Teachers' Perceptions of Obstacles to Incorporating a Problem Solving Style of Mathematics into their Teaching

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Despite recommendations to incorporate mathematical problem solving into the practice of primary teachers there is little evidence of the widespread acceptance of such advice by Early Years teachers. Understanding teachers' perceptions of the obstacles they encounter when incorporating mathematical problem solving into their teaching can shed light on the matter. Survey responses of 22 teachers of Foundation and Year 1 across three Victorian schools indicated that the initial obstacles teachers perceived were those concerning children, teaching pedagogy, planning, resources, tasks and time.

The future will rest on a foundation of applied mathematical, scientific and technological knowledge of today's children. Jonassen wrote that, "problem solving is generally regarded as the most important cognitive activity in everyday and professional contexts" (2000, p. 63). In addition, as Gagne stated, "the central point of education is to teach people to think, to use their rational powers, to become better problem solvers" (1980, p. 85). For Polya, considered the father of mathematical problem solving, mathematical epistemology and mathematical pedagogy are deeply intertwined (Schoenfeld, 1992) and educators ideally look for "authentic problem-solving situations in which children behave as mathematicians and have opportunities to develop mathematical power" (Baroody, 2000, p. 61). The ability to solve problems is a fundamental life skill and develops naturally through experiences, conversations and imagination (Cheeseman, 2009; Geist, 2001). Teachers are critical in creating rich mathematics learning experiences for children at school and in helping them to "make sense of problems and persevere in solving them" (NGA Center, 2010, cited in Blair, 2014). In the Australian Curriculum: Mathematics (Australian Curriculum Assessment and Reporting Authority, 2016) problem solving is one of four fluency strands that are interwoven across all the mathematical content strands at every level of school. Yet while teachers are often aware of the potential of young children as problem-solvers in their own lives, they are uncertain about how to harness that potential in mathematics classrooms. Blair (2014) found that inquiry-based learning has not found its way into daily teaching practice.

Problem solving is not new. Yet children seldom work on engaging and challenging mathematical problems in Early Years primary classrooms. It is important to understand this situation and to understand the obstacles that teachers believe prevent them from incorporating mathematical problem solving into their practice.

Incorporating new elements into existing teaching is always a complex process. Jackson et al. (2015) developed an empirically grounded theory of action for instructional improvement in mathematics. These authors maintained that five interrelated components were necessary to support "ambitious teaching": materials and instructional guidance; teacher professional development and collaborative meetings; job-embedded support for teachers' learning; school instructional leadership; and school system leadership. While the research project reported here was not a large-scale project like that of Jackson and his colleagues, this project incorporated four components of Jackson's theoretical framework with the use of supportive curriculum materials and instructional guidance, teacher professional learning days out of the classroom, collaborative meetings, and school-based support for learning. The

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intention was to stimulate and support ambitious teaching of mathematical problem solving with young children. The nature of obstacles teachers perceived they faced when they make changes to their teaching to incorporate problem solving, is the subject of this paper.

Method

A design research project that was: an intervention in the real world, iterative, process-oriented, useful for its users in real contexts, and theory-oriented (van den Akker, Gravemeijer, McKenney, & Nieveen, 2006) was the context in which the data reported here were collected. The project entitled *Fostering Inquiry in Mathematics* (FIiM) connected mathematics education research and teacher professional development with 22 teachers. Underpinning the project was a history of research evidence of the effectiveness of teacher professional growth stimulated by innovative mathematical problem solving materials (for example, Clarke, 1997). Challenging tasks (Cheeseman, Clarke, Roche, & Wilson, 2013; Clarke & Clarke, 2004) which took a problem solving approach to mathematics in the Early Years of school were provided to teachers to be trialled in classrooms. In addition, research describing features of highly effective teachers of mathematics with young children (Cheeseman, 2010; Clarke et al., 2002) was emphasised in the professional development component of FIiM to enhance teachers' practice and lead to improved learning by children. Pedagogical approaches to problem solving and investigations in mathematics were raised with teachers to emphasise the importance of teacher noticing (Mason, 2011), engaging in mathematical conversations (Cheeseman, 2015), and encouraging curiosity and persistence (Cheeseman & McDonough, 2016). The outcomes of the project were evaluated in terms of children's learning, and teacher feedback. Children's learning was observed in classrooms, and tested by clinical interview. Children's drawings were also collected to reveal their dispositions to learning mathematics. Teachers were encouraged to reflect on any changes in their practice and on effects on children's learning of mathematics. Data related to these evaluations of project outcomes appear elsewhere (for example, Ferguson, Cheeseman, & McDonough, 2018).

