Student re-engagement and valuing of mathematics learning through an intervention program

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This paper reports results from an investigation of the impact of an intervention program which was designed to help underperforming students reengage in mathematics learning. The paper outlines teacher and tutor perceptions of the program's impact on students who participated in the intervention which intends to "get students ready" for their subsequent mathematics lesson. Over the course of the iteration, the students' cognitive and behavioural engagement improved. Perhaps even more encouraging was the improvement in the students' dispositions, leading towards greater valuing of mathematics learning.

"I hate mathematics" is a phrase that is too commonly expressed by many students. Adults and children often proclaim their lack of success in mathematics without embarrassment, treating this lack of accomplishment in mathematics as a permanent state caused by a tendency to believe that success in mathematics is more related to ability than effort (McLeod, 1992). The media portrays headlines such as "Mathematics is in a death spiral in Australian schools" (Mather & Tadros, 2014) and the concern grows over the lowering levels of engagement with mathematics in Australia.

Some students struggle to thrive when it comes to learning mathematics in classrooms (Gervasoni, 2015). By the time students reach the middle years, wide differences in mathematics achievement and dispositions between students are apparent (Thomson, Wernert, O'Grady & Rodrigues, 2016). It seems as if these students have significantly "fallen behind" resulting in large gaps in their understanding of mathematics. Unable to "keep up" with the rest of the class, these students disengage with their mathematics learning and develop a pervasive negative attitude towards the subject. Additionally, curriculum pressures demand that mathematics teachers "move along" and their concern for underperforming students intensifies. Gervasoni (2015) suggests that these children may benefit from participation in an intervention program.

The Getting Ready in Numeracy (G.R.I.N.) program is an initiative that aims to re-engage disengaged students by preparing them for their subsequent mathematics lesson (Sullivan & Gunningham, 2011). This involves G.R.I.N. students attending a tutoring session before their mathematics lesson. In this session, they are provided with an opportunity to work with a small group of students and a G.R.I.N. tutor to explore targeted fluency practice, language development and to obtain familiarity with key pre-requisite concepts that will be explored in the mathematics lesson that will follow (Sullivan & Gunningham, 2011). This strategy aims to decrease the cognitive load of the students so that they are able to engage and keep up with the momentum of their mathematics lesson. During the G.R.I.N. session, the G.R.I.N. tutor highlights and familiarises students with the vocabulary of their next mathematics lesson; uses questioning to focus the students' attention on the relevant concept(s) and to 'resurrect' any prior knowledge of the concept that the

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students may have; and briefly models the types of activities to be undertaken in the subsequent mathematics lesson (Sullivan & Gunningham, 2011).

G.R.I.N. sessions include mathematical discussions as well as modelling and manipulation of materials and equipment that will 'front-load' the students for the subsequent mathematics lesson. In order to help students who have fallen behind in mathematics learning, the G.R.I.N. program offers additional support to re-engage disengaged students and help them regain their confidence and a positive attitude so they will ultimately value the learning of mathematics. In this paper, we explore the perceptions of G.R.I.N. from the perspective of both tutors and teachers through semi-structured interviews. In particular, we examine the successes and challenges of the program in terms of re-engaging previously disengaged students with their mathematics learning.

Values and Engagement

Student engagement has an extensive research base (Fredricks, Blumefeld & Paris, 2004) and is shown to be a complex and multi-faceted construct. Researchers, psychologists and educators differ in opinions as to what constitutes engagement, how the construct can be measured and what factors combine to result in engagement (Fielding-Wells & Makar, 2008). However, there is a consensus that engagement involves three commonly identified dimensions: affective engagement, behavioural engagement and cognitive engagement (Fielding-Wells & Makar, 2008; Kong, Wong & Lam, 2003). It is important that the inter-relatedness of each of the individual dimensions of engagement be considered and not assumed. For example, a student not making eye contact with the teacher in class may seem behaviourally disengaged but their attentive listening is a non-obvious indicator of cognitive engagement and affective engagement.

Sullivan and McDonough (2007) claim that two sets of factors must align to promote student engagement with the learning of mathematics. The first set includes students having the requisite prior knowledge; this is what the G.R.I.N. program offers to students who have failed to achieve this through their typical classroom experience. Other factors from the first set include a curriculum that is relevant to students' lives, interesting classroom tasks and pedagogies, and assessment regimes that match the students' expectations. These factors are also supported by the G.R.I.N. program when the mathematics teacher meets with the G.R.I.N. tutor to plan the G.R.I.N. sessions and the subsequent mathematics lesson. This involves reviewing curriculum documents to identify the important ideas, checking available resources, planning assessments of student readiness and drawing on the experience of colleagues (Sullivan, Clarke & Clarke, 2012). The second set of factors proposed by Sullivan and McDonough (2007) reflects the individual aspect of engagement: students relating to students' goals for learning, their willingness to persist, and the extent to which they see participation in schooling as creating opportunities.

