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7. PERSONALISING MATHEMATICS FOR LOW SES STUDENTS IN SCHOOLS WITH OPEN-PLAN SETTINGS

REDESIGNING MATHEMATICS LEARNING IN SCHOOL

When recently surveyed about the most useful part of their current mathematics program, three Year 9 students at Ironbark College commented:

> I find the individual program great because we all get to work at our own pace and our own level.
>
> Working at the level I am at, not just working on whatever we should be at.
>
> The pre-test because I know what level I'm on and what I need to practise.

Mathematics educators now broadly agree about key dimensions of quality mathematics programs and experiences (Schoenfeld, 2014), but achieving these practices in schools with high concentrations of low SES students remains a challenge in many countries (Black, 2007; Greeno & Collins, 2008). In this chapter we first review current understandings of what enables quality learning in mathematics, as a basis for reporting on the impacts of personalised learning approaches to this subject in three of the BEP colleges: Whirrakee, Ironbark and Melaleuca. We claim that the open-plan settings operated as a catalyst for curricular reform in mathematics, leading to improved student performance and enhanced student attitudes to this subject.

Quality in Mathematics Learning

There is now broad agreement about what enables quality learning in mathematics. As identified by Schoenfeld (2014), effective mathematics programs have five key dimensions around: (1) curricular coherence of the subject, (2) cognitive demand of tasks, (3), student access to mathematical content, (4) opportunities for student agency, authority and identity, and (5) effective use of assessment. Curricular coherence refers to the extent to which discussion in mathematics is focused, and connects procedures, concepts and contexts, so that students learn key mathematical content and practices, and develop mathematical habits of mind.

V. Prain et al. (Eds.), Personalising Learning in Open-Plan Schools, 121–141.

Cognitive demand is about balancing challenge and consolidation of learning (Stein, Engle, Smith, & Hughes, 2008). Access to content is about ensuring all students are engaged in mathematical core concepts and processes (Oakes, Joseph, & Muir, 2003). Opportunities for student agency, authority and identity occur when students conjecture, pose arguments, build on one another's suggestions, and see themselves as able in mathematics (Engle, Langer-Osuna, & McKinney de Royston, 2014). Effective assessment provides the opportunity to monitor student understanding and to provide timely planning that addresses immediate student needs and offers ways to progress in performance (Black & Wiliam, 2009). We claim that these conditions are met in the three programs outlined in this chapter, and address widely acknowledged problems in schools with high concentrations of low SES students.

Overcoming Well-Recognised Barriers

Extensive research has identified persistent challenges in engaging low SES middle years students (Years 5–9) in the school curriculum generally, and in mathematics in particular (Black, 2007; Greeno & Collins, 2008; Lokan, Greenwood, & Cresswell, 2001; Luke et al., 2003; Sirin, 2005; Vale et al., 2010). Claimed causes for poor performance include: (a) negative contextual influences of low family SES on student aspirations (Sirin, 2005); (b) negative contextual influences of schools with large concentrations of low SES students (Auwarter & Aruguete, 2008; Perry & McConney, 2011); (c) inflexible curricula, lack of links to the community, and lack of variety and responsiveness in teaching strategies (Alfassi, 2004; Black, 2007; Luke et al., 2003), and (d) lack of quality resources and qualified mathematics teachers in low SES schools (Greenberg et al., 2004; Hill, Rowan, & Ball, 2005; Mogari et al., 2009; Wenglinsky, 1998). Numerous research studies link teachers' domain specific academic qualifications to student achievement. Teachers need rich mathematical content knowledge and deep understanding of mathematical concepts to teach mathematics effectively (Brown & Borko, 1992; Collias, Pajak, & Rigden, 2000; Darling-Hammond, 2000; Greenberg et al., 2004; Mewborn, 2001; Mogari et al., 2009; Wenglinsky, 2002). Mewborn (2001) confirmed that although conceptual knowledge is vital for mathematics teachers, it "doesn't ensure that teachers are able to teach it in ways that enable students to develop…deep conceptual understanding". Teachers also need pedagogical content knowledge (PCK) for effective mathematics teaching. That is, the ability to translate content understanding into teaching and learning experiences. Baumert and colleagues (2010) argued that PCK contributes more to student gains than does content knowledge. Hill, Rowan, and Ball (2005) also called for more research into the teaching practice of knowledgeable teachers to understand those aspects of mathematical knowledge that matter for teaching. Targeted professional development has also been found to impact positively on students' achievement (Kennedy, 1998). Ideally, an expert figure provides corrective feedback and suggestions to teachers (Onwu & Mogari, 2004; Mogari et al., 2009; DEECD, 2010).

