IDENTIFYING MATHEMATICS IN CHILDREN'S LITERATURE: YEAR SEVEN STUDENT'S RESULTS

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Using children's literature in mathematics is not a new idea. Although resources have been produced to support teachers in using literature in their mathematics programmes, there is little research to show this approach is successful. One debate associated with using children's literature in mathematics teaching/learning is how much support is required for children to recognise the mathematics in the literature. The research that is available has focused on very young children interacting with stories being read to them or identifying adaptations needed to the text and/or illustrations to allow children to recognise the mathematical information inherent in the story. This paper presents the results of a study that used book reviews as a tool to identify the extent Year 7 students could identify the mathematics in children's literature.

Background

The use of children's literature[1] in mathematics is an idea that has been promoted since the 1970s (Whitin & Wilde, 1992). This combination of reading and mathematics allows children to use their strengths in one subject to support their learning in the other and worthy of including in classroom programmes (Thraikill, 1994). In integrating literature and mathematics, the challenge is in keeping the integrity of both curriculum areas (Perger, 2004). The ability to focus on the mathematics without losing the enjoyment of stories would seem to depend on the skill of the reader and the extent to which the mathematics can be identified. To support this, books have been published to aid teachers in identifying the mathematical possibilities within specific examples of children's literature, for example *Books You Can Count On* (Griffiths & Clyne, 1988). Reference to children's literature can also be found in teacher publications such as The National Council of Teachers of Mathematics' (NCTM) *Teaching Children Mathematics* journal and in the teacher's edition of some mathematics textbooks. Here

[1] *Note:* The definition of children's literature used in this paper is that of Anderson (2006). She identifies children's literature as all books written for children excluding comics, joke and cartoon books as well as non-fiction or reference books that were not intended to be read from cover to cover such as dictionaries or encyclopaedias.

the children's literature is used to support the mathematical learning focus of the chapter, for example *Elementary and Middle School Mathematics: Teaching Developmentally* (Van de Walle, 2004).

With a renewed focus on literacy and numeracy, publishers have produced books linked to both curriculum areas (e.g., the MacMillan *Side-By-Side* series). These books are often levelled to children's reading ability, yet they rely on children using their knowledge of mathematics to gain meaning of the story. Although there are a variety of resources available that encourage teachers to use children's literature in their mathematics programmes there is little research that identifies the benefits of combining children's literature and mathematics (Anderson, Anderson & Shapiro, 2005; Hong, 1996).

One issue relating to the use of children's literature in mathematics is the extent to which the mathematics needs to be outlined for it to be a useful tool for mathematical learning. Whitin and Whitin (2004), although supporters of using children's literature in mathematics programmes, considered the task of identifying the mathematics a time consuming one for teachers. To help teachers with this process they developed a set of criteria for teachers to use when assessing the quality of children's stories they may wish to use. The criteria they developed identified four aspects they consider mathematics related children's literature book should demonstrate. The four aspects are "mathematical integrity", a "potential for varied responses", an "aesthetic dimension", and "ethnic, gender, and cultural inclusiveness" (2004, p. 4). In developing these criteria Whitin and Whitin referred to the NCTM's *Curriculum and Evaluation Standards for Mathematics* (1989) and the *Principles and Standards for School Mathematics* (2002) as well as standards set by the National Council of Teachers of English (NCTE) and the International Reading Association (IRA). The development of these criteria would indicate the responsibility for identifying the mathematics is that of the teacher. Whitin and Whitin believed that when teachers choose children's books carefully and introduce them effectively not only will mathematics learning be enriched but there is the potential for learning in other curriculum areas as well.

