Improving Mathematical Learning Through Contextualisation

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A significant issue for primary teachers is finding ways to encourage students to recognise mathematical ideas embedded in a broad range of contexts, and to connect and apply their mathematical knowledge to such contexts. Indeed, it has been noted that students frequently engage in a haphazard and random application of their mathematical knowledge outside the mathematics classroom. This paper is based on a qualitative multiple case study involving 8 Year Six and Seven students. The study investigated the capacity of those students to recognise, apply, and question the use of mathematical ideas embedded in a range of contexts. It also considered the extent to which students’ capacity to connect mathematical knowledge to other contexts could motivate them to learn mathematics. In particular it investigated the effect of the Mathematical Search strategy in achieving those ends. It found that students’ thinking about mathematics and their attitudes towards it could be enhanced by targeting mathematical connections through the use of the Mathematical Search and associated teaching and learning strategies.

Background

The original impetus and later focus for the study on which this paper is based came from two sources. First, in her address to the 1995 biennial conference of the Australian Association of Mathematics Teachers (AAMT), Watson (1995) highlighted the fact that many Australians appear oblivious to the vast amount of statistical data that confront them on a daily basis. Indeed, when such data are noticed, many people appear unable to interpret them or to recognise when they are used inappropriately. Second, in a study of primary school students working with worded problems, Peter-Koop (2004) found that the students often failed to identify embedded mathematical ideas and tended to arbitrarily apply numbers in randomly chosen operations that may have borne no relation to the essence of a particular problem. Both writers alluded to the notion that numeracy is much more than mathematical knowledge but that it necessarily includes the application of that knowledge in context.

When considering these ideas, it is worth noting the report of the 1997 Numeracy Education Strategy Development Conference which stated the following about numeracy:

To be numerate is to use mathematics effectively to meet the general demands of life at home, in paid work, and for participation in community and civic life. In school education, numeracy is a fundamental component of learning, performance, discourse and critique across all areas of the curriculum. It involves the disposition to use, in context, a combination of: underpinning mathematical concepts and skills from across the discipline (numerical, spatial, graphical, statistical and algebraic); mathematical thinking and strategies; general thinking skills; and grounded appreciation of context. (AAMT, 1997, p. 15)

When viewed in the context of the above statement, the work of Watson (1995) and Peter-Koop (2004) has implications for teachers of numeracy, especially when the words ‘use mathematics effectively’ and ‘grounded appreciation of context’ are considered. It is not sufficient for teachers to teach only the mathematical content but it is imperative that they help students recognise, interpret and apply mathematics in a wide range of contexts not necessarily associated with the mathematics classroom. It follows that this is an area of
interest to researchers, that is, to investigate ways in which student numeracy might be enhanced by the use of particular teaching and learning strategies. The overall study (Hurst, 2007) on which this paper is based focussed on the use of the *Mathematical Search* and associated strategies and whether they could assist in the development of numeracy in a group of Western Australian primary school students.

**Theoretical Framework**

The research questions for the original study were developed from a substantial search of research based literature on numeracy and the following key ideas were synthesised:

- Numeracy across the curriculum
- Embedding of mathematics in authentic, real-life contexts
- Development of questioning skills

**Numeracy across the curriculum**

Steen (1997) considered that too much emphasis has been placed on computational skills and that “school mathematics continues to emphasise school focussed goals rather than the goals expected by the outside world” (p. xxvi). Steen’s comments were supported by the Curriculum Council of Western Australia’s Curriculum Framework (1998), which underlined the central importance of the ‘Working Mathematically’ strand. Effectively, this placed the onus on teachers to provide more than what is regarded as ‘classroom mathematics’ and that the provision of opportunities to develop real numeracy, through applying mathematical knowledge to other learning areas, is important. In considering the notion of ‘situated cognition’ and transferability of learning, Boaler noted that traditional approaches to developing student numeracy were based on the assumption that “mathematics can be learned in school, embedded within any particular learning structures, and then lifted out of school to be applied to any situation in the real world” (1993, p. 12). However, as Kemp and Hogan (2000) pointed out, “evidence suggests that students do not automatically use their mathematical knowledge in other areas” (p. 13). Indeed, this was confirmed in a later study by Boaler (2002).

