A STRATEGY FOR SUPPORTING STUDENTS WHO HAVE FALLEN BEHIND IN THE LEARNING OF MATHEMATICS

PETER SULLIVAN
Monash University
peter.sullivan@monash.edu

SUE GUNNINGHAM
Sue Gunningham Consultancy Services
sue.gunningham@bigpond.com

Given the diversity of achievement in most classes and the other pressures on teachers, it seems unrealistic to assume that class teachers, as part of their everyday teaching, can provide whatever support is needed by students who have fallen a long way behind. The following is a report of a specific initiative aimed to investigate the potential of an out of class student support intervention, the goal of which is to prepare students for the mathematics lessons they will experience subsequent to the support.

Introduction

One of the consistent conclusions from international comparisons is that while Australian students overall are doing well, there is a long tail of underachievement (Thompson & De Bortoli, 2007). This is no surprise to teachers of mathematics. A Year 9 mathematics teacher sent us the following story. He was revising some recent work, and the students were working on this problem.

> You earn $12 per hour for 22.5 hours. You pay 26% of your earnings in tax. How much tax will you pay?

A girl, Emma, wanted help.

Mr T:	Do you have a job?
Emma:	Yes
Mr T:	How much an hour do they pay you?
Emma:	I don't know—I just started.
Mr T:	Let's say you earn $12 an hour and you work for 3 hours. How much is that?
Emma:	I don't know. Do you divide?
Mr T:	No. Think about earning $12 an hour. You work one hour, and then another, and then another. How much have you earned?
Emma:	I don't know.
Kylie (sitting nearby):	Is it $36?
Mr T:	Yes. Good.
Emma (to Kylie):	God, you're smart.

This story highlights a number of critical issues for mathematics education: How has this student survived so long in the system without action being taken to address her

inability to answer such questions? What benefit is she gaining from her Year 9 mathematics classes?

However it seems that this is not an isolated case. Consider the following two NAPLAN items taken from the 2009 Year 9 assessment in which students do not use a calculator. One item was presented as follows:

> Steven cuts his birthday cake into 8 equal slices. He eats 25% of the cake in whole slices. How many slices of cake are left?

This was a "write in" answer and 85% of Victorian students did this correctly. Even though it is a very straightforward question, there were 15% who gave the wrong or no answer. Attributing difficulties to the reading does not explain the number who could not do it. All Year 9 work in mathematics classes would be much more difficult than this question.

Another item was as follows:

> A copier prints 1200 leaflets. One-third of the leaflets are on yellow paper and the rest are on blue paper. There are smudges on 5% of the blue leaflets. How many blue leaflets have smudges?

The students could choose from four options: 40, 60, 400, or 800. There were 59% of the Victorian students who chose the correct answer. Recognising that this item involves three steps after reading the question, there are 41% who could not choose the correct response from the four options. We suspect that those students would have substantial difficulty in comprehending most of their Year 9 mathematics. We also suspect that their difficulties started well before that stage.

Given the diversity of achievement in most classes and the other pressures on teachers, it seems unrealistic to assume that class teachers, as part of their everyday teaching, can provide whatever support is needed by students who have fallen such a long way behind. The following is a report of a specific initiative aimed to investigate the potential of an out-of-class student support intervention, the goal of which is to prepare students for the mathematics lessons they will experience subsequent to the support.

Theoretical framework

One aspect of the rationale for this approach is derived from cognitive load theory (Bransford, Brown, & Cocking, 1999). Pegg (2010), for example, outlined his perspective on maximising learning based on this perspective. The theory suggests that all information is processed in working memory and then stored in long term memory. The idea is to have the information that is stored in long term memory efficiently chunked so that it can be readily retrieved. The initial processing of information and preparation for this chunking happens in working memory, which is of limited capacity.

While Pegg (2010) focused on developing fluency in calculation as a way of reducing the load on working memory, this intervention program focuses on the ways that students attend to stimuli around them and the key information that they select for processing. In all situations, and especially in classrooms, there is more happening than can be effectively attended to, so it is necessary to select from among the sensory experiences.