In the first stage of the project 22 mathematical problem solving activities focused on the Number strand of the curriculum in Foundation and Year 1 (ACARA, 2013) were written by the author as lesson ideas suitable for children 5 to 7 years old (Cheeseman, 2017). After three months in the project, teachers completed an online survey that asked about aspects of the research. The question reported here asked participants to "list any obstacles you have experienced trying to incorporate a problem solving style of mathematics in the classroom".

Teachers' written responses were analysed using a grounded theory approach (Strauss & Corbin, 1990). Qualitative data examined during the research project were used to build a theoretical view of the situation under study. Six categories emerged from the data concerning children, teaching pedagogy, planning, resources, tasks and time. These categorised data were given to the teachers for their review and feedback.

Findings and Discussion

Table 1 shows how each idea expressed by the teachers was categorised. The table is structured by the frequency of response. The findings will be discussed later under four sub-headings: children; teachers and pedagogical issues; planning matters; and time and resources.

Reaction of the Children to the "New"

Teachers in the FIiM project noted that young children who are new to school have just grasped the general school routines in mathematics. The view was expressed that problem

Table 1
Categorisation of Obstacles Teachers Encountered Implementing Problem Solving Tasks

Category	Responses of teachers (n = 24)
Children (8)	At this age, children are self-important and rightly so, but it does present a problem if they do not learn from each other.
	Students in the early years are new to problem solving in Numeracy.
	Overwhelming for some students- not used to failing and being a risk-taker in their mathematical learning
	As our students are Foundation, they still require a large amount of explicit teaching to support their knowledge and understanding.
	Children that need structure struggle with some of these activities.
	If students don't have certain skills needed for the task that can make it difficult for students to complete the task successfully.
	For some kids it can be too open
	Getting children to challenge themselves
Teachers and pedagogy (6)	Lost interest among some students who want to only explain their own reasoning.
	As they get started, it is hard to know when to step in and get a child going and when to hang back and see how they go.
	Our team is still experimenting with how to offer engaging, hands-on learning experiences that support and extend critical thinking but ensures that their knowledge is sound and correct.
	Behaviour
	One to one time with students and juggling 26 students each session. Conversations are the key elements and it is difficult to deeply engage with all of the students. Focusing on small groups is good, but it's hard not getting to all students.
	Experience with problem solving as a teacher to be able to execute in the classroom
Planning (3)	We are planning units of work in Mathematics and the inquiry tasks can seem a little separate but we are working on making them more central and linked to the curriculum demands we have when planning. I can see this improving already.
	Trying to link the tasks to our current planner and fitting them in.
	Trying to incorporate tasks with my other lessons that we have previously planned.
Resources (3)	We do need to improve the resources available to students so that they are reinforcing basic skills e g. number lines, counting grids, calculators so that students can make decisions for themselves about what will be the best way to solve the problem and what they need to do.
	Lack of resources (a school issue that we are working on)
	None really, maybe just lack of resources.
Tasks (2)	Some tasks too closed and students completed easily and quickly.
	Had to modify some tasks for the range of learning abilities in my class
Time (2)	I think it is about allowing an extended amount of time for students to truly inquire and try many different ways to solving these tasks.
	Setting up: Would love to organise double numeracy sessions

solving approaches can involve new routines and expectations. For example, one teacher commented: “Students in the early years are new to problem solving in Numeracy.” This comment reflects the perception that “new” can be difficult for children, yet many young children are also very excited by trying new things. In fact problem solving is not “new” to children starting school who problem-solve with mathematical ideas in their lives before school. Many examples could be given to illustrate ways in which young children’s lives are rich in problem solving where children make decisions about number, position and size. Often children’s prior-to-school experiences are in authentic measurement contexts (Cheeseman & Pullen, 2017). Clements and Sarama noted that children “learn to mathematize their informal experiences by abstracting, representing, and elaborating them mathematically" (2011, p. 968). Research shows that young children have intuitive and informal capabilities in both spatial and geometric concepts, and numeric and quantitative concepts (Bransford, Brown, & Cocking, 1999).