Willis (1998) supported the view that numeracy is more likely to be enhanced if taught in the context in which it occurs. She argued that students can better understand mathematical concepts and learn to apply them when they are presented in realistic contexts. Indeed, “children learn best in precisely this way, that the richness of the context helps them to make sense of these mathematical ideas” (Willis, 1998, p. 8). Morony, Hogan and Thornton (2004) linked the idea of numeracy across the curriculum to the previously mentioned definition of numeracy (AAMT, 1997) in stating:

> Education must be about enabling people to understand and interact with the world. The skills, habits of mind and dispositions developed through effective attention to numeracy across the curriculum are clearly key components of understanding and interacting with the world. (p. 2)

It is important to note here that the term ‘numeracy’ may be equated with ‘statistical literacy’ (Watson, 1995), ‘quantitative literacy’ (Steen, n.d.) and ‘mathematical literacy’ (Organisation for Economic Cooperation and Development or OECD, 2003). Such terms appear to denote the same ideas as contained in the AAMT (1997) definition of numeracy.
Embedding of mathematics in authentic, real-life contexts

Willis’s (1998) comments lead to the idea of ‘authentic’ and real-life’ contexts. In its 2003 Report of the Program for International Student Assessment (PISA), the OECD described mathematical literacy in this way:

An individual’s capacity to identify and understand the role that mathematics plays in the world, to make well-founded judgments and to use and engage in mathematics in ways that meet the needs of that individual’s life as a constructive, concerned, and reflective citizen (OECD, 2003, p. 15).

This infers that it is better to embed the mathematics to be learned in real-life or authentic contexts of the type that students are likely to encounter in situations out of school and to which they can relate (Garvey, 2002). Such contexts needed to be varied and challenging and able to provide students with an opportunity to discover mathematical connections (Humble, 2002).

Kemp and Hogan (2000) noted that many of the contexts used by teachers to embed mathematics in the name of ‘problem solving’ are too contrived and lack realism. This may be because teachers are using such contexts primarily to teach the mathematics associated with the contrived problem, rather than for developing true numeracy.

Development of questioning skills

Watson (1995) was concerned at the inability of people to question the ways in which mathematical information was used and presented in the mass media. It seems inherent in the definitions of numeracy presented so far that the ability to answer and pose questions about the use of mathematics is an essential skill. Westwood (2000) espoused the value of activities where students are required to justify, explain and demonstrate their reasoning, and noted how they help to develop higher levels of understanding. Bobis, Mulligan, Lowrie and Taplin (1999) noted the importance of using different types of questions, namely descriptive, divergent and convergent in order to maximise the participation of all students. Similarly, Sullivan and Lilburn (1997) supported the need to develop numeracy skills such as thinking, analysing, criticising and solving unfamiliar problems in saying that the use of different levels of questions should be used by all teachers of mathematics. Sullivan and Lilburn specifically noted the use of Bloom’s (1956) taxonomy which, if used appropriately, could provide ample opportunities for students to apply mathematical concepts as well as analyse, synthesise and evaluate their use.

The development of the conceptual framework for the original study was informed by the Numeracy Framework developed by Willis and Hogan (Hogan, 2000; Morony et al., 2004, Willis, 1998) which incorporated three perspectives on student numeracy. These three perspectives reflected the three key ideas that were developed from the literature search, and which were described in the preceding paragraphs. A blend of the following three perspectives is required for students to display intelligent mathematical action in context:

