

Intervention in Mathematics: Is Assistance More Effective in Grade 1 or Grade 2?

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It is an accepted practice throughout Australia and New Zealand for schools to implement *Reading Recovery* Programs for Grade 1 children. In contrast, intervention programs in mathematics are less well established. As part of the *Early Numeracy Research Program* (1999-2001), an intervention program was introduced in 21 schools in both Grade 1 and Grade 2. Children's progress was compared to determine whether the program was more effective in either grade. Further perspectives were gained from 21 specialist teachers and the classroom teachers and parents of two children participating in the program. Although Grade 2 children made more progress in two of the four domains considered, the parents and classroom teachers believed that the program is best implemented in Grade 1.

In most classrooms there are children who experience difficulty learning mathematics. Knowing how best to assist these children is often a dilemma for school communities. On one level, this dilemma can be resolved by improving mathematics learning and teaching for all children and through ensuring that children receive the best possible opportunities to learn mathematics successfully. Indeed, school systems in both Australia and New Zealand have focused attention on improving learning and teaching in the early years of schooling in anticipation that students who begin school successfully will continue to do so in later years. In Mathematics, initiatives such as *Count Me In Too* (Stewart, Wright, & Gould, 1998), the *Early Numeracy Research Project* (ENRP, Clarke, 2001) and the *Count Me In Too Project* (Higgins, 2001) have each resulted in improved mathematics learning outcomes for young students. However, despite excellent classroom experiences and curriculum provision, some children continue to experience difficulty and need assistance beyond that which the classroom teacher can provide.

A review of the effects of programs designed to prevent early school failure concluded that optimising learning for young students depends on providing good pre-school and kindergarten experiences, improved curriculum and instruction at school, brief tutoring at critical junctures, and family support (Slavin, Karweit, & Wasik, 1992). Projects such as the *ENRP* and *Count Me in Too* have focused on some of these areas, and have led to improved kindergarten experiences for children and improved mathematics curriculum and instruction. However, one area that continues to be problematic for schools is providing children with brief tutoring at critical junctures in their mathematics education.

As part of the ENRP, 21 schools introduced a structured mathematics intervention program for children who were having difficulty learning mathematics. Some schools chose to provide this assistance in Grade 1 (six year olds), and other schools chose Grade 2 (seven year olds). This paper considers both quantitative and qualitative data to explore whether the specialised assistance provided was more effective at one or other grade level.

Critical Times to Intervene in Mathematics

Reading Recovery (Clay, 1993) has gained widespread international support from teachers and parents as an effective program for identifying and assisting 'at risk' students

in the area of literacy. Advocates of the *Reading Recovery* Program are unequivocal in stating that the critical time to intervene for the purpose of improving *reading* is in a child's second year of school. This age is also recommended by Wright, Cowper, Stafford, Stanger, and Stewart (1994) as the most appropriate time to intervene in mathematics. For this purpose, Wright developed the *Mathematics Recovery* Program for Grade 1 children. *Mathematics Intervention* (Merrifield & Pearn, 1999) is another program that focuses on intervention for Grade 1 children, but has been used also with older children. In contrast, eight year olds were the target of a study by Askew, Bibby and Brown (1998) that investigated the effects of a mathematics intervention program on students' learning. Participants were those who were operating below or just below the expected level of attainment for their age as specified by national tests, and who were considered to be low attainers in mathematics rather than having special education needs in mathematics. Although these programs focus on children of different ages, they all intervene with children during the first four years of schooling, and are therefore providing assistance at a relatively early point in children's education. However, there is a lack of research data comparing whether a particular grade level is more critical than another for mathematics intervention. Research in this area tends to focus on comparing the effect of a particular approach to assistance with a comparison group, or on describing the learning gains of children who participate in a particular program. However, the effect of grade level was explored as part of the *Early Numeracy Research Project* in respect to the intervention program *Extending Mathematical Understanding*.

The Extending Mathematical Understanding Program

ENRP trial schools were invited to nominate specialist teachers to be trained in 2000 to implement a specialised assistance program, *Extending Mathematical Understanding* (EMU) for their students who were low attaining in mathematics. Twenty-one of the thirty-five ENRP trial schools accepted for 2000. Schools decided whether to implement the program using an individual or small group structure in students' second or third year of school (Grade 1 or Grade 2). This meant that a comparison could be made between the effectiveness of the different program implementations. This report concentrates on some outcomes of the EMU program for the 42 Grade 1 students and 63 Grade 2 students who participated in the program in 2000.