Two teachers wrote comments that reflected their views of children as learners, "Children who need structure, struggle with some of these [problem solving] activities." In addition, "For some kids it can be too open." These comments raise important questions about the role of the teacher and the responsibilities of the learner. Many young children expect to be told exactly what to do by adults, especially teachers. Therefore, the expectation that they have to think things through for themselves takes time to establish in a classroom. Similarly, the view that some children will struggle raises the fact that there are different views of the need for struggle with mathematics. For some teachers of young children, it is important that mathematics is easy and fun, whereas for others it is important for children to concentrate and to persist so that they experience the joy of solving a problem after a struggle. In the FIiM project, I was encouraging children to welcome challenge and, as one teacher said, "This can take time. Getting children to challenge themselves, for example, during the "Count How Many" tasks - most children just resorted to the "easy" way of counting by ones."

As a group of professionals experimenting with teaching practice, we were also encouraging children to communicate their mathematical thinking. Teachers in the project were aware that young children are often egocentric and more interested in talking about themselves and their ideas than listening to those of their classmates. As one teacher put it: "Some students who want to only explain their own reasoning lost interest. At this age, children are self-important and rightly so, but it does present a problem if they do not learn from each other." Another teacher observed and commented "[children were] finding the answer but unable to explain their reasoning - impatient with [their] peers in group tasks and taking over rather than explaining." These comments reflect the personal and social skills required of children in collaborative problem solving where they are asked to cooperate, to speak, and to listen.

Other obstacles to the implementation of problem solving and investigations related to the demands that are made of teachers.

Teacher Factors and Pedagogical Issues

The teacher's role was part of the professional development. FIiM teachers were asked to think about and discuss the role of the teacher in a problem-solving classroom. Teachers were encouraged to: "establish the problem, maintain the mathematical focus, lead without telling, support and shape ideas, and help children to a solution" (Cheeseman, 2017, p. 3).

I acknowledge the role of the teacher in a problem-solving classroom is something that takes time and some experience to work out in practice. For example, a perceived obstacle noted by one respondent was a lack of "experience with problem solving as a teacher - to be able to execute it [the role] in the classroom." In particular, it takes determination to resist the temptation to direct the children's thinking or to tell them what to do rather than to lead without telling. Letting young children struggle to get started on a problem is something new for many teachers. One respondent noted the judgement needed by teachers: "As they [children] get started, it is hard to know when to step in and get a child going and when to hang back and see how they go."

The selection of a task was another difficulty, in addition to concentrating on their classroom behaviours, teachers were struggling to identify the "match" between the suggested tasks and the apparent learning needs of their children. The range of mathematical experience of young children is large (Young-Loveridge, 1989) and on entry to school children's mathematical knowledge, while substantial, is varied (Clarke, Clarke, &

Cheeseman, 2006). Teachers adapted tasks to suit their children. For example, “Had to modify some tasks also had to modify for the range of learning abilities in my class.” This need to adapt tasks was seen as an obstacle.

It is interesting to examine the thinking behind another teacher’s comment that it is “Overwhelming for some students - not used to failing and being a risk-taker in their mathematical learning.” Perhaps in some ways this remark reflects a hesitancy to let children struggle. Or maybe it is acknowledging that it takes time for children to build persistence and resilience. It raises questions about how we support children to become more willing to take risks and more aware that effort is what is expected of them (Dweck, 2007). In the teacher’s comment, not completing a task or finding a solution was equated with “failing”. This raises the question: What are teachers’ expectations of tasks? The same respondent went on to comment: “Some tasks [were] too closed and students completed [them] easily and quickly.” Does a task have to be “just right”? Not too hard and not too easy? How is that achieved? In planning for problem solving, teachers were asked to consider launching a problem “for which the solution is not immediately apparent” (Baroody & Wilkins, 1999, p. 63). So, rather than selecting a problem that the children *can* do, teachers make sure they find a task that the children *cannot yet* do. Even then, for some students the task may not be a problem at all and may be completed easily; for other students the problem may be too difficult to get started. To address the range of thinking in the children, each task in the collection of FIiM materials had a suggested *enabling prompt* and *extending prompt* (Sullivan, Mousley & Zevenbergen, 2006). Perhaps this differentiation technique was new to many teachers. It is true to say that a range of mathematical thinking is found in mathematics classrooms and creates difficulties and obstacles for many teachers.

The place of problem solving in a balanced program was raised by one respondent:

> As our students are Foundation, they still require a large amount of explicit teaching to support their knowledge and understanding. As such, our team is still experimenting with how to offer engaging, hands-on learning experiences that support and extend critical thinking but ensure that their knowledge is sound and correct.