> In mathematics education, valuing refers to an individual's embrace of convictions which are considered to be of importance and worth. It provides the individual with the will and grit to maintain any 'I want to' mindset in the learning and teaching of mathematics. In the process, the conative variable shapes the manner in which an individual's reasoning, emotions and actions relating to mathematics pedagogy develop and establish (Seah, 2018, p. 616).

Research evidence has supported the belief that mathematics performance is related to students' valuing (Seah, 2018). Students' possession or acquisition of relevant valuing allows each of them to apply appropriate cognitive skills and also to develop positive dispositions which promote desirable outcomes in mathematics learning. Thus, to improve student outcomes such as measurable performance or relational understanding, the learner should want to engage, to understand, to learn and to achieve in the first place (Seah, 2018).

> Facilitating the valuing of relevant attributes in mathematics by the students themselves is a crucial - and often forgotten – component of mathematics pedagogy, for this in turn supports the development of cognitive functioning and nurturing of affective states that would more directly impact on the quality of learning. (Seah, 2018, p. 566).

However, what specific values should a program such as G.R.I.N. help to cultivate? One way of addressing this question is to consider Dweck's (2000) proposal that finding ways to support low achieving students is as much connected to their orientation to learning as it is to their level of their knowledge. Dweck categorised students' orientation to learning in terms of whether they hold either mastery goals or performance goals. Dweck argued that students with mastery goals seek to understand the content, and evaluate their success, by whether they feel they can use and transfer their knowledge. In contrast, students with performance goals are, at best, interested in whether they can perform assigned tasks correctly.

Dweck connected performance goals to a fixed view of intelligence in which students believe that the intelligence that they have is what they were born with and which cannot be changed. Students with mastery goals see intelligence as incremental and feel they can change their intelligence or achievement depending on factors over which they have some control. More critical for students from middle primary levels upward is what Elliot (1999) described as performance avoidance. In this, some students choose not to engage in a task or experience at all rather than trying at the task and failing (see also Desforges & Cockburn, 1987).

GRIN attempts to re-orientate students with a negative self-concept as mathematics learners towards a mastery orientation. The underlying assumption is that if the risk of failure is reduced through increased familiarity with the focus content and associated processes, then students who would otherwise be disinclined to participate may join in with others in attempting the tasks set. This initial familiarity will support the belief that, through effort, the student can come to have success with the material presented.

The success of an intervention program such as G.R.I.N. is therefore also dependant on the G.R.I.N. students acquiring values that promote a mastery orientation towards the learning of mathematics. The findings reported below are intended to address the following research question: What is the impact of G.R.I.N. on students' dispositions towards learning mathematics?

Research Design

The current study endeavoured to build on the initial evaluation of the G.R.I.N. pilot program (see Sullivan & Gunningham, 2011) by collecting qualitative data from G.R.I.N tutors and classroom teachers from the 2017 and 2018 iterations of the program. Participants were two G.R.I.N. tutors and two classroom teachers from four different schools who agreed to participate in in-depth semi-structured interviews at the end of the school year, about their perceptions of the G.R.I.N. program. The key prompts used during the interviews were probing how the G.R.I.N. program impacted students, teachers, tutors and the teaching of mathematics at the school more generally, as well as some of the challenges, concerns or issues around the implementation of the program. For the purpose of this paper, the discussion will focus on the change in student dispositions and engagement towards the learning of mathematics.

Analytical Approach

The Constant Comparative Method (Glaser, 1965) was employed as the preferred analytical approach for making sense of the interview data. The power of this method revolves around its capacity to use data to inform and build theory. The four stage process that an analyst need to work through to employ the Constant Comparative Model is:

1. Comparing incidents applicable to each category
2. Integrating categories and their properties
3. Delimiting the theory
4. Writing the theory

The coding of the data allowed for three meta-categories: Student Gains: Confidence and Capability; Systemic Challenges: Communication and Coordination; and Contested Areas: Pedagogy and Professional Expertise. The following section will focus on the first meta-category Student Gains: Confidence and Capability for the purpose of this paper. We report our findings in two main sections: Growth mindset and Engagement. Extensive quotes from participants will be included when relevant to support the analysis and help the pertinence of a particular category.