The *Extending Mathematical Understanding* (EMU) Program comprised daily 30 minute sessions for between 10 and 20 weeks, depending on the progress of students. Teachers worked with groups of three or four students or with individual students. The program is not remedial in nature, but is built upon constructivist learning principles (see, e.g., von Glasersfeld, 1989). It focused on children developing powerful mathematical understandings. Children were engaged in experiences that required 'hard' thinking, and children were required to reflect upon their activity and articulate what they had learnt and how they had learnt. The EMU Program provided different learning experiences for children than were possible within the classroom setting during mathematics lessons. In particular, the specialist teachers were trained to provide intensive instruction and feedback that was directed to the particular learning needs of each child. Observations of more than 30 EMU sessions in 2000 showed that, within each 30 minute session, children and teachers engaged in more than 100 interactions focused on the mathematical ideas investigated during a session. This high level of interaction between the teacher and a child is not possible in a classroom setting. The specialist teachers were able to constantly focus

children's attention on key ideas and facilitate their construction of knowledge and understanding. They helped children develop the language that would facilitate communication about mathematics, and provided manipulatives to support children's thinking at critical moments in their learning. Teachers constantly encouraged children to describe their thinking and strategies for solving problems, and provided *wait time* to encourage student's thinking and ability to provide extended responses.

The EMU program included further diagnosis of individual difficulties using the *Extending Mathematical Understanding (EMU) Assessment Interview* and learning experiences focusing on the counting, place value, addition and subtraction and multiplication and division aspects of the ENRP framework. Typically, each EMU session was structured to include 10 minutes of activities focusing on counting and place value, 15 minutes of rich learning activities focusing on problem solving (often with an addition and subtraction, or multiplication and division focus), and 5 minutes reflection about the key aspects that were covered in the session.

Comparison of Intervention at Grade 1 and Grade 2

An issue that teachers grappled with when deciding how to implement the EMU Program was whether to intervene in Grade 1 or Grade 2. This was a difficult choice for many schools. The idea of intervening as early as possible before children experienced failure was foremost in most teachers thinking. However, there were other factors to consider. For example, in Victoria most schools have *Reading Recovery* Programs for Grade 1 children, and some teachers anticipated that Grade 1 might be the most appropriate grade for a specialised mathematics intervention program also. Other teachers considered that intervention programs should be spread over two years, with Reading Recovery in Grade 1 and the EMU program in Grade 2. Other teachers believed that while it may be best, in the long run, to offer the EMU program in Grade 1, when faced with a number of Grade 2 children who were 'at risk' in mathematics, they thought it would be best to begin the program with Grade 2 children before they "fell" further behind. An advantage of implementing the EMU program at both Grade 1 and Grade 2 was that data could be collected and used to compare the effectiveness of the program at both levels.

For this purpose, children's mathematical progress was determined using the ENRP assessment interview and framework of growth points (Clarke, 2001). The children were assessed by their classroom teachers in both March and November, and the growth points reached by the children determined. Table 1 shows the mean growth in each of the Number Domains for the children who participated in an EMU program and the comparison groups.

Table 1

Mean Growth Points Gains for Children in the EMU Program and Comparison Groups.

Mathematics Domains	Mean gains in Growth Points			
	Grade 1		Grade 2	
	EMU <i>n</i> =42	Compar. Group <i>n</i> =469	EMU <i>n</i> =63	Compar. Group <i>n</i> =364
Counting	1.64	1.01	1.24	1.16
Place Value	0.86	0.68	1.25	1.07
Addition & Subtraction	1.00	0.99	1.24	1.05
Mult. & Division	1.21	0.98	0.94	0.51

The comparison groups were comprised of ENRP trial school children who did not

participate in an EMU program, but had the same growth point profiles as children who did participate.

The data presented in Table 1 shows that the mean gains were greater for children who participated in an EMU program, with one exception. Mean growth point gains for Addition and Subtraction for the Grade 1 groups were almost identical. The comparisons suggest also that the EMU program was effective for both Grade 1 and Grade 2 children.

The data in Table 1 can also be used to compare the mean gains for Grade 1 and Grade 2 children participating in the EMU Program. The gains are greater for Grade 1 children in Counting and Multiplication and Division, and for Grade 2 children in Place Value and Addition and Subtraction. However, statistical analysis of the effect of grade level on the effectiveness of the EMU program demonstrated that grade level was significant for only two of the four number domains. Grade 2 was significantly more effective for Addition and Subtraction ($F(1, 101) = 7.249, p = 0.008$), and for Place Value ($F(1, 101) = 7.991, p = 0.006$). There were no significant differences attributable to grade level for the Counting or Multiplication and Division domains.