What does “a large amount of explicit teaching” imply about teachers’ views of how children learn mathematics? The idea that if teachers explicitly tell children information they will have it “correct” seems embedded in this quote. How representative this view is I cannot say. Nor can I say exactly what “explicit teaching” means to this respondent. It might be interesting to ask teachers what their children know about mathematics on entry to school and how they think children learned this knowledge. In this way, it could also be possible to understand teachers’ theories of learning.

A long-held quandary expressed by teachers of problem solving was raised by the comment: “If students don’t have certain skills needed for the task that can make it difficult for students to complete the task successfully.” Skills before problems or problems before skills, is the chicken and egg dilemma. Both cases can be argued. If children cannot yet count rationally (Gelman & Gallistel, 1978) how can they solve problems involving quantifying? Alternatively, what is the point of learning to count unless you need to count objects reliably? In a way, there is no “right” answer to this dilemma. Perhaps one approach is to do both: have children practice their skills through games and activities while presenting them with problems that are contexts in which to use their growing skill sets.

The idea that children need to be explicitly taught mathematics before they tackle problems was expressed to researchers in the *Encouraging Persistence Maintaining Challenge Project* (EPMC) (Sullivan et al., 2014) across the mid to upper primary years and into Year 8 level. It seems that many teachers are reluctant to offer children mathematical experiences first then discuss the mathematics and elicit the resultant learning.

One approach to introducing "challenging tasks" in the EPMC (Cheeseman, Clarke, Roche, & Walker, 2016) was to begin the problem of the day with an introduction that clarified the meaning of the problem then the students were expected to struggle to find a solution. Perhaps a question to ask in the current research is: Are young learners able to meet problems the same way?

The role of the teacher in a problem-solving classroom involves *letting the children go* as is said in the vernacular, to get on with their thinking. At the same time, teachers need to monitor children to ensure that individuals can make a start after a reasonable time and, after they make progress towards a solution, listen to their mathematical thinking. Often this "between table teaching" (Clarke, 2004) happens with individual children in a conversational style (Cheeseman, 2018). Teachers manage such "dialogic teaching" (Wood, Nelson, & Warfield, 2001) in different ways. For many teachers the balance between extended conversation with a few children and fleeting interactions with others is hard to reconcile. One example of an obstacle was the difficulty of spending time with all:

> One-to-one time with students and juggling 26 students each session. Conversations are the key elements and it is difficult to engage deeply with all of the students. Focusing on small groups is good, but it is hard not getting to all students.

Time and Resources

The shortage of resources can be seen as an obstacle to incorporating new approaches to mathematics as exemplified by the comment: "Lack of resources [is] a school issue that we are working on." In addition, time and teaching materials for problem solving were mentioned, as was the need to integrate new problems into planned units of work:

> I think it is about allowing an extended amount of time for students to truly inquire and try many different ways to solving these tasks. We do need to improve the resources available to students so that they are reinforcing basic skills e.g., number lines, counting grids, calculators so that students can make decisions for themselves about what will be the best way to solve the problem and what they need to do so. At the moment we are planning units of work in mathematics and the inquiry tasks can seem a little separate but we are working on making them more central and linked to the curriculum demands we have when planning. I can see this improving already.

Experimenting with new learning materials and teaching approaches is not as straightforward as it may seem. In many schools, planners are constructed by teams of Year level teachers in advance of the school term. While planners create a sense of direction and an overview of intended learning, they also produce some inflexibility in the program. This constraint can be a limitation to a change initiative based on implementing teaching materials.

In Conclusion

Due to the limited number of participants in this study, the findings cannot be claimed to represent the profession broadly. However, the results are indicative of teachers' perceptions of obstacles faced when incorporating problem solving into their classroom practice.

The results presented here indicate that some teachers' views of young children and their learning of mathematics are obstacles to using investigative or problem solving tasks. Some teachers viewed 5 to 7 year-old children as passive recipients of "correct" mathematical knowledge. These views may reflect a transmissive theory of learning but this is implied rather than supported by evidence gathered during the research process. The view that young children need to be told what to do in mathematics may also be an obstacle to teachers' willingness to expect young children to solve problems in mathematics. In fact, the selection of tasks that require children to struggle, persist, and make independent decisions, requires teachers to view young children as active learners who can initiate mathematical thinking.