Schiro (1997) also recognised a benefit in using children's literature in teaching mathematics, although he believed that the mathematics could easily be missed or appear confusing to the reader if not made explicitly obvious. In a study to identify literature appropriate for mathematical learning, Schiro (1997) developed a criterion for assessing children's literature. This criterion differed from Whitin and Whitin's (2004) in that it focused on how explicit the mathematics was presented rather than the quality of the mathematics and the story. His explanation required the mathematics to be made explicit in both illustrations and text if it were to benefit mathematical learning. He considered the responsibility of making the mathematics clearly that of the author and illustrator. Schiro recommended that algorithms be included in text and that numerals be presented in digit form to support the mathematical word. Schiro stated that mathematical information also needed to be incorporated into the illustrations if the reader is to understand the mathematics inherent in the story. For example the illustrations for the story *Ten in the Bed* should include the mathematical equation 10 – 1 = 9 written on the end of the bed. In the story *One grain of Rice* (Demi, 1997), for example, tables could be incorporate into the illustrations so as to demonstrate the increasing value of the numbers. This inclusion of numeral data into texts and

illustrations would seem to indicate that the reader needs this support to identify the mathematics within children's literature. Yet in doing so is the opportunity for mathematical thinking being taken away from the reader?

Perkins (2001) states that if we believe mathematics is everywhere we should be able to easily find it represented in children's literature, whether the books have been written with a mathematical focus or not. Supporting this idea, young children have been observed using mathematical language when discussing a story being read to them (Van den Heuvel-Panhuizen & Van den Boogaard, 2008; Anderson et al., 2005). Van den Heuvel-Panhuizen and Van den Boogaard's (2008) study in The Netherlands showed that young children are able to identify the mathematics in children's literature without the need for adaptations or teacher direction. They identified examples of mathematical related thinking during the reading of a picture book to four young children. They found that five-year old children used mathematical language during discussing the illustrations with peers. When analysing the children's talk they discovered that half their utterances were mathematically related.

The importance of illustrations in promoting mathematical discussion when children are read to was also identified in a Canadian study. Anderson et al. (2005) used videoed sessions of 39 parents reading specific examples of children's literature with their four-year old children. During these sessions parents and children were viewed engaging in mathematical dialogue to co-construct the meaning of the text. Size, number, and shape were the concepts discussed, in order of frequency. Many of these discussions were child initiated. The evidence of these studies would indicate that even young children are able to recognise mathematics within children's literature without the adaptations Schiro (1997) considered necessary.

Using children's literature in a mathematics programme can enhance the learning of mathematical concepts through giving children the opportunity to talk about mathematics. Van den Heuvel-Panhuizen and Van den Boogaard (2008) found that providing an opportunity to talk about a story not only contributed to the understanding of mathematical concepts but also helped develop a positive attitude towards mathematics. Griffiths and Clyne (1991) recognised that children's literature was able to play a larger role in mathematical learning as it provided a model, illustrated a concept, posed a problem or stimulated an investigation.

In summary, the effectiveness of using children's literature as a tool for teaching/learning mathematics would seem to hinge on the reader identifying the mathematical possibilities within the story, but the extent to which the mathematics needs to be made explicit to the reader is debatable. At one end of the argument Schiro (1997) states mathematical information needs to be presented to the reader in digit and/or equation format in both text and illustrations. At the other end of the scale Van den Heuvel-Panhuizen and Van den Boogaard (2008) believed that young children are able to identify the mathematics even when the teacher has given no clear indication that it is present.

Given this debate as to how much support is required for readers to be able to identify the mathematics, a group of Year 7 students were asked to complete two tasks. These tasks were designed to allow students to demonstrate the extent to which they could recognise the mathematics in children's literature. This paper presents the findings of that study.

This study

This study focused on two questions:

- Could students identify the mathematics in a storybook without being given any indication that mathematical concepts / opportunities where present?
- What mathematics do students identify in a story, when there is no indication of mathematical content, and when they are told mathematics is present?

To answer these questions, a group of Year 7 students (11 year olds) approaching the end of their first year at intermediate school were given two tasks. Tasks were completed as part of their normal class programme separated by an interval break. Students had been exposed to a variety of children's literature throughout the year although never in their mathematics programme. Thirty books were provided for students (see Appendix A) to choose from. These all contained opportunities for mathematical learning although in some the mathematics was more obvious than others. There was a range of instructional reading and mathematical concept levels. Each student chose a different book to review for each task.