These challenges were met in the three BEP schools through the following extended strategies: (1) professional learning support for mathematics teachers through external coaches and extensive work on developing a multi-level curriculum (see Prain et al., 2014); (2) block-timetabling of teacher teams to design, enact and review this curriculum and provide timely targeted feedback to students at all levels of the program, and (3) development of high expectations of students in engaging with mathematics learning.

Our Research Aims and Methods

We aimed to identify the effects of this curricular reform on teacher perspectives and student performance and attitudes towards mathematics. We used a case study approach, incorporating quantitative and qualitative data collection and analyses (Merriam, 1998; Tashakkori & Teddlie, 2010; Yin, 2008). Quantitative data included national assessment scores in mathematics for Years 7 and 9 over five years (2008–2012), analysed against benchmarking of expected performance of Australian schools of similar SES at the relevant levels across these years (see Table 7.1). The researchers analysed these data for patterns in the results over time. In Australian secondary schools, student performance at Years 7 and 9 is measured in mathematics and literacy against all other schools in Australia by tests known as the National Assessment Program-Literacy and Numeracy (NAPLAN). NAPLAN is a simple form of data with a 'one size fits all' approach to assessing and measuring students' abilities and progress. The results place students on a scale that compares them to all other Australian students of their year level and with schools calculated to be of similar Index of Community Socio-Educational Advantage (ICSEA) values. In Australia, like the data gathered for PISA, the students' SES is based on data collected at the local level on parents' or carers' income, education and occupation. The school's ICSEA values are calculated on the basis of these student data. In addition, Australian data incorporates a school's metropolitan, regional or remote status and the proportion of indigenous student enrolments. Quantitative data also included a survey of 784 students in Years 7 and 9 on their perceptions of the usefulness of teaching and learning strategies in their mathematics program (see Table 7.2). Responses were scored on a four-point scale where a score of 4.0 represented very useful and 1.0 represented not useful. Themes in the responses from 'most useful' to 'least useful' were identified by the researchers.

A research officer collected qualitative data through one-hour interviews with the school principals, the mathematics coordinators and eight mathematics teachers. These data sources were analysed individually and collectively by the three researchers to address issues of reliability in interpretation. The methods of qualitative data analyses followed principles outlined for qualitative case study research, focusing on identification of patterns in participant responses (Denzin & Lincoln, 2008; Merriam, 1998; Yin, 2008), leading to the development of themes in the light of relevant literature. These themes were identified individually by the researchers, and subsequently refined through group discussion and consensus.

Context of the Study

The AusVELS (AusVELS.vcaa.vic.edu.au) curriculum outlines what is essential for Victorian students to learn during their time at school. This curriculum provides a set of common state-wide standards based on the Australian national curriculum which schools use to plan student learning programs, assess student progress, and report to parents. Each school developed a program where, based on a pre-test topic or task, students were placed into topic-based ability groups with individual work programs set for each student including a goal for the end of unit AusVELS level that they should reach. The visual summary of each school's mathematics program is provided in Figure 7.1. At each school the open-plan settings enabled the development of the models described. The structural changes to the school timetable were also afforded by the open-plan settings and allowed for multiple mathematics classes to be scheduled at the same time in the same space. This change allowed the mathematics teachers at each school to work as a team to aggregate their efforts and to provide a much more targeted curriculum for the students, where the teachers were able to manipulate student groupings, and to tailor a program that could effectively cater for a wide range of students.

Ironbark College

The program consists of a sequence of learning experiences for each mathematics topic, with the same program across all four sub-schools (Figure 7.1). All the mathematics teachers planned together, but taught in teams of three. Prior to a pre-test to determine each student's AusVELS level in the topic, a brief refresher "workshop" was provided to remind the students of what they had studied in their previous year.