Students who have fallen behind have greater difficulty in selecting the appropriate information and so the instruction, the task, the language, and even what the other students are saying and doing becomes confusing. The hypothesis is that if the attention of such students can be focused on key information, they can select more appropriately what is likely to help them learn. An example of the way this works is in mathematical language. If students do not know what is meant by terms such as parallel, right angle, index, remainder, or average, then instruction using those terms will be confusing and ineffective since so much of their working memory will be utilised trying to seek clues for the meaning of the relevant terminology.

Without necessarily drawing on this particular theory, many educators have based their approaches to instruction on the same principles. Tzur (2008), for example, argued that instruction should begin with what the students already know and are confident with and then move to content that is unfamiliar, rather than what he claims is the common approach of starting with unfamiliar content.

A second rationale for this approach is that classrooms are social and students prefer to participate positively, thereby satisfying a need for social connectedness (see Hannula, 2004). Of course, sometimes some students do not seem to reflect that need in their behaviour. This can be explained by Dweck's (2000) notion of describing students as either seeking mastery of the content or affirmation of their performance from the teacher (or someone else). Elliot (1999) explained that students who have a performance orientation but who see the risk of failure as high will actively avoid participation, which is commonly manifest in them threatening classroom order.

Approaches to supporting students experiencing difficulty

There are a number of existing programs designed to support students who have fallen behind in their learning. Gervasoni (2004) for example, argued that low achieving students can lose confidence in their ability, and develop poor attitudes to learning and to school. One outcome is that the gap grows between the knowledge of these children and of other children and that the typical learning experiences provided by the classroom teacher for the class do not enable each child to participate fully and benefit. Ginsburg (1997) concluded that "as mathematics becomes more complex, children with mathematics learning difficulties experience increasing amounts of failure, become increasingly confused, and lose whatever interest and motivation they started out with" (p. 26). Gervasoni (2004) outlined the *Extending Mathematical Understanding* program that involves professional development for teachers along with dedicated time in small groups with students experiencing difficulties. Gervasoni presented evidence that students who experience the program's structured intervention improve. A similar program, *QuickSmart*, also results in impressive improvement in students who complete the program (Graham, Bellert, Thomas, & Pegg, 2007).

Programs such as these are clearly successful in what they seek to achieve and this particular initiative is seeking to extend these in a particular direction.

The *Getting Ready* intervention

The intervention reported below was supported by the Wyndham Network of Schools in the Western Metropolitan Region of Melbourne[1]. The participating schools agreed to release tutors to work with selected students in small groups, with the goal of providing preliminary information on the upcoming topic to those students, prior to their participation in the classroom mathematics lesson.

Initially the tutors met with the second author on three occasions to consider appropriate models for working with students in the tutoring sessions. The advice offered to the tutors was that they should:

- highlight and familiarise students with the vocabulary of their next mathematics lesson;
- use questioning to focus the students' attention on the relevant concept(s) and to 'resurrect' any prior knowledge of the concept that the students may have; and
- briefly model the sorts of activities to be undertaken in the next classroom lesson.

It was emphasised to tutors that they should not seek to teach the content, because the goal is that the students prepare to learn in the lesson, as distinct from removing the need for them to concentrate when they get to the lesson.

Year 3 students were selected for inclusion in the program by the tutors on the basis of the annual teacher judgement data, Early Years Interview results, and 'On-demand' testing data. Year 8 students were chosen on the basis of their NAPLAN results from the previous year, with students appearing in the bottom 20% of the applicable data being eligible for selection to the program. Where this number proved too many, the tutors conferred with the classroom teachers to select from the identified cohort, those students whom it was believed, would most benefit from inclusion in the program.