The first task students completed was to select a book and write a book review. Added to the book review, students were asked to identify how a teacher might use the book in their classroom programme. Students were not given any indication which areas of the curriculum or age level the books could be used for. All students present in the class at the time the task was presented participated. 16 students of mixed ability (in both mathematics and reading) completed a book review.

The second task was set once students returned to class after a twenty-minute interval break. This time, 19 students participated, again of mixed mathematics and reading ability. They included 16 students who completed the first task and 3 others. The same selection of books was used. For this task students were informed that the books they could choose from were purchased to be used in a mathematics programme. The task required students to identify the mathematics that children could learn from reading or being read the books. Each student chose one book and listed the mathematical learning that could be achieved through the use of the book selected.

Results and discussion

Book review task (Task 1)

Like the children in Van den Heuvel and Van den Boogard's (2008) study the majority of Year 7 students in this study were able to identify the mathematics even when not altered to its presence. 13 of the 16 students recognised mathematical learning possibilities for a teacher using the book they had reviewed (see Table 1)

Table 1: Mathematical concepts identified in book review task

	Number	Measurement	Geometry
Concepts Identified	Counting	Length (cm, m)	Shape
	Place Value	Weight	
	Addition	Angles - degrees	
	Multiplication	Time	
	Division	Area of a Circle	
	Knowledge of Numbers	Size	

As in Anderson et al. (2004) number, measurement (size) and geometry (shape) were the areas of mathematics identified. The students noted that angles (degrees) and the area of a circle could also relate to concepts in the geometry.

When presenting learning possibilities students stated the mathematics clearly and concisely. For example,

> If I were a teacher, the children in my class would learn how to divide in half.
> *(The Great Divide, Dodds, 2000)*

> If I were a teacher children will learn how to multiply, add and learn more about maths.
> *(Anno's Mysterious Multiplying Jar, Anno & Anno, 1982)*

> If I were a teacher the children would learn how to find the area of a circle and how to measure. *(Sir Cumference and the Dragon of Pi, Neuschwander, 1999)*

Two students elaborated further on the mathematics children could learn if a teacher used the book they had reviewed by listing the concepts children could learn in more detail. For example,

> Children could learn how zero's make a number even bigger and numbers never end. They could also learn how to count from one to a googol; which has 100 zeros! You can also learn the names of other huge numbers.
> *(Can You Count to a Googol? Wells, 2000)*

Another student included detail of a task he would set the class.

> If I were a teacher I would get my students to find out how many humpback whales and dogs would fit in the class room and how many peas would fit in a bowl. The students would learn about measurements like metres, centimetres, and weight.
> *(Counting on Frank, Clement, 1990)*

These students recognised only mathematical learning possibilities in the books they reviewed. The mathematics identified by these students in their book review task indicated that they were able to recognize mathematical possibilities within children's literature. The specific links to the mathematics and/or detail they were able to provide, as to the learning possibilities, indicates that the mathematics was neither obscure nor confusing. The adaptations to text and illustrations Schiro (1997) recommended were not required for these children to recognise the mathematics inherent in the books they reviewed.

When identifying mathematical possibilities for a teacher, four students were confident enough to also recommend an age group for the book they reviewed. All the age levels identified were appropriate for the story and the mathematics they had

selected. Three of these students justified the age group through links to other curriculum areas or interests. These justifications included an interest a child at that age group might have, i.e. cats for the story *Six Dinner Sid* (Moore, 1990), or other learning such as learning to read which they saw as focus of year level. The ability for books with a strong mathematical content to enrich learning in other curriculum areas was something Whitin and Whitin (2004) and Griffths and Clyne (1991) stated to be an advantage of using children's literature in a mathematics programme. Five students in this study identified learning in both mathematics and other areas of their lives. These areas included other curriculum areas such as reading, language (narrative text), and science. Students also made links to real life learning that could eventuate from the story reviewed such as "love and romance" and "wisdom". Here students identified the links Griffths and Clyne, as well as Whitin and Whitin, had assigned to teachers. The students' ability to identify mathematical learning, specific concepts, possible activities and learning in other curriculum areas, and as well learning associated with real life, would support Griffths and Clyne's (1991) observation that children's literature is able to play a role in mathematical learning.

