a word problem might read, 'Find a number that decreased by 30 is 4 times its opposite'. To help ELLs comprehend this word problem, a teacher needs to take time to explain the vocabulary and break down the sentence into comprehensible chunks of phrases and words. (Brown, Cady & Taylor, 2009) ■



Mathematics and literature

12

An interesting aspect of the connections between mathematics and language is to be found in reports of the use of literature to teach mathematics. A 2005 focus issue of Mathematics Teaching in the Middle School published by the National Council of Teachers of Mathematics showed how various topics from the middle school mathematics curriculum could be taught by using literature such as children's story books, folk and fairy tales, poetry and the Harry Potter series.

Zambo (2005) described some mathematical activities based on the Chinese tale, *A Grain of Rice*, and how he linked these activities to observing and listening to the students as they worked to solve the problems.

The initial activity involved reading the story up to the 25th day and posing the question: 'How many grains of rice would Pong Lo have received on the 25th day?' Zambo notes that the students used various strategies – adding, multiplying, using calculators, using paper and pencil, searching for a formula. He reports that as individuals and groups shared their solution strategies, they saw the connections among adding a number to itself, multiplying by 2, and raising 2 to a power. He then continued to read the book, which provided the answer of a total of 16,777,216 grains of rice that were delivered on the 25th day. Other activities included:

- ▶ Make a graph of the number of grains of rice received each day to illustrate exponential growth.
- ▶ Estimate how much space all that rice would occupy. Would it fill a swimming pool, the classroom, the entire school?
- ▶ Determine if the descriptions in the book are realistic: for example, would the 131,072 grains of rice delivered on the 18th day really fill 4 ebony chests?
- ▶ Learn about the abacus. (The royal mathematician in the book always uses one.)

Zambo explained his belief *that good literature can activate an individual's curiosity and interest and motivate them to explore mathematics*. He also argues that *literature can provide a context for understanding mathematics*.

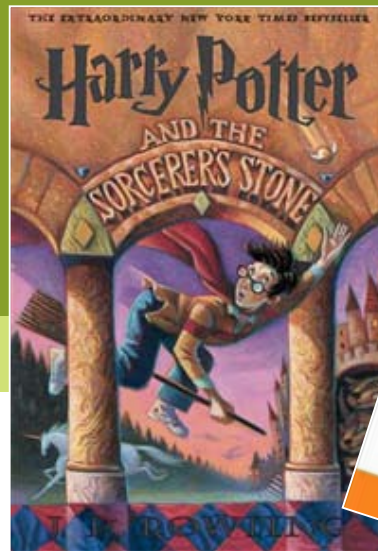
In the same issue McShea, Vogel and Yarnevich (2005) used examples from the Harry Potter books to show students the *magic of mathematics and to teach them that problem-solving skills are the key to success*.

One exercise involved exploring the conversions among different kinds of 'Potter money'. '*The gold ones are Galleons, [Hagrid] explained. Seventeen silver Sickles to a Galleon, and twenty-nine Knuts to a Sickle, it's easy enough*'. (Rowling, 1997)

A typical conversion problem would be:

A Firebolt broomstick costs 3 gold Galleons, and Harry had only brought silver Sickles and bronze Knuts. How many of these would be needed to buy the Firebolt broomstick?





Another activity, based on the episode involving Harry's first experience of spending the money he had acquired, once free of the Dursleys, was designed to teach functions and linear modelling:

Assume that Harry bought Chocolate Frogs, which cost 11 bronze Knuts per bag, and Bertie Bott's Every Flavour Beans, which cost 17 bronze Knuts per bag. How many bags of each candy did Harry buy if his purchase totalled 11 silver Sickles and 7 bronze Knuts?

Students initially used arithmetic skills for the conversion exercise, but after they had done this, they were introduced to the concept of linear modelling and variables were assigned for the unknown values. The necessary linear equation was first written in words:

Cost per bag • number of bags of Chocolate Frogs bought + cost per bag • number of bags of Bertie Bott's Every Flavor Beans = total cost of Harry's purchase.

An example from the first novel in the series was used to emphasise the importance of understanding probabilities: *Can you figure out the chances that Ron, Harry and Hermione will all be placed in Gryffindor?* The authors of this study noted that the interdisciplinary approach used here added to the students' appreciation of mathematics and their ability to work as problem solvers (McShea, Vogel and Yarnevich, 2005).

Lewis Carroll's *Alice's Adventures in Wonderland* has also been used to relate mathematics and literature (Taber, 2007). For example, asking students to compare and contrast the way in which the Cheshire Cat appears and disappears with the changes in Alice's size provides an opportunity to discuss the distinctions between additive and multiplicative change. The author of this study concluded that

'Alice's Adventures in Wonderland' can provide a rich environment for mathematics and language learning. Reading the story while learning about topics such as multiplication of fractions, multiplicative change, proportional reasoning, or similarity provides a context of imaginative representation in which students can explore, discuss and deepen their understanding of mathematics. Focusing on the mathematical aspects of the story will also help students analyse and gain a deeper appreciation for the literary qualities of the story. (Taber, 2007)

Connecting mathematics with literature also supports learning for 3-6 year olds. Recognised benefits for this age group include the way children can:

- ▶ read and understand how mathematics is a natural part of their physical and social worlds,
- ▶ learn through books how mathematical ideas can be represented in different ways,
- ▶ focus on the patterns of number and colour to predict how stories are constructed, and
- ▶ use the natural context of stories to discuss and reason about mathematical ideas (Whitin & Whitin, 2005).

Ward (2005), proposed that the growing body of research in the fields of mathematics and literacy supports the inclusion of children's literature into the teaching and learning of mathematics.

Thus, given that many mathematical ideas and concepts are abstract or symbolic, children's literature has a unique advantage in the mathematics classroom because these ideas and concepts can be presented within the context of a story, using pictures, and more informal, familiar language. ... By integrating mathematics and literature, students gain experience with solving word problems couched in familiar stories and thus avoid struggling with unfamiliar vocabulary. (Ward, 2005) ■



Comment

Teaching the language and literacies of mathematics

14

This review has explored research highlighting some of the ways in which language plays a vital role in mathematics learning. When teachers are aware of this, they can help students overcome misunderstandings about language that create barriers to completing mathematical tasks.

The digest began by identifying some aspects of the role played by language in mathematics learning. Issues related to the specialised symbols and expressions of mathematical language, and the use of everyday terms in technical ways in mathematics classrooms. Other issues involved language factors involved in solving word problems, and the added challenges for mathematics students who are learners of English as an additional language.

Teachers have a significant role to play in explicit teaching to help students deal with the complexities of language in mathematics. Understanding about the nature of language used in mathematics classrooms enables teachers to support students to deal with potential difficulties related to language. In the case of word problems, for example, three types of vocabulary are involved: mathematics vocabulary, procedural vocabulary, and descriptive vocabulary.

The concluding section on the use of literature to teach mathematics highlights some of the possibilities for using literature to provide a context for understanding mathematics.



useful websites

<http://www.nctm.org/search.aspx?c=all&q=Language%20and%20mathematics>

This site provides an extensive collection of published writings on many aspects of language and mathematics, including mathematical language, the intersection of language and mathematics, and teaching mathematics to English Language Learners.

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