The data collection

There are three types of data presented: the first and major section uses the response of participants to elaborate details of the intervention; the second section is a brief description of insights from a videotape record of a tutoring session; and the third section is some analysis of pre- and post assessments including comparisons of the results of those who were tutored and those who were not.

From the participants

As a preliminary evaluation of the initiative, participants were interviewed at the end of the first phase, some six months from commencement of the project. In particular, the interviews were intended to explore:

> What are the organisation and administrative challenges in implementing this initiative?
> What was the experience of the tutors, the class teachers and the participating students?

Sixteen people were interviewed at the end of phase one: three tutors (one from each school, designated as Schools A, B, and C); six teachers (four from School A, and one each from Schools B and C); and seven students (five from School A and two from School B). The following presents selected representative responses on aspects of the initiative.

[1] The program was supported by Sharon Taylor, managed by Lucy Glover and Steve Boyle, and involved the participation of a range of energetic and professional tutors and teachers.

One of the interview questions sought participants' perspectives on the aims of the intervention. The aim of the program being implemented before mathematics lessons was to give students "pre-knowledge" based on relevant language, according to two tutors and one teacher. Particular comments were:

> What my hope is, is that I'm giving them the pre-knowledge, so front-loading the kids, so when they actually go to the numeracy lesson ahead they will have an idea of what is going to happen. In that way, that will free up some learning space so they're not still behind the eight ball. So they come in, they know what's expected and then they can gain more out of the numeracy lesson than they normally would have. (Tutor, School C)

The response of other teachers were similar. It seems that their perspective on the aims and intention of the initiative were aligned with the goals of the program.

The interviews also sought insights into what the respondents saw as the benefits of the program. One tutor discussed the benefits to the students with regard to how they think about their learning.

> I can see the benefits to being one step ahead rather than always being on the back foot trying to continuously catch up. I think it's a benefit even if it's just seeing the main word and then that's a word that they're familiar with so when they go into the grade they say "Oh, I remember that word, I know what it is". And that's what I'm actually finding when I go back to revisiting. "Do you remember yesterday when we talked about this—can you tell me about it?" So it's going back so we can go forward, making constant connections. It's helped me hone my teaching skills, and then I'm relaying it back on to the teachers to say "We need to work on this". Because it's just the three of us we need to focus on what they're actually doing, instead of with 20 kids. (Tutor, School B)

These benefits are indeed those that were hypothesised.

Another of the consistent messages from teachers was that they found that students gained in confidence when they came back to the classroom.

> I think it's because they feel more confident about the topic we're learning about because they've already had a bit of work with [the tutor], so I think that helps them a lot. It's sort of a confidence thing where they can participate and they're willing to participate in discussions. (Teacher, School B)
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> Definitely. Confidence. Before if I was questioning them they would never put their hand up where as their hands are up straight away trying to tell me what they've been learning with [the tutor]. They want to tell me everything they've been learning. They do have a greater confidence to be put into a discussion, so it gives them the confidence to contribute in the class where before they would just sit on the floor, not really put their hand up, but now I can see the connection between working with [the tutor] and when they come in here. They are familiar with the words, they are familiar with the vocab, and different areas like that. (Teacher, School C)

While confidence is not the end goal, it is clearly advantageous and is likely to lay the foundation for changed approaches to participation.

Building on the development of students' confidence, there were examples of how the intervention transformed the experience of some students when they returned to their class. The following is an illustrative example:

> My thought was that we are targeting those students that just need that extra bit to give them that shove, and the biggest thing I've noticed is their confidence. They are coming back in and these kids are putting up their hand and they are getting the answer right. I do a lot of language in mathematics before I start anything, so that's constant reinforcement. They are not just hearing it from me, they are hearing it from [the tutor] as well and that

> has made the biggest difference. I got so excited yesterday because one student who is part of the program has come from being so quiet—she doesn't like to speak a lot, she's almost mute and ESL—and she now puts her hand up for everything. … And another child in my class in the program, he is now so positive. I say "Maths" and he goes "Yeah, I've done this with [the tutor], and he gets so excited because he knows what he's doing. I think it's ace. (Teacher, School A)

These comments are very powerful and indicate the potential of this approach in transforming willingness of students to participate in class.