Other obstacles to incorporating problem solving are pedagogical matters. Posing problems in the mathematics classroom takes pedagogical knowledge and skill. The role of the teacher is different in problem solving classrooms as the traditional pattern of demonstrating a skill to children then having them apply the skill is overturned. The pedagogical skill to: establish the problem, maintain the mathematical focus, lead without telling, support and shape ideas, and help children to a solution is complex and requires skill and judgement. These skills develop over time with experience. It can be rather threatening for some teachers to be placed in the situation where they feel like a novice teacher again.

In addition, reference was made to pedagogical advice to Early Years teachers advocating "explicit teaching". Whether "explicit teaching" means expository "teacher tell" approaches to the teachers surveyed cannot be determined but the term does seem to imply that inquiry by children is insufficient. It may be that system-wide pedagogical directives can generate uncertainty for teachers.

Some teachers pointed to organisational and management matters in primary schools that create obstacles to changed practice. The recognition that time, support, flexibility of planning, and resources are needed when experimenting with teaching practice was apparent in their responses. These factors could be considered as necessary in any educational change.

Understanding the views of teachers can be the first step towards overcoming their perceived obstacles. Convincing teachers of the value of experimenting with investigative problems in their classrooms may build their trust in young children's mathematical potential. With experience and success with problem solving tasks, teachers' pedagogical knowledge will be built. As was seen from some teachers' responses, the first place to start was with support, resources and planning because these organisational obstacles were relatively straightforward to overcome.

References

Australian Curriculum Assessment and Reporting Authority. (2016). *Australian Curriculum: Mathematics*. Retrieved from http://www.australiancurriculum.edu.au/mathematics/curriculum/f-10?layout=1

Baroody, A., & Wilkins, J. (1999). The development of informal counting, number, and arithmetic skills and concepts. In J. V. Copley (Ed.), *Mathematics in the early years* (pp. 48-65). Reston, VA: National Council of Teachers of Mathematics.

Baroody, A. J. (2000). Does mathematics instruction for three- to five-year-olds really make sense? *Young Children, 55*(4), 61-67.

Blair, A. (2014). Inquiry maths: An idea whose time has come. *Mathematics Teaching, 240*(32), 32-35.

Bransford, J., Brown, A., & Cocking, R. (2000). *How people learn: Brain, mind, experience, and school*. Washington: National Academy Press.

Cheeseman, J. (2009). Challenging mathematical conversations. In R. Hunter & B. Bicknell (Eds.), *Crossing divides* (Proceedings of the Mathematics Education Research Group of Australasia conference, Vol. 1, pp. 113-120): Palmerston North, NZ: MERGA.

Cheeseman, J. (2010). *Challenging children to think: An investigation of the behaviours of highly effective teachers that stimulate children to probe their mathematical understandings.* (PhD), Monash University, Melbourne.

Cheeseman, J. (2015). Mathematical conversations that challenge children's thinking. In R. Perry, A. MacDonald, & A. Gervasoni (Eds.), *Mathematics and transition to school: Early learning and development.* Singapore, Springer.

Cheeseman, J., Clarke, D., Roche, A., & Walker, N. (2016). Introducing challenging tasks: Inviting and clarifying without explaining and demonstrating. *Australian Primary Mathematics Classroom, 21*(3), 3-7.

Cheeseman, J., Clarke, D., Roche, A., & Wilson, K. (2013). Teachers' views of the challenging elements of a task. In V. Steinle, L. Ball, & C. Bardini (Eds.), *Mathematics education: Yesterday, today and tomorrow* (Proceedings of the 36th annual conference of the Mathematics Education Research Group of Australasia, pp. 154-161). Melbourne: MERGA.

Cheeseman, J., & McDonough, A. (2016). Fostering mathematical curiosity. In S. Dockett & A. MacDonald (Eds.), *Just do good research: Commentary on the work and influence of Bob Perry* (pp. 142-151). Albury, Australia: Peridot Education.

Cheeseman, J., & Pullen, Y. (2017). The impact of a measurement-focused program on young children's number learning. In A. Downton, S. Livy, & J. Hall (Eds.), *40 years on: We are still learning* (Proceedings of the Mathematics Research Group of Australasia, pp. 149-156). Melbourne: MERGA.

Clarke, B. A., Clarke, D., & Cheeseman, J. (2006). The mathematical knowledge and understanding young children bring to school. *Mathematics Education Research Journal, 18*(1), 78-102.