Based on the pre-test, students were placed into three topic-based ability groups with individual work programs set for each student including a goal for the end of unit AusVELS level that they should reach. Following a differentiated sequence of work on the mathematics topic the students all sat a post-test. The corrected post-tests were used to provide feedback to individual students and the class on their progress and to recognise and celebrate individual performances. The post-test was not simply used as a summative assessment, and there was provision for students

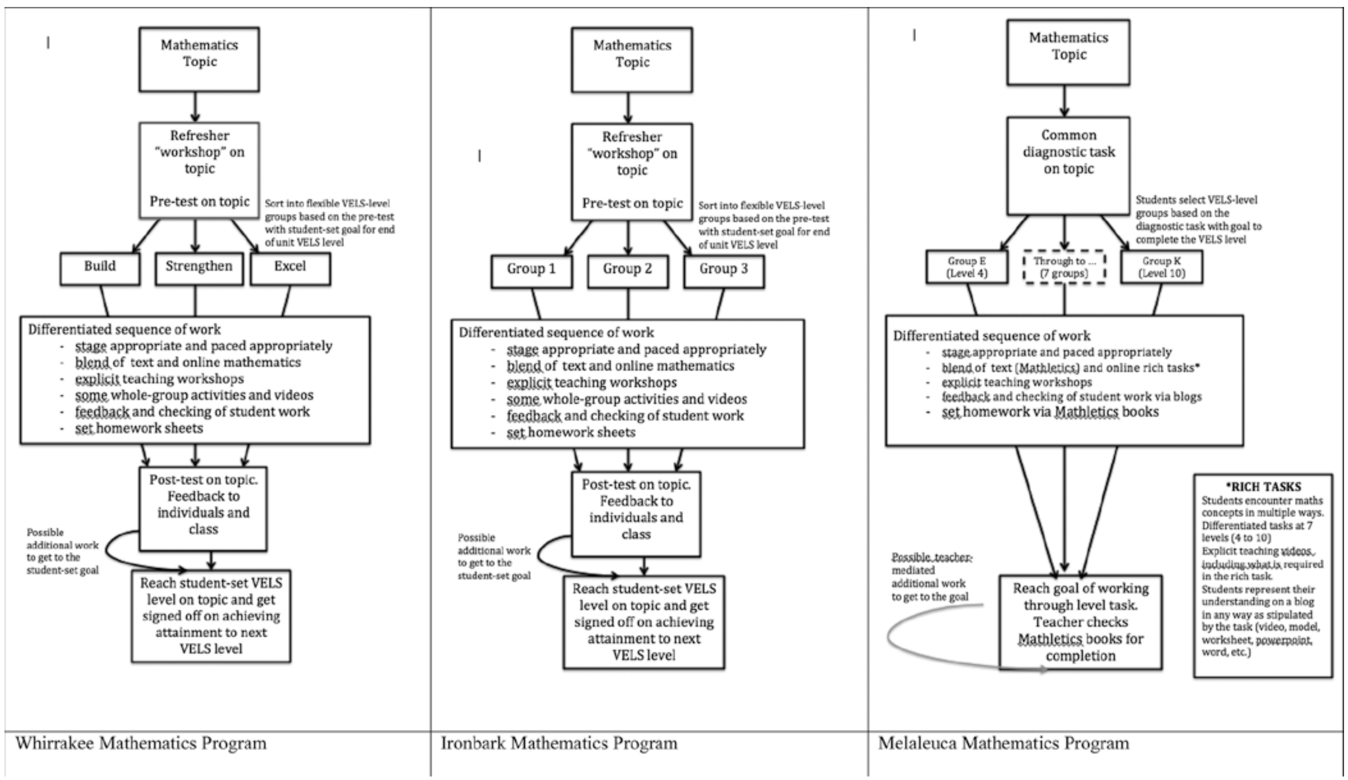

Figure 7.1. Description of mathematics program model in the three schools

to complete additional work to demonstrate that they had reached their personal AusVELS-level goal.