A somewhat unexpected outcome was that the program seemed to impact on classroom teaching. The following is a comment by one of the teachers:

> Yes. Even with my own teaching – I've been able to keep the lessons flowing rather than having to stop and start. This way it's been easier to go through all the topics. (Teacher, School A)
> It's benefited my kids dramatically, but I don't know whether it's just my kids and the fact I've taken it on so completely that might have been what's made the difference. (Teacher, School A)

It is interesting that this should happen, and perhaps might be one of the major benefits of this approach to intervention over others, in that it potentially improves the learning of all students.

Participating students were also interviewed and the following are some representative comments:

> [The tutor] helps me know maths very well and it's very fun to do maths. She teaches me how to skip numbers and it's easier for me to skip numbers so I don't have to count by ones [for subtraction]. (Student, School B)
> [The tutor] helps me practice my writing. She's helped with multiplication and ladders and vertical. She has helped me with division because we've been doing that (in class). (Student, School B)
> It made it easier. 'Cause first I didn't know it [division] and then with (the tutor). I learnt something. (Student, School A)
> Because you get to learn how to do them and also sometimes I get confused about it. She explains things and tells us to do them in our scrap books. (Student, School A)
> It is because then I can understand and I know what to do. I always answer questions. (Student, School A)

The students clearly feel that they have learned, and see the connection to class participation.

Lessons from the video records

One of the video records shows three Year 8 boys participating in a tutoring session. The boys start the session very restless, paying little attention to the task, and potentially threatening order even in the small group. The tutor on the video progressively engages the students in reviewing what they know about the topic and clarifying any language issues that may have been relevant.

The tutor also models the action expected in the class, which was using a protractor and compass. The boys became progressively more engaged in the task, and at the end were fully engaged in listening and watching. Subsequent reports indicate that the students returned to their class and participated well and appropriately in the full class learning experience.

The inference is that an outcome of the tutoring is that students are more able to participate in the social experience that is the classroom. Another insight is that allowing such students to watch, as distinct from merely listening may be a potentially useful strategy in both tutoring and whole class sessions.

Some comparisons of assessment scores

All schools used a form of assessment at the start of the year and then again near the end of Term 3, using VCAA on demand testing. The schools were quite different in the way that the results were recorded, so they are presented separately.

Table 1 presents the results for the four primary schools that participated. The scores relate to the VELS levels. Notionally each year students should improve 0.5 of a level. In each case the gains in the means of the tutored students are compared with the students who did not participate in the tutoring.

Table 1. Comparison of gains for tutored and non-tutored Year 3 students.

Name	Tutored students' gains (n)	Not tutored students' gains (n)
Primary School A	.44 (12)	.30 (12)
Primary School B	.40 (12)	.32 (26)
Primary School C	.38 (22)	.40 (81)
Primary School D	.30 (11)	.50 (55)

In two primary schools the tutored students improved more than the others, and in two schools the reverse is the case. Therefore it is not possible to make judgments about effectiveness for tutored students from these data. It is noted though that the assessments measured knowledge over broader content than was covered by the tutoring program, indicating that any learning of students being tutored seemed to apply beyond those topics taught. Table 2 presents results for Year 8 students in two secondary schools.

Table 2. Comparison of gains for tutored and non-tutored Year 8 students in two schools.

School	Group	N	Mean gain	Median gain
Secondary school A (N=168)	Tutored	24	.45	.55
	Not tutored	144	-0.03	.08
Secondary school B (N=111)	Tutored	21	.48	.50
	Not tutored	90	.29	.40

In both cases, the gains for the tutored students were greater than for the not tutored students, and in one case much greater. Again, given that the comparison is on more than the taught topics, this improvement is outstanding.

