Collaborative Word Problem Solving in a Cognitive-apprenticeship-computer-based Environment

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Introduction

Over the past decade, attempts have been made to examine the role of metacognition within computer environments (Mevarech, 1999; Kramarski & Ritkof, 2002). In these studies, the students would either be working or discussing their tasks in small groups or in pairs. The researchers consistently indicated the importance of training students to monitor, control and regulate their learning as they were using computers, and allowing students to work in small groups or in pairs appeared to maximise that potential (Artzt & Armour-Thomas, 1992). For example, in Artzt and Armour-Thomas's (1992) study, the researchers examined the role of metacognition in group problem solving and found that personalities and attitudes of the participants rather than the ability level predicted whether children would share metacognitive insights. This study reports on one strand of a larger investigation to explore the extent to which metacognition plays a part in primary students' word problem solving in a computer environment. Specifically, the study adopted a case study design where analysis of students' collaborative talk during word problem solving of four pairs of students was used to examine the factors that might contribute to successful word problem solving in a cognitive-apprenticeship-computer-based environment called WordMath (Looi & Tan, 1998).

Methods

Four pairs of students (11-12 years old) from a Singapore school were involved in the study. The pairs of students were chosen based on two factors: having similar academic profiles and being able to work together. The students and their mathematics teachers underwent the following four phases of the study. They included: 1) interviewing mathematics teachers and implementing a student questionnaire to elicit information about the students' metacognitive knowledge, 2) having four training sessions where pairs of students worked collaboratively to solve word problems with WordMath, 3) having two extra training sessions for each pair to enable students to feel comfortable working collaboratively in front of a video camera, and 4) implementing posttest where pairs of students' collaborative talk of four word problems were video-recorded and data analysed.

Results

Affect and Word Problem Solving

Findings from the teacher interview, student questionnaire, students' collaborative talk, and their word problem solving performance suggested that there were affective factors that related to students' word problem solving. These affective factors will be discussed in the following sections.

Students' Beliefs and Word Problem Solving Performance

Schoenfeld (1992) stated that beliefs were interpreted as an individual's understandings and feelings that shaped the ways the individual conceptualised and engaged in mathematical behaviour. From his studies, he noted that students' mathematical beliefs shaped their behaviour in ways that had extraordinarily powerful (and often negative) consequences (op cite p. 359).

In the study, it appeared that students' beliefs also had an influence on their word problem solving performance. Students (i.e. S1 and S2, S5 and S6, and S7 and S8) whose beliefs were that the ability to solve word problems depended on following an 'effective' heuristic (e.g. read the word problem, understand the story, draw models); on checking for careless mistakes; and on one's confidence and love for the subject were successful in their word problem solving. In contrast, students (i.e. S3 and S4) whose beliefs were that the ability to solve a word problem depended on the size of the numbers in the word problem and the number of steps required to solve the word problem were unsuccessful in all their word problem solving. Finally, it was a concern to hear that Singapore students had developed a belief, indicated by all students, that being an effective word problem solver was to 'practice doing more exercises'. This belief might have stemmed from the Singapore mathematics curriculum which promotes word problem solving that focuses on mastery of relatively small chunks of subject matter and word problems that can be completed in a short amount of time. Teachers (I admit being one of them) might have also played a part in inculcating this belief. We have encouraged students to solve different types of word problems in order to expose them to different strategies. We have given them lots of homework in the belief that 'practice makes perfect'. However, Teong *(2003)* suggested that the complementary interplay of practice and being aware of one's cognitive processes was one of the factors that determined success in word problem solving.

Effective Pair Collaboration

In this study, the pairs of students had similar academic profiles. Despite this similarity, the pairs of students functioned differently. Like the findings from Artzt and Armour-Thomas' (1992) study, some variables that might have contributed to these differences were the personalities and attitudes of the dominating member in the pair. For example, S3 and S4 hardly worked together and were unsuccessful in solving all word problems, whereas the pair S1 and S2 was very interactive and managed to be successful in their word problem solving. For S3 and S4, the more assertive member, S4, on a number of occasions, got fixed on his fault strategy and was not receptive to S3's feedback. As a result, the pair continued to rely on S4's flawed strategy and failed in solving all word problems. In contrast, each member in S1 and S2 challenged each other's strategies and this forced each of them to overtly express their ideas which helped them move forward to the solutions of all word problems.

It was also observed that success in word problem solving appeared to be related to how students were paired according to similar metacognitive knowledge and not according to similar academic profiles. For example, S7 and S8 were successful in all their word problem solving. There was a possibility that the similar metacognitive knowledge of mathematical word problem solving each student possessed was related to their success in all word problem solving. S7 believed (questionnaire) that while solving word problem, she needed to 'draw one *or more models, refer to every step I do, read the problem* twice; *keep track of what I do; and avoid all careless* mistakes', and S8 believed (questionnaire) that while solving word problems, she needed to *'draw* a *model or table for question which I'm not* sure *of; write* ***short words beside the method*** so *that I know what I* am *doing"*. S8 also believed (questionnaire) in keeping track of her word problem solving by referring to the models, tables or the word problem again to look at the short notes she has written. In all word problem solving, S7 and S8 consistently kept track of their cognitive actions. On the other hand, S3 and S4 had very negative feelings towards mathematics, confirmed by their mathematics teacher (interview). S4 believed (questionnaire) in *'guessing'* and S3 believed (questionnaire) in *'drawing* part-whole models'. In addition, S4 occasionally kept track of his word problem solving and did not believe (questionnaire) in checking except 'when *it* is *PSLE*', and S3 kept track of this word problem solving so that it would prevent him from day dreaming and 'play *with* my *things'* (questionnaire). They were not successful in their word problem solving.

Conclusion

In this study, the analysis of the teacher interview, student questionnaire and students' collaborative talk suggested that there were affective factors that might contribute to successful word problem solving in a cognitive-apprenticeship-computer-based environment. For example, effective pair collaboration appeared to be influenced by students' mathematical beliefs and how they were paired according to their metacognitive knowledge, which in turn influenced their word problem solving performance. Though this observation was not conclusive, it was in fine with Artzt and Armour-Thomas' (1992) findings, and this issue merited further development.

The findings from this study also suggested that there was a need for educators to be aware of our students' mathematical beliefs in the mathematics classroom. Specifically, there was a need for curriculum policy to look into how we, educators, could promote 'positive' mathematical beliefs amongst our students. Finally, there was a need for teachers, who encouraged collaborative work in mathematics classrooms, to be aware of the existing group dynamics, and consistently monitor and make necessary changes in groupings. It was hoped that this consistent monitoring would maximise students' collaborative interaction which might lead to success in learning mathematics.

References

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