- **Mathematical knowledge** – the knowledge needed for intelligent mathematical action
- **Contextual knowledge** – the ability to link mathematics to experiences
- **Strategic knowledge** – the ability to ask questions about the application of particular mathematical knowledge
The key ideas of numeracy across the curriculum, authentic contexts, and the development of questioning skills were incorporated into the conceptual framework for the original study (Hurst, 2007a), as were the three perspectives on numeracy contained in the Numeracy Framework devised by Willis and Hogan (Hogan, 2000; Morony et al., 2004, Willis, 1998). Indeed, the development of the three modes of thinking described in the Numeracy Framework (mathematical, contextual and strategic thinking) became the centrepiece of the conceptual framework. It seemed that there needed to be a strategy that could be used to simultaneously encourage teachers to view numeracy as a cross-curricular idea, incorporate the use of authentic contexts, and encourage the development of higher order questioning by students. Hence, the original study sought to find out if the Mathematical Search, in combination with associated teaching and learning strategies, could achieve those ends. The Mathematical Search was devised by the researcher and was used on four occasions by the researcher during the course of the study. It was developed with the intent of ascertaining whether or not a specific strategy of that type could enhance the capacity of students to recognise and use mathematical ideas embedded in a variety of
contexts. In the study, only written contexts were used. Students had not used the \textit{Mathematical Search} prior to their involvement in the study (Hurst, 2007b).

The purpose of the \textit{Mathematical Search} was to encourage students to actively seek mathematical concepts and facts embedded in any of a variety of contextual situations. The \textit{Mathematical Search} strategy was used on four occasions during the project. On three of these, students asked to read a body of text based on themes and topics that were being taught in classes, such as Indigenous Australians, Gold Rushes, and Environmental Pests. On the fourth occasion, students were asked to find a context (article, brochure, advertisement, or other source) that contained mathematical ideas. Their task was to identify the mathematical ideas in the text, describe what the mathematics told about the main ideas in the text, and to use the mathematical ideas to explain some of the patterns, trends and any apparent inconsistencies in the text. In this study, students were also asked to pose questions about the text using the mathematical ideas described. The \textit{Mathematical Search} was supported by other teaching and learning strategies such as concept mapping, graph scaffolding, debriefing discussions following a \textit{Mathematical Search}, and one to one interviewing (Hurst, 2007b).

\section*{Design and Methodology}

The original six month study employed a multiple case study approach involving eight female Western Australian primary school students, aged 11 or 12 years, and in Years Six or Seven. It was never intended that such a study would provide conclusive evidence of the effect of the \textit{Mathematical Search} strategy, but rather that the evidence drawn from the analysis of gathered data ought to be considered as a starting point for further investigation by researchers and teachers, based on the strategies used in the study. Nonetheless, evidence gathered from such a multiple case study is more compelling than that gained from a single case study (Frankel and Wallen, 2003; Yin, 2003). As well, the possibility of making reasonable generalisations was increased by data triangulation. Data were generated from evidence gathered from a variety of sources listed in Table 1.

\begin{table}[h!]
\begin{center}
\begin{tabular}{|l|p{10cm}|}
\hline
\textbf{Instrument} & \textbf{Purpose} \\
\hline
Pre-Project and Post-Project Benchmark Task in Mathematics & Provide benchmarks for comparison in order to have a basis for assessing changes in student thinking. \\
\hline
Pre-Project and Post-Project Student Interview & Provide an understanding of initial and later student thinking about mathematics in context. Act as reference points for later comparisons after implementation of project tasks. Ascertain extent of changes to student thinking about the value of the project tasks and mathematical learning in context. \\
\hline
Project tasks \textit{Mathematical Searches} (four) and other tasks & Provide students with opportunities to identify, discuss meanings of, and apply mathematical knowledge in a variety of contexts. Generate work samples to serve as indicators of student thinking and progress. \\
\hline
Researcher’s Reflective Journal and Anecdotal Notes & Record details of observations made during classroom visits to administer project tasks. These visits occurred at least monthly over a six month period. \\
\hline
\end{tabular}
\end{center}
\end{table}
Description of data collection instruments

The Pre-Project and Post-Project Benchmark Tasks consisted of a simple table of information and students were asked to identify key ideas that the information showed (mathematical knowledge), to give possible explanations for variations in that information (contextual knowledge), and to pose questions that could be used to infer other ideas from the information (strategic knowledge). The Pre-Project and Post-Project Student Interviews were to some extent ‘task-based’ as students were presented with items, such as brochures, maps and advertisements, that contained embedded mathematical ideas. They were questioned about the mathematics they could identify, what it showed them about the context in which it was embedded, and how they could use the mathematics to learn more about the context. Students were also asked about their attitude towards mathematics, and in the later interview, their opinion of the Mathematical Search tasks they had done.