These findings suggest that in determining whether the EMU Program is more effective at one grade level than another, then the mathematical domain must be considered. However, even though children made significantly more progress in Addition and Subtraction and Place Value in Grade 2, children make important progress in Grade 1 also. It may be that given the assistance in Grade 1, then children might be better able to benefit from the regular classroom program, and might not require an intervention program in Grade 2.

A further examination of the growth point data for each of the number domains shows that there are several growth points that act as barriers or prolonged transition points for some children. Another measure of the effectiveness of the EMU program at each grade level may be the program's effectiveness in assisting children to move beyond these barriers. These prolonged transitions or barriers can be identified using an area graph. Figure 1 shows the Counting area graph for the low-attaining trial school children in 2000 who had the same ENRP profiles as the Grade 1 children participating in an EMU program.

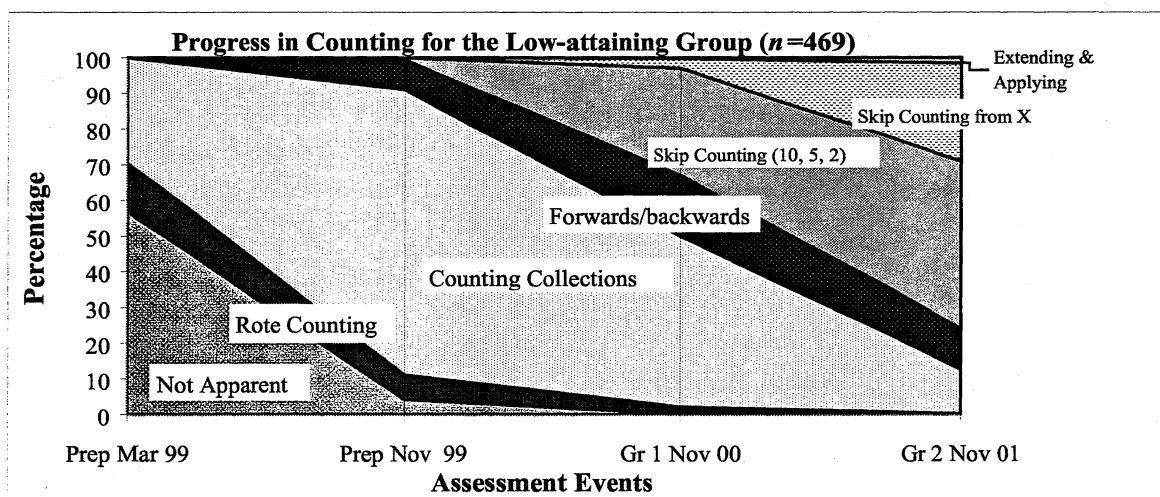


Figure 1. Low-attaining students (%) achieving Counting growth points over time.

The different shadings in the graph represent different growth points for Counting. The four data sets are points on the horizontal axis, and the vertical axis represents the percentage of the group achieving each growth point. The areas bounded by the lines give an indication of the difficulty students have in achieving particular growth points. For example, the large area in the middle of the figure indicates that many Prep students and Grade 1 students can count collections but are not yet counting forwards and backwards by ones from varying starting points. Indeed, many children remain on growth point 2 for extended periods. The figure suggests that counting forwards and backwards by ones from various starting points presents a barrier but, once overcome, students move readily to the subsequent point, as is indicated by the narrowness of the band associated with the next growth point. By the end of Grade 1 and throughout Grade 2, growth point 5 (counting by 10, 5 and 2 from X) becomes another significant transition point for many children.

Similar analysis for the domains of Place Value, Addition and Subtraction, and Multiplication and Division suggest further growth points transitions that are prolonged for many children. These are summarised in Table 2.

In comparing the effectiveness of an additional assistance program in Grade 1 or Grade 2, it is useful to compare how many children made these important transitions in their mathematical learning. Table 2 shows the percentage of Grade 1 and Grade 2 children participating in an EMU program who made these transitions.

Table 2.

The Percentage of Children Who Made the Difficult Growth Point Transitions in 2000.