Clarke, B. A., & Clarke, D. M. (2004). Mathematics teaching in Grades K-2: Painting a picture of challenging, supportive, and effective classrooms. In R. N. Rubenstein & G. W. Bright (Eds.), *Perspectives on the teaching of mathematics. 66th Yearbook of the National Council of Teachers of Mathematics* (pp. 67-81). Reston, VA: NCTM.

Clarke, D. J. (2004). Patterns of participation in the mathematics classroom In M. J. Hoines & A. B. Fuglestad (Eds.) *Proceedings of the 28th Conference of the International Group for the Psychology of Mathematics Education* (Vol. 2, pp. 231-238). Bergen, Norway: PME.

Clarke, D. M., Cheeseman, J., Gervasoni, A., Gronn, D., Horne, M., McDonough, A., . . . Rowley, G. (2002). *Early Numeracy Research Project: Final report, February 2002*. Retrieved from Fitzroy, Victoria:

Clarke, D. M. (1997). The changing role of the mathematics teacher. *Journal for Research in Mathematics Education, 28*(3), 278-308.

Clements, D., & Sarama, J. (2011). Early childhood mathematics intervention. *Science, 333*(6045), 968-970.

Dweck, C. S. (2007). The perils and promises of praise. *Educational Leadership: Early intervention at every age, 65*(2), 34-39.

Ferguson, S., Cheeseman, J., & McDonough, A. (2018). Children's drawings can be windows into mathematics learning. In XXX (Ed.), *Making wave, opening spaces* (Proceedings of the 41st annual conference of the Mathematics Education Research Group of Australasia). Auckland: MERGA.

Gagné, R.M. (1980).*The conditions of learning*. New York: Holt, Rinehart, & Winston.

Geist, E. (2001). Children are born mathematicians: Promoting the construction of early mathematical conceptsin children under five. *Young Children, 56*(3), 12-19.

Gelman, R., & Gallistel, C. R. (1978). *The child's understanding of number.* Cambridge, Mass: Harvard University Press.

Jackson, K., Cobb, P., Wilson, J., Webster, M., Dunlap, C., & Appelgate, M. (2015). Investigating the development of mathematics leaders' capacity to support teachers' learning on a large scale. *ZDM, 47*(1), 93-104.

Jonassen, D. (2000). Toward a design theory of problem solving. *Educational Technology Research and Development, 48*(4), 63–85.

Mason, J. (2011). Noticing: Roots and branches. In M. Sherin, V. Jacobs, & J. Philipp (Eds.), *Mathematics teacher noticing: Seeing through teachers' eyes* (pp. 35-50). New York: Routledge.

Schoenfeld, A. (1992). Learning to think mathematically: Problem solving, metacognition, and sense-making in mathematics. In D. Grouws (Ed.), *Handbook for research on mathematics teaching and learning* (pp. 334-370). New York: MacMillan.

Strauss, A., & Corbin, J. (1990). *Basics of qualitative research: Grounded theory procedures and techniques*. Newbury Park: Sage Publications.

Sullivan, P., Clarke, D., Cheeseman, J., Mornane, A., Roche, A., Sawatzki, C., & Walker, N. (2014). Students' willingness to engage with mathematical challenges: Implications for classroom pedagogies. In J. Anderson, M. Cavanagh, & A. Prescott (Eds.), *Curriculum in focus: Research guided practice* (Proceedings of the 37th annual conference of the Mathematics Education Research Group of Australasia) (pp. 597–604). Sydney: MERGA.

Sullivan, P., Mousley, J., & Zevenbergen, R. (2006). Developing guidelines for helping students experiencing difficulty in learning mathematics. In P. Grootenboer, R. Zevenbergen, & M. Chinnappan (Eds.), *Proceedings of the 29th Annual Conference of the Mathematics Education Research Group of Australasia* (Vol. 2, pp. 496-504). Canberra: MERGA.

van den Akker, J., Gravemeijer, K., McKenney, S., & Nieveen, N. (Eds.). (2006). *Educational design research*. New York: Routledge.

Wood, T., Nelson, B., & Warfield, J. (2001). *Beyond classical pedagogy: Teaching elementary school mathematics.* Mahwah, NJ: Lawrence Erlbaum Associates.

Young-Loveridge, J. (1989). The development of children's number concepts: The first year of school. *New Zealand Journal of Educational Studies, 24*(1).