Associated strategies

The central strategy used in the study was the Mathematical Search but it was employed in concert with other associated strategies. Hence, its success in enhancing, or otherwise, the development of mathematical, contextual and strategic knowledge should be viewed in the context of the conceptual framework as a ‘Model for Teaching Numeracy in Context’, rather than as a single strategy. For instance, task debriefing was conducted after each Mathematical Search. On these occasions, student findings about the embedded mathematical content were discussed and further possibilities as to how the mathematics might be used in contextual and strategic ways were raised. In essence, the use of the Mathematical Search was modelled for students. In some debriefing sessions, concept mapping was used to help students build a picture of the mathematics that could be found in everyday topics, such as ‘public transport’ and ‘restaurants and cafes’ and the use of questioning was also modelled.

Empirical assertions

During the initial phase of data analysis, interview transcripts, work samples, and field notes were analysed and some thirteen empirical assertions were developed from the data. An empirical assertion could be described as a contention, statement, declaration or claim that something in particular is likely to occur, based on the contender’s observations and experiences (Erickson, 1986). One of the thirteen empirical assertions generated from the research questions is discussed in this paper. That is

Students in this study will display an improved capacity to recognise mathematical ideas in a written context, and to use contextual and strategic thinking when considering mathematical ideas embedded within a written context, having used the Mathematical Search strategy on several occasions. (Hurst, 2007a,b)

Findings and Discussion

In order to determine whether or not the strategies used did enhance student thinking, it is necessary to briefly show the basis on which decisions about the extent of the enhancement were made. It was considered that student thinking had developed if modes of thinking not present in early samples and interviews were present in later ones. For example, if a student showed evidence of contextual or strategic thinking in the Post-
Project Interview or Benchmark Task, but had not done so in the Pre-Project Interview or Benchmark Task, then it was considered that this represented a gain in thinking. With respect to ‘levels of gain’, a student displaying mathematical thinking on Benchmark Task 1 is deemed to have made ‘substantial gains’ if, on Benchmark Task 2, she displayed contextual thinking, as well as mathematical thinking. A student is considered to have made ‘reasonable gains’ if, for example, emerging contextual thinking on Benchmark Task 1 had developed into established contextual thinking on Benchmark Task 2. Similar criteria described ‘very substantial gains’, ‘no gains’, or ‘loss’ (Hurst, 2007b).

Mathematical thinking is characterised by the recognition, reiteration, and/or application of specific mathematical information to perform a mathematical operation. For example, a student working with an advertisement showing a price reduction and ‘new’ price for a sale item might use the information to calculate the ‘normal’ price of the item. Contextual thinking may involve the interpretation of data or the posing of questions that require such interpretation. For example, a student working with a similar advertisement to the above might consider a claim made in the advertisement that the product ‘whitens in fourteen days’ and pose the question such as ‘Does the container last for fourteen days?’ Strategic thinking may involve the synthesis of data to produce a new idea or the evaluation of data for consistency and the identification of anomalies. For example, a student working with an advertisement claiming that ‘Everything is reduced by 15%’ might test the claim by comparing original and discount prices to see if the claim was accurate (Hurst, 2007b)

The following data were generated from each of the four instruments listed in Table 1 as well as from interviews conducted with teachers of the eight case study students. The latter has been included to add strength to the findings as it represents data generated from a source that did not directly involve the eight students. The first set of data presented here was derived from Benchmark Tasks 1 and 2. In Benchmark Task 1, students were asked to consider tabular information about the amount of funds raised by different classes in a school, and in Benchmark Task 2, they were asked to consider similar information about a traffic count conducted by students. In both instances, they were given the following instructions:

**Benchmark Task 1**
- Describe what the data tells you, in general, about what the four students did.
- Explain the differences in the data obtained by each of the four students.