Whirrakee College

As shown in Figure 7.1, Whirrakee's model is very similar to Ironbark's. We focus in this school on the learning model employed within Pods (consisting of three classes of approximately 75 students and three teachers). The model has three distinct groups of students working separately within the one open-learning space, although whole Pod teaching also occurs when relevant. Based on the results from the pre-test for a mathematics topic, students are divided into three groups, the Build, Strengthen, and Excel groups. These groups vary in size due to the nature of the teacher work within each. The Build group is small, approximately 14 students, and takes the students who are below the expected level in this mathematics topic. This small group size allows the teacher to work intensively with the students at one large table to provide a differentiated program based on their skills. The teacher employs concrete examples, modelling, explicit instruction and scaffolding with continuous feedback throughout the learning task. The Excel group of most capable students is the largest with up to 35 students, where the teacher negotiates the task with individuals and allows the learners to self-monitor their learning and to work independently. Where necessary, explicit instruction or whole group discussion can be employed. The Strengthen middle group consists of 26 students and is run more like a differentiated "mainstream" class with a blend of scaffolding, explicit instruction and structure to develop independent learning routines.

Melaleuca College

This program is designed around seven themes to create enhanced mathematical learning: learners create understanding through involvement in rich tasks; learners decide how they represent their understanding; learners identify what they know and need to learn; teaching is done at 'point of need' through workshops; technology is used authentically; the new learning spaces are used flexibly; and teachers work as a team to plan and deliver the program. The program was trialled in 2013 and extended to all Years 7 to Years 9 classes in 2014. This program occupies approximately 60% of student time and provides the context and purpose through which students explore each mathematics topic. Running parallel to the rich tasks is the more traditional program that provides students with the mathematical concepts and practice that needs to be applied to complete the rich task. Each rich task is designed to be open, and have no "right answer". Students need to be creative and make choices in how they provide evidence of completion of the task. This encourages students to "engage in multiple representations of the concept and show how they link together.

As shown in Figure 7.1 the tasks are differentiated on a continuum from Level 4 (Grade 4) through to Level 10 (Year 10). These are represented to the students not as year levels but as letters from E through to K. Students choose their appropriate level by completing a common introductory diagnostic task that is completed by between two and four classes at a time in the flexible learning spaces. The task is pitched "at level" so, for example, Year 8 students complete this diagnostic task set at Level 8. Based on their ability to complete this diagnostic task, students then choose the level of rich task based on what feels right for them. This is a process that is very consistently managed:

> The language used with the students is consistent – students understand that if a task is too easy, that is, if it can be done without any assistance, it is the "wrong task". Similarly, if the task requires students to obtain assistance every few minutes, it is also the "wrong task". Students are encouraged to identify the "right task" based on the need to "stretch" their thinking and require occasional assistance. The vast majority of students choose the right task – those that don't can still be directed by the teacher to the right task. (Mathematics Co-ordinator, 2013)

As teachers are working as a team, each teacher then takes responsibility for a range of tasks (and students) from Group E through to Group K. The teachers support the students working on their tasks and may "roam the open space, identifying students working on the task for which they are responsible and supporting their learning". At times they will "call their students together to give instruction or address a misconception, or clarify what evidence is needed to complete the task". This flexible use of teachers and space means that at times students are free to work anywhere in the open-plan learning spaces.

At Melaleuca College the greatest innovation is the use of technology to augment teacher instruction through videos and for students to upload their representations of evidence of completion of the rich task on their own blog. The website provides the site to house the course that can be accessed directly or by scanning QR codes that are located on large cards pinned up around the open-learning space. This site includes all the rich task material and has instructional videos for each task including explicit teaching of the mathematics concepts. This enables students to "access the videos if they wish to skip ahead; need assistance at home; need to catch up after absence; or need to revisit the material in class". The blogs allow teachers to monitor student progress, and allow students to store their representations in a place that can be accessed from school, or home and via any mobile technology. This enables much greater sharing of student work then the traditional exercise book or folder. Student work placed on the blog can be shared with teachers, peers and parents using any mobile device and is securely filed for later reference. We consider that that this storage and retrieval function is an important feature for low SES students.

STUDY FINDINGS

We report our findings in two sections: (1) analysis of quantitative data on the performances of the colleges in numeracy over the life of the research project, and student survey results, and (2) analysis of teacher and student perceptions of the effects of the differentiated mathematics curriculum.

QUANTITATIVE FINDINGS

One of the graphs presented in Chapter 1 in relation to numeracy, is reproduced below in Figure 7.2. This graph plots each school's ranking among "similar schools", where a ranking of 1 indicates that the school is the top performing school among "similar schools" and a ranking of 0 indicates the school is the lowest performing school among "similar schools". This ranking has been calculated in the following way: for a school ranked R out of N "similar schools" the ranking, r, is calculated by r = (N-R)/(N-1). For example, in 2012, Ironbark's Year 9 NAPLAN (Numeracy) average score was ranked 3/21 "similar schools" and so its ranking, r = (21–3)/(21–1).