Findings

Growth mindset

One of the teacher perceived benefits to the students participating in G.R.I.N., is the development of a growth mindset with regards to their mathematics learning. A growth mindset is characterised by the belief that through sustained effort, one's ability and competency in any given area can be improved (Dweck, 2008). The construct of a growth mindset overlaps with that of a mastery orientation and is contrasted with a fixed mindset, which is the belief that one's ability or intelligence is fixed (Dweck, 2000).

A G.R.I.N. teacher participant, who is also a Professional Learning Team (PLT) leader, highlighted the power of students working with the G.R.I.N. tutor in order to reframe their experience when confronted with struggle and confusion in mathematics lessons. The G.R.I.N. tutor had helped students to recognise that mathematics learning can be challenging and that it is common phenomenon to be in the zone of confusion during this time until understanding was achieved. In mathematics learning, challenging tasks require students to demonstrate patience and perseverance. The word "yet" is significant when considering the quote below:

> We have found that it's made a big difference to students' attitude to their learning…The tutor that has worked with them has worked on things like growth mindset and has helped these kids who were struggling in maths, who were often saying, "I just can't do it", "You know, it's too hard, I can't do it". So, with the teaching and with a growth mindset of 'I can't do it yet' she has found great power in using the word 'yet' with the kids. So, they can't do it yet but if they persevere and you know stick with the task and stick with her, they will actually get there. PLT teacher

Another element of a growth mindset is the willingness to take risks and 'have a go'; to make mistakes and view this as an integral aspect of learning. The G.R.I.N. program is designed for an appointed G.R.I.N. tutor to work with a small group of three underperforming students in mathematics (identified as the G.R.I.N. students). The students participating in the G.R.I.N. program are a sub-set of the larger cohort (classroom). As mentioned previously, the G.R.I.N. tutor meets with the three G.R.I.N. students before each mathematics lesson, generally at least three times a week. The fact that G.R.I.N. involves students exploring mathematical ideas in a relatively intimate setting characterised by mutual

trust may be responsible for students' subsequent willingness to attempt mathematical problems that they were unsure of when they return to their mathematics classroom. As one teacher stated:

> The biggest benefits for students, I think, are confidence, particularly confidence in going into solving problems. So, being able to have a problem that they didn't know the answer to and be able to have the confidence to make some mistakes and try some different things within solving it. I think that's been the biggest change, as opposed to 'I can't do it and shut down and I'm not going to do it anymore' or 'I can't do it so I'm going to look for an excuse to get out of the classroom and do something, misbehave or whatever. Leading Teacher, Mathematics.

However, it was also noted that it was sometimes difficult to sustain the students' growth mindset once the mathematics learning became more challenging. This is a useful reminder that changing the way one thinks about themselves as a learner can be a slow and difficult process and that G.R.I.N. is unlikely to be a panacea.

> In the first 4-6 weeks, some students were really high confidence and they were loving it and then they were coming back to class and they were doing really well so the expectation went up on what they could do and the amount of work they could do… But as it started getting harder… about the 8 week mark, they were sometimes starting to say, "I don't want to do this anymore. This is too hard". There were a few weeks where we had to really push them to actually got to the G.R.I.N. sessions and we were saying, "No, you can't just give up now that it's getting hard". It sort of got to that point when they grew a lot quickly and then the growth slowed down a bit for them. So, getting kids through that bit was a challenge. Leading Teacher, Mathematics.

Engagement

Another significant benefit to participating in the G.R.I.N. program was its impact on student enthusiasm and engagement in mathematics classes. In particular, students seemed more willing to contribute to discussion and more actively participated in the lessons.

> A noticeable change in confidence, participation in class activities, much more engaged in discussions, mathematical discussions and reflections in the classroom. They were the biggest ones. We did see a spark in their data over time [pre and post data] but the biggest one was confidence level in the classroom. Leading Teacher, Mathematics.

In a different interview with a Numeracy Leader who was also appointed as the G.R.I.N. tutor, it was noted that increased self-efficacy in mathematics as a direct result of participating in G.R.I.N. appeared to be translating to greater engagement with mathematical discussions back in the classroom.

> We have noticed more so a change in their confidence. They are putting their hands up more in class. They're coming to G.R.I.N. knowing now that this will help them in the classroom maths session and they are coming back the following day with "Oh, this helped me in class yesterday" or "I am now the smart kid in the class" because they can see a difference, it's really impacted their confidence. We only do it twice a week considering and it's a pretty profound impact. G.R.I.N. tutor and Numeracy Leader.

A Literacy and Numeracy Intervention teacher noted that the increased levels of student engagement and enthusiasm for participating in the G.R.I.N. program itself, changed considerably over the course of the program.