**Benchmark Task 2**
- Describe what the data tells you, giving examples to support what you are saying.
- How might you explain the differences in money raised by the classes?

Of the eight case study students, five made ‘substantial’ or reasonable’ gains and three made ‘no gain’. However, for each of the eight students, the frequency and quality of responses for Benchmark Task 2 were much higher than for Benchmark Task 1. Though the latter could perhaps be attributed to some extent to familiarity with the task style, it is suggested that, because the majority of students achieved ‘substantial’ or at least ‘reasonable’ gains, the development of thinking may be due to the nature of the tasks that were completed between the two benchmark tasks; that is, the *Mathematical Searches*. Tables 2 and 3 (Hurst, 2007a) contain summaries of responses to Benchmark Tasks 1 and 2 from two students, Lexie and Tania.
Table 2
Comparison of responses by Lexie for Benchmark Tasks 1 and 2 (‘Reasonable’ gain)

<table>
<thead>
<tr>
<th>Benchmark 1</th>
<th>Benchmark 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Contextual Thinking - Learner User (emerging)</strong></td>
<td><strong>Contextual Thinking - Learner User</strong></td>
</tr>
<tr>
<td>I am guessing that it was because there is likely to be more people in Year 7 than in Year 1.</td>
<td>There is going to be a lot of difference because they all live in different areas. Because of that it would change because someone might live near a hospital and see more than one emergency vehicle go by. They could live somewhere like near a main road so that they might have done it quicker like Craig who did it fastest compared to Brett who did it in 28 minutes. Brett and Deanne saw some bicycles while Craig and Freya didn’t see any so that means Brett and Deanne might live somewhere quieter and bicycles might be ridden there because it’s much safer than a main road where Craig and Freya might live. The same again, a light truck was seen by Craig and Deanne and not the other two, but they might live close to a truck yard. Also Craig might live on a main road because policemen are usually driving on the main road to make sure no-one’s speeding.</td>
</tr>
</tbody>
</table>

Table 3
Comparison of responses by Tania for Benchmark Tasks 1 and 2 (‘Very Substantial’ gain)

<table>
<thead>
<tr>
<th>Benchmark 1</th>
<th>Benchmark 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Contextual Thinking – Learner User (emerging)</strong></td>
<td><strong>Contextual Thinking – Learner User</strong></td>
</tr>
<tr>
<td>I think Year Seven raised the most because there are more children in that year.</td>
<td>Brett took 28 minutes and Craig took 12 minutes. Is this because Brett was on a road with a traffic jam or the speed limit was low, or made up some of the answers? Maybe they were at different times of the day or more populated cities.</td>
</tr>
<tr>
<td><strong>Strategic Thinking – Critical User</strong></td>
<td></td>
</tr>
<tr>
<td>There must have been at least four emergencies because it shows four emergency vehicles on the chart. But that might not be true because it says at the top that they’re all from different schools so they might not be in the same city or did it on a different day. Each time the sedan cars were the most seen. Maybe because they were the cheapest or the most useful?</td>
<td></td>
</tr>
</tbody>
</table>
Similar results were observed in the responses of the eight students to *Mathematical Search* #1, when compared to those from *Mathematical Search* #4, and for responses for Interview #1, when compared to those from Interview #2 (Hurst, 2007b). The levels of gain as shown in those instruments are depicted in Table 4.