Three students failed to identify any mathematics. Two of these students had chosen books where the mathematics was not obvious, although these books could have provided motivation for mathematical investigations. One example of children's literature where obvious mathematics was not identified was a counting book. Of course, the inability to identify the mathematics may relate to an individual's mathematical or reading ability, but individual participant's ability in reading and mathematics was not identified in this study.

Identifying the mathematics (Task 2)

The second task students were assigned a more mathematics-focused task. It was to list possible mathematical learning in a book chosen from the same selection as in task one. For those students who completed both tasks, a different book from the one they had used for task one was chosen for task two. For this task students were alerted to the fact that the books had been purchased for use in mathematical programmes. No information about what mathematics the books contained was given.

All students were able to identify appropriate mathematical learning possibilities. Once again students identified mathematical concepts associated with number, measurement and geometry. See Table 2 for mathematical concepts identified during Task 2, in order of frequency mentioned.

Table 2: Mathematics identified in children's literature

	Number	**Measurement**	**Geometry**
Concepts Identified	Division	Volume/Capacity	Shapes
	Multiplication	Weight	Tangrams
	Addition	Distance	
	Subtraction	Height	
	Counting	Area of a Circle	
	Reading Big Numbers	Time	
	Place Value	Cooking	

The Year 7 students in this study linked 11 books to number, 7 to measurement and 3 to geometry. The frequency of mathematical concepts has changed from the measurement (size), number, and geometry (shape) noted by Anderson et al (2004) in that the identification of number has overtaken that of measurement. This could be due to a stronger focus on number as students reach higher levels of the school curriculum.

The mathematics identified in this second task was more detailed than in the first. For example, in the first task when no indication of mathematical content was given, the mathematics associated with the book *The Dot and the Line* (Juster, 1963) was noted as "some mathematics shapes". In the second task when students are altered to the mathematical content the specific mathematical learning was identified as "children could learn shapes—squares, triangles, hexagons, parallelograms, rhomboids, polyhedrons, trapezoids, decagons, tetragrams as well as angles". The two books where students failed to identify the mathematics in Task 1 (one where the mathematics was not obvious) had appropriate mathematical content identified in this second task. This difference could be attributed to different students completing the book review. This would indicate teachers could play an important role in enhancing the mathematics in examples of children's literature through the way they introduce it the story (Whitin & Whitin, 2004).

Although students were only asked to identify mathematics in the second task, some students made links to other learning as well. These included riddles and rhymes, history, reading and science. One student also made links to more general aspects of mathematics such as problem solving ("being able to answer mathematics problems"). Another student who seems to agree with Perkins' (2001) belief that if mathematics is everywhere we should be able to find it represented in children's literature linked mathematics to everyday life. In reference to the book *Maths Curse* (Scieszka, 1995) she concluded her list of possible mathematical learning with the sentence "Children can learn that maths is all around us and mathematics has real life applications and is very important".

Conclusion

The year 7 students in this study showed that they could identify opportunities for mathematical learning in samples of children's literature. Mathematics was the predominant curriculum area identified even when no indication of mathematical possibilities was provided. Without adaptations to text or illustrations, or teachers' input, these students identified appropriate mathematical learning, often linking it to a wider field of knowledge— both other curriculum areas and life skills. It is possible that if the adaptations recommended by Shiro (1997) had been evident in the text or illustrations of these books, the mathematical opportunities may have been limited to those of the author and students may not have made the wider links to other curriculum areas or the life skills they did. When altered to the presence of mathematical content the student's descriptions of the mathematical possibilities was even more detailed. This would indicate that although students can independently identify the mathematics in children's literature, the input of a teacher could further enhance learning opportunities. With a student's ability to recognise the mathematics and a teacher's careful selection and introduction of books, the use of children's literature could be a powerful tool in both motivating and consolidating mathematical knowledge.

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