This graph and its underlying statistics were the catalyst for this chapter's investigation into student perceptions of the effectiveness of the components of the mathematics programs that had been introduced in three of the four schools.

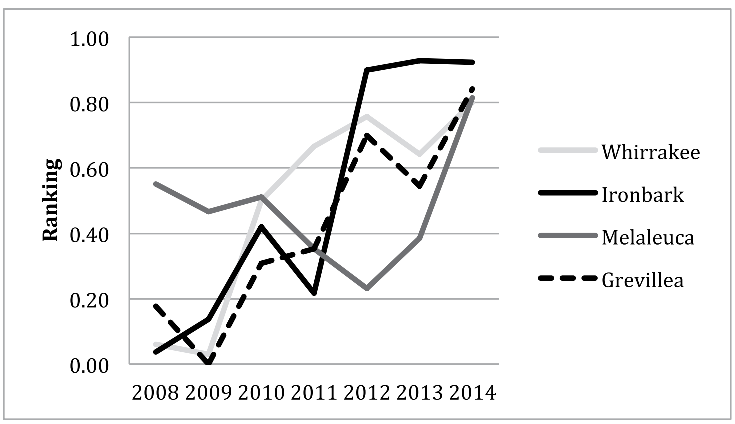

Figure 7.2. School ranking among "similar schools" for year 9 numeracy, 2008–2014

This study investigated student's perceptions in three BEP colleges. They were selected because of their 2013 NAPLAN rankings as shown in Figure 7.2. The two highest-ranking colleges (Whirrakee and Ironbark) were selected as they had increased their rankings earlier and more substantially than the other BEP schools. The third college selected was Melaleuca because it had the lowest ranking among like schools and had introduced a program to address this deficit in NAPLAN results. Melaleuca has dramatically increased its ranking relative to like schools in the 2014 NAPLAN data which indicates that its mathematics program is worthy of documentation. This study had to be limited to three school mathematics programs because of time and resources constraints, and the authors acknowledge that based on the 2014 data now available Grevillea would also have been worthy to be documented. However, the decisions on documenting three different school mathematics programs in this chapter was made in 2013 using the available 2013 NAPLAN data, and so Grevillea was not studied.

This documentation and comparison of the three mathematics programs was based on their program models. The researchers sought to obtain student perceptions of the relative benefits of each element of these programs to their mathematics learning. Students were surveyed using an online Survey Monkey survey. The breakdown of the numbers of students surveyed is provided in Table 7.1.

Table 7.1. Number of students surveyed at each of the three schools in this study

School	*Year Level*	*Female*	*Male*	*Total*
Whirrakee	Year 7	89	79	168
	Year 9	101	97	198
	Total	190	176	366
Ironbark	Year 7	64	61	125
	Year 9	37	53	90
	Total	101	114	215
Melaleuca	Year 7	60	47	107
	Year 9	54	42	96
	Total	114	89	203

The students were asked to rate the components of their mathematics programs in the following way. On a four-point scale (Not useful (1), Sometimes useful (2), Useful (3), Very useful (4)), students indicated how useful they had found the different components. Each school had different models, but each element of their programs was matched against equivalent elements in the other schools. The list of components matched across the three schools with one school having an additional component. These components and the minor variations at each school are presented in Table 7.2.