Table 4
*Comparative gains for student responses to Mathematical Searches 1 and 4, and Interviews 1 and 2.*

<table>
<thead>
<tr>
<th>Student</th>
<th>Mathematical Search #1 to #4</th>
<th>Gain</th>
<th>Interview #1 to Interview #2</th>
<th>Gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mary</td>
<td>M(em) to M/C</td>
<td>Very Substantial</td>
<td>M/C to M/C/S</td>
<td>Substantial</td>
</tr>
<tr>
<td>Sara</td>
<td>M(em) to M</td>
<td>Reasonable</td>
<td>M/C to M/C/S</td>
<td>Substantial</td>
</tr>
<tr>
<td>Jenny</td>
<td>M to M/C/S (em)</td>
<td>Very Substantial</td>
<td>M/C to M/C/S</td>
<td>Substantial</td>
</tr>
<tr>
<td>Tania</td>
<td>M to M/C</td>
<td>Substantial</td>
<td>M/C to M/C/S</td>
<td>Substantial</td>
</tr>
<tr>
<td>Kerryn</td>
<td>M/C to M/C</td>
<td>No gain</td>
<td>M/C(em) to M/C/S</td>
<td>Very Substantial</td>
</tr>
<tr>
<td>Louise</td>
<td>M to M/C</td>
<td>Substantial</td>
<td>M/C to M/C/S</td>
<td>Substantial</td>
</tr>
<tr>
<td>Lexie</td>
<td>M/C(em) to M/C</td>
<td>Reasonable</td>
<td>M/C to M/C/S(em)</td>
<td>Reasonable</td>
</tr>
<tr>
<td>Sonia</td>
<td>M/C to M/C/S (em)</td>
<td>Reasonable</td>
<td>M/C to M/C/S</td>
<td>Substantial</td>
</tr>
</tbody>
</table>


In addition to the summary presented in Table 4, some student responses from the Post-Project Interviews are presented here. These responses appear to support Assertion 1 in that the eight case study students unanimously thought that the *Mathematical Search* helped them to develop their thinking about mathematics. The following responses (Hurst, 2007a) were made in reply to the interview question “Do you think that doing these tasks [Mathematical Searches] helped you to understand mathematics better and if so, how did they help you with your thinking about mathematics?”

I think they’ve helped my mind expand and look at things in a different way that I haven’t seen them before, to make it easier and different to learn, and I think it’s helped a lot. Instead of just looking at a picture or something once, I look at it closely and see if I can find any maths in it. (Jenny, student, Post-Project Interview, November 18, 2005)

Well, ever since the first task, it really made me think, just looking around at things. It really, really did make me think about everywhere maths is and I talked about it a lot to my parents and they realised a lot too. I know some things I probably wouldn’t have noticed as well about maths and I realised that there was heaps of maths everywhere. (Kerryn, student, Post-Project Interview, November 20, 2005)

Yeah, ’cause it helped me understand maths because I didn’t know there was maths in writing. I thought there was just maths in numbers, but there’s maths in writing as well. (Lexie, student, Post-Project Interview, November 25, 2005)

The Researcher’s Reflective Journal was used to record anecdotal observations made during class visits, as well as following discussions with teachers of the case study students, and during the analysis of the raw data from work samples and interviews. It enabled the researcher to gauge the thoughts of students and teachers about the effect of the *Mathematical Search* during the course of the project. The following excerpts (Hurst,
2007a) indicate a change in the thinking of teachers about the use of the Mathematical Search strategy as the project progressed.

With respect to the first Project Task (Mathematical Search #1), comments such as ‘the kids found this quite hard’ were very common. This again was to be expected as that type of task would have been quite foreign to the experience of the students. Indeed, this reinforces the rationale for using the Mathematical Search as the basis of this project; it is something that the students had not encountered before. This point was obvious from early discussions with teachers and reinforced by the responses of their students, as well as the reactions of the teachers to their students’ responses. The above comments help to underline the reliability of the data collection phase of the project, in that the main project task is something that students have not encountered before. (Researcher’s Reflective Journal, August 2, 2005)

When I was working through the debriefing of one Mathematical Search task with her class, Cath made the comment ‘I can really see all of the mathematics they’ve learned since Year Five coming together in this task.’ ** I thought this was a very significant moment in the research project. It is an acknowledgement from one of the project teachers that things are certainly working. (Researcher’s Reflective Journal, October 26, 2005)

The interviews conducted with teachers of the case study students before and after the implementation of the Mathematical Search tasks also generated much useful data. Teachers saw the value of the strategy in different ways. Some saw it making students more aware of mathematics in general, or more aware of aspects of mathematics of which they had not previously been so aware. Some saw its strength in encouraging students to pose questions, or in connecting their mathematical knowledge to other contexts. Still others felt that, because of the challenging nature of the tasks and a de-emphasising of the constant need for correct answers, students developed more confidence. The following excerpts from teacher interviews provide some examples of how teachers valued the Mathematical Search strategy (Hurst, 2007a).