> I suppose their enthusiasm for maths, in terms of the start they didn't even want to come to G.R.I.N., they really just didn't want to do maths. They used to say to me "Are we just getting punished, this is like a punishment, we are no good, we suck". Then as time went on, I was getting, "Are we having G.R.I.N. today? Are you going to be here? Are we having G.R.I.N. tomorrow?"... And then when I have to discontinue some of them because they caught up, "I still want to come to G.R.I.N. though. Can I still come?" So that kind of shift more than anything that I noticed. G.R.I.N. tutor and Literacy and Numeracy Intervention Teacher.

The Literacy and Numeracy Intervention Teacher also suggested that participating in the G.R.I.N program provided students with opportunities for students to actively ask questions and engage in mathematical dialogue in the G.R.I.N session. Such opportunities were attributed to the small group setting afforded by G.R.I.N.

> The kids have loved the G.R.I.N program saying "It's so easy to understand". Because there are only 3-4 students, the kids get a chance to ask their questions. G.R.I.N tutor and Literacy and Numeracy Intervention Teacher.

To summarise, it may be speculated that the G.R.I.N program enhanced student engagement in their mathematics learning through two mechanisms. First, it decreased the cognitive load for students by familiarising students with the mathematical material and relevant language to be learnt, allowing students to make better sense of the content being explored in whole-class discussions, and thus be more inclined to participate. Secondly, it provided opportunities for students to understand the process of being engaged in a mathematical discussion (for example, asking questions to resolve misunderstandings), an experience that may have been previously daunting to the students. Having this experience on a small scale (e.g. in the G.R.I.N group), would likely give students the confidence to engage with such a discussion on a larger scale (e.g. classroom discussion).

Discussion and Conclusion

The findings reported above provide some insights into the impact of G.R.I.N. on teachers' perceptions of students' dispositions towards learning mathematics. The interview data shows that the G.R.I.N. program was successful in re-engaging underperforming students in mathematics learning as there was evidence of the three commonly identified dimensions of engagement namely; cognitive, behavioural and affective (Fielding-Wells & Makar, 2008). It can be suggested that G.R.I.N. sessions resurrect the prior mathematical knowledge of students, thereby re-activating their cognitive engagement. G.R.I.N. students also showed greater participation in their mathematics lessons by asking questions and offering possible solutions and these were signs of more frequent behavioural engagement. Enhanced confidence was a clear indicator of increased affective engagement for the G.R.I.N. students. All interviewed teachers had noticed a change in the way the students were approaching their mathematics learning. A transformation from hesitation to excitement suggests that this program produces positive results and is worthy of further investigation, especially to identify which aspects help students to remain engaged in the long-term.

Classrooms are social and students would prefer to participate positively in this environment thereby satisfying a need for connectedness (see Hannula, 2004) rather than avoiding opportunities to participate (see Elliot, 1999). Students in G.R.I.N work closely with a G.R.I.N tutor to prepare for their subsequent mathematics lesson. Interactions between teachers and students bring to the fore what teachers and students value similarly and differently (Seah, 2018). The effectiveness of G.R.I.N is enhanced when the G.R.I.N tutor has the luxury to be able to negotiate these inevitable value differences within this small group setting (Kalogeropoulos & Bishop, 2017), so as to bring about a learning environment in which everyone's values are aligned and inter-personal relationships are in harmony (Seah, 2018). For example, G.R.I.N students who benefit from spending additional time exploring concrete representations may be provided with more opportunities and time to use manipulatives to support their mathematics learning. This is sometimes overlooked in a mathematics classroom not necessarily intentionally but because, in a larger cohort, the workload of teachers, curriculum demands and time constraints impact on the decisions made by teachers.

A caution of the G.R.I.N program is that students may revert to becoming disengaged if they are unable to 'keep up' with the class once they have exited the program. The program recommends that the G.R.I.N. students work with the G.R.I.N. tutor for at least six months before their progress is evaluated to determine whether they should be continued in the program for another semester and what additional support may be needed for those students being exited from the program. Consequently, further research into which factors support G.R.I.N students to maintain a growth mindset is suggested. The G.R.I.N program can provide the cognitive skills to cope with mathematical challenges; however, it is when we help students' value challenge that they will be willing to approach mathematics with confidence and with the attitude to succeed. Students' valuing can be shaped in the mathematics education process and the modification and (re)shaping of values may be easier during childhood and adolescence (Seah, 2018). Therefore, there is hope in teachers being the value agents in helping students internalise that mathematics is an important subject to study. The partnership between the G.R.I.N tutor and the classroom teacher may be a bridge in helping students to develop the long-term motivation, grit and perseverance when studying mathematics. We propose that future research into G.R.I.N. and similar programs should evaluate how such programs can support the purposeful shaping of students' valuing for their long-term engagement with mathematics learning.

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