Difficult Growth Point Transitions or Barriers	Gr 1 (%)	Gr 2 (%)
	n=42	n=63
Counting (3) – counting forwards & backwards by ones from variable starting points	50	65
Counting (5) – counting by tens, fives and twos from variable starting points	10	14
Place Value (2)– reading, writing, interpreting and ordering 2 digit numbers	45	73
Place Value (3) – reading, writing, interpreting and ordering 3 digit numbers	10	33
Addition and Subtraction (2) - count-on	57	67
Addition and Subtraction (3) - count-back, count-down-to, count-up-from	12	37
Mult. & Division (2) – Uses models to solve multiplicative & sharing situations	81	63
Mult. & Division (3) – Uses abstract strategies without modelling	0	13

Table 2 shows that, with the exception of the modelling growth point in Multiplication and Division, a higher percentage of Grade 2 children made each transition than did Grade 1 children. Although it might be expected that these transitions would be more achievable for the older students, it is interesting to note that, for several growth point transitions, the difference in the percentage of Grade 1 and Grade 2 children making the transition is no more than 15 percent. Therefore, even though more Grade 2 children make these transitions, this may not be significant when the factor of intervening a year earlier is considered and the difference this makes to children's subsequent learning in Grade 2.

These findings indicate that there is no clear answer as to whether the EMU Program is more effective at one grade level than another. The answer varies according to the mathematical domain being considered. Indeed, there may be other factors to consider. This possibility was explored by interviewing teachers, parents, principals to gain their perspectives on whether the intervention may be more effective in Grade 1 or Grade 2.

Perspectives of Parents and Teachers

The 21 Specialist teachers were interviewed and asked whether the EMU program was most effective in Grade 1 or Grade 2. The responses are summarised in Table 3.

Table 3

Specialist Teachers' Perceptions of the Most Effective Grade Level for the EMU Program

Perception of most effective year level	Number of responses
Grade 1	7
Grade 2	2
Both Grade 1 and Grade 2	10

The summary indicates that about half of the teachers thought the program was effective in either grade. One teacher qualified this response by explaining that she thought that both grades were effective, but that the program was more beneficial in Grade 1. Of the teachers who thought one grade level was more effective, most thought that Grade 1 was more effective. Reasons for this opinion included the following, "in Year 2 it is a stigma; they are more self-conscious. In Grade 1 [the children perceive] it as a privilege to participate. You are intervening to stop incorrect learning. It is a safety net."

One specialist teacher of Grade 2 children believed that his students would have benefited from having the additional assistance program in Grade 1. Another teacher commented, "sorting out common problems in Grade 1 is really good, so [children] don't see themselves as not good at maths." Another teacher explained, "if you want to make quick progress, then run the program in Year 2. The program is more beneficial in Year 1, but the progress is slower."

Two teachers believed the program was more effective in Grade 2. One teacher commented, "it is more effective with Grade 2. It could be maturity. The boys [Grade 1] wanted to play *Snap* all the time."

Three teachers were unable to answer this question because their schools made the decision to run the program with Grade 2 children only because of literacy being a focus in Grade 1. They were therefore not able to make a comparison between the effectiveness of the program the different grade levels. One teacher explained,

It was a lower primary unit decision to focus on Year 2. The Year 1 children are taken out so much for Reading Recovery. We have a lot of candidates for Reading Recovery at our school and children for top-up [literacy] programs, so lots of children are taken out. Therefore, we didn't want to be taking children from the Year 1 level again. Many of the kids who need additional assistance for maths also need Reading Recovery.

The classroom teachers, parents and principals of two Grade 2 children participating in the EMU program were asked whether the EMU program would be more effective in Grade 1 or Grade 2. The children are referred to in this paper as Sarah and David. Pseudonyms are used also for the teachers. David's teacher thought that Grade 1 was the preferred year for the EMU program.

If there is an obvious difficulty with a child in their developing of their mathematical understanding I think the earlier you can work with them the better...But then that doesn't also eliminate that there may be children for whatever circumstances in Grade 2 who need the help. I don't think they should be barred from it, but a child around the age of a Grade 1 child is [at] a premium age to start working on difficulties.

This teacher saw no difficulty with children doing Reading Recovery and EMU in the same year. She explained, “it’s all for the benefit of the child’s understanding and development.”