I think it was extremely useful in developing an aspect of mathematics that we hadn’t looked at and that was analysis of mathematical concepts within written texts. It’s something that we hadn’t explored at all and I think it’s something extremely useful to students. I think it really pushed them in a direction they hadn’t been. You see students questioning things day to day but within a text relating to mathematics, you never really see so much. After doing this perhaps you would see more. (Pete, teacher, Interview 2, November 25, 2005)

I think it has [helped them] and that was actually evident when they did their little project [where they had to find their own context with embedded mathematics]. They really enjoyed that but I think that having done the tasks beforehand gave them the confidence and also a starting point for those activities because they were able to say well ‘What questions can I ask about it?’ and ‘What words give a clue that it’s maths?’ (Merryl, teacher, Interview 2, November 25, 2005)

I remember you pointing out Sally and a few girls who just keep questioning ‘But why?’, and these are not silly questions, they’re good questions and that helps the others too. That’s been a good result of it that it’s brought that up. (Merryl, teacher, Interview 2, November 25, 2005)

I’d say it’s been useful in their mathematical awareness. Learning is a bit harder to pick. I certainly think there’s been an improved level of confidence . . . . They struggled initially with the questions, because they weren’t sure exactly what they meant and they didn’t know if they got them right or not. (Karen, teacher, Interview 2, November 25, 2005)
On the basis of the data generated from a variety of instruments used in the original project, it is suggested that the empirical assertion mentioned earlier has been warranted. That is

**Students in this study will display an improved capacity to recognise mathematical ideas in a written context, and to use contextual and strategic thinking when considering mathematical ideas embedded within a written context, having used the Mathematical Search strategy on several occasions.** (Hurst, 2007a,b)

**Conclusions and Implications**

The evidence presented in this paper has shown that student thinking about mathematics embedded in an everyday context could be enhanced by the use of dedicated strategies such as the **Mathematical Search**, albeit within the confines of a multiple case study of eight students. As was stated earlier, it was never intended that the original study on which this paper is based would provide conclusive evidence of the effect of the **Mathematical Search** strategy, but rather that the evidence drawn from the analysis of gathered data ought to be considered as a starting point for further investigation by researchers and teachers. Indeed, other issues need to be considered. These issues include the frequency of use of the strategy, the implementation of associated strategies such as task debriefing, and the choice of context in which the mathematical ideas might be embedded. Teacher style and philosophy, and student reading ability where written texts are used, need to be considered as factors that could influence the use of the **Mathematical Search**. Nonetheless, the study has begun to address the important research issue of investigating the effectiveness of teaching and learning strategies in helping students connect their mathematical knowledge to various contexts and situations. The following implications can be made for both teaching and research (Hurst, 2007b).

**Implications for Teaching Practice**

The **Mathematical Search**

- has been shown, in this study, to be an effective link between classroom mathematics and other learning areas and contexts in which mathematics might be embedded,
- is an effective tool for helping students in this study to recognise their own mathematical knowledge when it is embedded in a range of contexts and to make meaning from it,
- could be successfully applied to audio visual and pictorial contexts, as well as written texts, and
- is effective when used in tandem with a range of other strategies, shown in Figure 1 as ‘Learning Strategies’.

**Implications for Further Research**

Further research could replicate the study or focus on the use of the **Mathematical Search** and associated strategies where other variables could be considered such as

- the involvement of both male and female students,
- the involvement of different age groups,
• consideration of the socio-economic status of students,
• specific selection of students with varying reading ability,
• the use of the Mathematical Search in audio-visual contexts, and
• the use of the Mathematical Search over extended periods of time, perhaps beginning at a younger age.

References


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