Important considerations/issues that evolved during the pilot

There were a number of organisational considerations that became apparent during the trials and constitute learning from the experience of developing the initiative interactively with the teachers and tutors.

- *Group size:* Initially the tutors worked with groups of varying sizes however over time it became apparent that the optimum group size was 2 or 3 students. A

common characteristic of the selected students was a lack of confidence when working in numeracy and this manifested itself as a reluctance to ask and/or answer questions, to offer suggestions or take risks during the sessions. It became apparent that the more students in the group, the greater the opportunity for each student to continue these practices. At the same time, the tutors could recognise a real benefit in having at least two students per group because this provided opportunity for students to discuss the mathematics in a familiar way, share strategies, support each other to take risks and finally to remind and prompt each other during their whole-class mathematics lessons.

- The tutors gradually all reduced their groups to either two or three students. Careful attention was paid to the mix of students in each group to avoid personality clashes. Similarly each group comprised students from the same class to ensure they would be able to support each other back in the classroom. Some tutors opted for groups of 3 to accommodate the frequent absenteeism that appears to be linked to low achievement, particularly in the secondary school setting. A group of three students meant that even if one student was absent, the remaining two students could have worthwhile dialogue during the session.
- *Absenteeism:* Initially, when a student was absent, some classroom teachers substituted other students into the tutoring session to 'fill the gap'. As it happened, this upset the balance of the sessions and became a source of frustration to the tutors. The short sharp timing of the session became lost when the model needed to be explained to the non-tutoring student, the reflection on past lesson success/challenges was difficult, the confidence of the tutored student sometimes regressed and the relationship between tutored student and tutor became difficult. It was therefore decided that in the case of an absenteeism non-G.R.I.N. students would not be substituted into the G.R.I.N. session.
- *Withdrawal from class:* We recommended to schools that students not be withdrawn from the same lesson repeatedly. By the same token, students with low confidence in numeracy may demonstrate confidence in other fields and should be given an opportunity to demonstrate this where possible. Tutors sought to spread the lessons from which a student was withdrawn across a range of subjects on different days and at different times during the week.
- *Adequate time for tutors and teachers to meet:* It was an ongoing challenge for tutors and teachers to meet regularly to share information about future lessons and discuss student progress. Some tutors are also classroom teachers and have ready access to team planning sessions, while others are forced to rely on teachers' work programs, casual conversations in the staffroom or chats on the run in corridors.
- *Professional learning of tutors:* All tutors met together on a monthly basis for the purposes of sharing ideas and professional learning. During these sessions the structure of the tutoring sessions was re-visited and refined as required and common tools for data collection were developed. Tutors also participated in professional development about effective questioning and 'wait time'. More recently tutors worked as a professional learning team and gave feedback to each other on the basis of video clips that they have taken of themselves delivering tutoring sessions. These video clips have become a powerful tool for focusing on

the structure and intervention model, the purpose for each section of the structure and the tutor's role within that structure.

Conclusion

It is reasonable to conclude that the intervention was extraordinarily successful. The tutoring initiative has a clear rationale, it was received positively by students, tutors, and class teachers, and there is evidence of positive broader learning gains from the students.

There are two important aspects to the initiative. First, participation in the tutoring does indeed prepare students to be able to participate in their usual classes by reducing their cognitive load in the class. Second, since learning and classrooms are social settings, it allows tutored students to participate normally in the social settings thereby changing the way that they see themselves.

It is noted that there are other advantages in this approach. The resources required are not much greater than the cost of providing the tutor. There is a need for teachers to plan effectively and to articulate their plans to the tutors. There is a need for close collaboration between teachers and tutors. While there is some requirement of education of tutors and teachers, these are minimal and the whole process is readily sustainable. There are multiple stories of transformational change in the behaviour of some students. The approach clearly has potential.

There is one further issue. Sometimes commentators suggest that some students cannot learn mathematics whatever we do. This project demonstrates that this is a false assumption and that students can learn if given appropriate opportunity.

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