Sarah’s classroom teacher also thought Grade 1 would be the preferable year for participation in the program. However, she would like children to have the opportunity to participate in Grade 2 also:

When it’s gone to...Grade 2, you’ve really left your run very, very late. There’s things that people have moved on with. ...When are they going to catch that up? I would aim to have them return to ...the normal classroom as quickly as possible. I’m not sure if it all can be achieved in the one year though-if it’s one of those things that might be beyond one year. It might be more like a two year target. ...I think we could make an error if we say “this is only for grade ones” ah la Reading Recovery. “Only people in Grade 1 are eligible.” If it has to be that we can only offer it in one year, it would probably be the Year 1 [that] I would look at.

Both parents interviewed would have liked their children to have participated in the EMU program in Grade 1. Sarah’s mother commented:

I think it would have been great if Sarah could have done it last year in Grade 1. But as I said ... she was falling behind in her reading so you couldn’t really ... do two things at once-I think she needs to concentrate on one thing or another. ...Grade 2 is great but I think the earlier the better with the maths. I think if they find it difficult after Grade 2 and into Grade 3 I think they’ll just keep suffering and getting further and further behind ... because they just don’t have the basics there and then going back to the real basics ... probably would make them feel a bit stupid because they don’t know... the really, really fundamentals of maths. So I mean Grade 2’s been great, but she probably needed the help last year. But then again it’s really hard to tell with her because she probably did lack knowledge in maths even Yeah, with Sarah even in Grade 1 it would have been great but you know Grade 2’s been great too. She really sort of enjoys it thoroughly so I don’t have a problem with it but, yeah Grade 1 would probably be a good time.

Sarah’s mother also pointed out that participating in Reading Recovery in Grade 1 may have had a detrimental effect on Sarah’s learning of mathematics because she missed out on mathematics classes to do Reading Recovery:

Mrs Jones did say, I think at the first ... parent teacher interview, that Sarah was a bit slow in her maths. But we did know that because she was taken out from a lot of maths... because she was in Reading Recovery. Mrs Southby said, that was her teacher in Grade 1, the only thing is it’s [Reading Recovery] been wonderful with her reading but she is missing out on some of the maths which we have started to notice. So that was probably one of the downfalls of her being pulled out of half an hour every day of that class. But it ... [Reading Recovery] was excellent, but then again... everything does have it’s little downfalls somewhere along the line. But [Mrs Southby] did mention that ...even last year, ...her maths were a bit behind.

This comment highlights the importance of planning appropriate times for withdrawal programs. It appears that running *Reading Recovery* during mathematics times may be detrimental for some children.

David’s mother also preferred Grade 1 for the EMU Program. She explained, “if he starts at an earlier age, then when he gets older, if he’s still got the difficulty, he’s got the help at an earlier age... I’d prefer the earlier age, Grade 1.

David’s principal also had an opinion about the most effective grade level for the EMU program. He believed that the EMU program was most effective for the Grade 1 children.

The testing [in our school] has shown that, especially the Grade 1s, [have] made rapid improvement and rapid progress. Their case has sort of caught up with the mainstream in the classes. Grade two-...they’ve had definite improvement but nothing like the Grade 1s. Whether that’s related to age and whether that sort of endorsed the Reading Recovery sort of philosophy, that children at that age, Grade 1, are the best age group to intervene, I don’t know, but from results here, that seems to be the

case...Grade 1s tend to be making the better progress and excellent progress.

The data suggest that the most effective level for the EMU program depends on several factors. Indeed, the effectiveness of the program depends partly on the mathematical domain being considered. The views expressed by the parents and teachers interviewed suggest that Grade 1 is preferable to Grade 2 because children are provided with assistance at an earlier age. Providing children with assistance in Grade 1 is important. However the teachers suggest that Grade 2 should be considered also.

Conclusion

Providing specialised assistance at critical points in their education is an important way to enhance the learning of children who experience difficulty learning mathematics. However, it is not clear whether intervention programs are more effective in Grade 1 or Grade 2. Analyses of growth point data presented in this paper suggest that the EMU Program was effective in both Grade 1 and Grade 2, but that Grade 2 children made significantly more progress in Place Value and Addition and Subtraction. Grade level had no significant effect on children's learning in the Counting or Multiplication and Division domains. This suggests that the effectiveness of the EMU program depends, in part, on the area of mathematics being considered. However, if a choice needed to be made between running the EMU Program in Grade 1 or Grade 2, the views expressed by the parents and teachers interviewed suggest that Grade 1 is more appropriate. Indeed, it seems preferable to provide children with assistance as early as possible, before they experience failure.

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