Table 7.2. Components of each schools' mathematics program

Component number	*Statement for each component (W=Whirrakee, I=Ironbark, M=Melaleuca)*
1	Learning intentions and success criteria showing me the what, why and how of each lesson (W, M) Learning intentions showing me the what, why and how of each lesson (I)
2	Pre test to find out my AusVELS level (W) Pre test to find out my AusVELS level (for Year 7) OR Starting topics from where I got up to in Year 8 (for Year 9) (I) Diagnostic task to find the level I need to work at (M)
3	Individual maths program based on my AusVELS level (W, I) Individual Mathletics program based on my AusVELS level (M)
4	Working in a group of students at the same AusVELS level (W, I, M)
5	Teacher workshops on different skills in B, S, E groups (W) Teacher workshops on different skills (I, M)
6	The teacher teaching me when I need it, individually or in my group (W, I, M)
7	Other students helping me (W, I, M)
8	Helping other students (W, I, M)
9	Using my netbook computer (W, I) Using my device to review videos and post Blogs (M)
10	Using other technologies (iPad, iPod, mobile device, etc.) (W, I, M)
11	Completing tasks to demonstrate my understanding (W) Completing hurdles to demonstrate my understanding (I) Completing task descriptions to demonstrate my understanding (M)
12	Completing checkpoints (assessment sheet) and getting the teacher's feedback (W) Completing assessment sheets and getting the teacher's feedback (I) Completing Mathletics booklets and getting the teacher's feedback (M)
13	Post test (test at the end of the topic) (W, I, M)
14	Opportunities to resubmit those parts of my work I have not understood (W, M) Opportunities to redo those parts of my work I have not understood (I)
15	Use of Mathsmate book/Mathletics (W)

Results from each of the three school surveys are presented in Table 7.3.

Table 7.3. Overall average Likert score for each component and the overall percentage of useful and very useful for each of the three schools

Component Number	*School*					
	Whirrakee (n=366)		*Ironbark (n=215)*		*Melaleuca (n=203)*	
	Av. Rating	*%U&VU*	*Av. Rating*	*%U&VU*	*Av. Rating*	*%U&VU*
1	2.36	41.5	2.31	37.2	2.42	44.3
2	2.72	58.5	2.76	60.9	2.64	58.1
3	2.79	60.7	2.85	65.6	2.61	55.2
4	2.99	66.7	2.87	66.5	2.73	61.6
5	2.88	65.3	2.73	59.1	2.50	48.8
6	3.25	81.1	2.97	67.9	2.87	64.5
7	2.91	66.9	2.57	48.8	2.78	63.5
8	2.79	62.8	2.58	49.3	2.62	58.1
9	3.15	74.6	2.83	59.5	2.56	54.2
10	2.71	51.9	2.78	55.3	2.89	66.5
11	2.94	74.6	2.53	47.4	2.47	50.7
12	2.92	67.8	2.67	58.1	2.60	53.7
13	2.82	62.0	2.79	60.0	2.41	39.9
14	2.92	64.2	2.73	51.2	2.54	49.8
15	2.34	41.0	–	–	–	–

Through a disaggregation of these data it has been found that these themes are consistent for Year 7 and Year 9 students, male and female students, and for low- and high-achieving students at each school.

To highlight the most and least preferred components of the mathematics programs at each school in Table 7.4 (and to be consistent with Table 7.3), the three highest ranked components, and lowest two ranked components, have been shaded. The darker shading indicates the top three ranked components and the lighter shading indicates the lowest two ranked components for each school. For all three schools component 6 (The teacher teaching me when I need it, individually or in my group) is one of the top three preferred components when disaggregated and ranked by year level, gender and ability group.

This shading makes clear the major student preferred components, where component 4 (*Working in a group of students at the same AusVELS level*) and component 6 (*The teacher teaching me when I need it, individually or in my group*) are two of the top three preferred components across the three schools. These results from the student surveys at each school is evidence that differentiation has been successfully achieved, and combined with the evidence from the NAPLAN

Table 7.4. Overall rank (by average Likert scores) for each component, disaggregated by year level (7 or 9), gender, and ability, for each of the three schools

Component No.	School																	
	Whirrakee (n=366) Rank by						Ironbark (n=215) Rank by						Melaleuca (n=203) Rank by					
	Year Level		Gender		Ability		Year Level		Gender		Ability		Year Level		Gender		Ability	
	7	9	f	m	l	h	7	9	f	m	l	h	7	9	f	m	l	h
1	15	14	14	15	15	14	14	14	14	14	14	14	13	12	14	11	12	14
2	6	13	13	10	11	12	2	12	4	9	11	2	6	7	5	6	6	5
3	9	12	10	12	12	10	5	3	2	5	5	3	10	5	8	7	7	8
4	3	7	3	3	3	3	8	1	7	2	3	5	5	3	4	4	2	4
5	5	9	9	6	6	6	10	7	8	6	6	7	12	9	10	13	13	9
6	1	1	1	1	1	1	1	2	1	1	1	4	2	1	1	2	3	1
7	11	3	7	5	5	9	12	9	11	12	7	13	3	4	2	5	4	3
8	12	8	11	7	9	11	11	13	12	11	12	10	9	6	6	8	8	7
9	2	2	2	2	2	2	3	5	5	4	2	9	4	14	12	3	5	11
10	13	10	12	13	4	13	9	4	3	7	4	11	1	2	3	1	1	2
11	8	4	6	4	8	4	13	11	13	13	13	12	11	13	11	12	11	12
12	7	6	5	8	10	8	7	10	10	8	10	8	7	8	7	10	10	6
13	4	11	8	11	13	7	6	6	9	3	8	1	14	11	13	14	14	13
14	10	5	4	9	7	5	4	8	6	10	9	6	8	10	9	9	9	10
15	14	15	15	14	14	15												

graph suggests that the models of mathematics teaching has been very successful in differentiating the mathematics curriculum and for lifting the performance of low socioeconomic students relative to their like schools.

The lighter shading in Table 7.4 indicates the lowest two ranked components for each school. In all three schools component 1 (Learning intentions and success criteria showing me the what, why and how of each lesson) was one of the lowest two preferred components. This result may reflect teacher uncertainty about how to characterise this aspect of mathematics classes, and the relative novelty of this approach, leading to student failure to perceive these aspects as deeply meaningful.

QUALITATIVE FINDINGS

Principal and Teacher Perspectives

Interview comments of teachers and principals support positive learning outcomes from the implementation of new mathematics curricula in the open-plan settings. According to Teacher A, one of the main enablers of the open-plan spaces is being "able to break the students into small groups and have them working in like ability areas". The open-plan learning spaces allowed students to function as a whole group with three teachers for preparation for the units or whole-group appropriate stimulus videos. The open-plan learning spaces also encouraged teachers to work together for planning and team-teaching. As noted by Teacher A, "Each teacher is given an AusVELS level to concentrate on to make sure the curriculum is relevant and accurate…Teachers also have a homework sheet to develop and they share that". Both Teacher A and Teacher B enjoyed collaborating with colleagues:

> It just gives you the opportunity to share. There's greater flexibility in what you can do and deliver, bouncing ideas, sharing curriculum, sharing ideas, helping one another out, collegiality, building a rapport with other staff members. I've only been here two years and I feel that my transition to this school has been a lot easier because I have been working closely with other teachers than I was at my previous school where I was working in isolation. (Teacher B)

Teacher B also "loves… having the choice and the flexibility of being able to move things around. Teacher X and I can change our students over [from one class to another] and I can still see my students if I need to. Teacher X and I communicate during the class." The visibility of open-pan spaces encourages a sense of community among teachers and students. Students have the advantage of variety in the flexible groupings of teachers and students they work with. "Because of our grouping, students work with people they wouldn't normally mix with or even their friends from another group that they don't work with normally" (Teacher B). The low density of open-plan learning spaces allows unused space to be used for spontaneous restructure of groupings. The mathematics coordinator has been "honestly quite surprised at the positive effect" the open-plan learning spaces have had on teaching and learning. "Students are being exposed to a wider range of teaching styles, teaching abilities, as well as other students and the way they learn. As peers they are learning a lot more from each other as well."

The principals, mathematics coordinators, and teachers reported positive changes in student and teacher practices and attitudes as a result of the innovation. Student motivation and desire to learn improved, evident in increased homework, more self-directed learning, students working above the expected AusVELS levels, and more positive attitude-to-school survey results. There was also increased cooperation amongst teachers who were operating at higher conceptual levels and planning together. One principal believed that the students were "trying harder while the mathematics coordinator claimed that the school had "a more supportive environment for the student". In commenting on teacher change, she said "a lot of people felt quite uncomfortable at the beginning. But seeing the students and their behaviour and their engagement helped the staff to see that it was working really well". The mathematics co-ordinator at Melaleuca believed that the program has "increased engagement in mathematics across all learning styles and abilities, and increased the capacity of students to work independently, take responsibility for their learning, use technology appropriately, and think creatively".

Student Perspectives

Students were also invited to comment, in open-ended questions, on which parts they found the most and least useful (Tables 7.5, 7.6 and 7.7). Their positive comments on the most useful program features align with the teachers' perspectives. Themes and schools where there were ten or fewer comments were excluded from the table. Comments on the most useful parts of the program (Whirrakee, 327 comments; Ironbark, 148 comments; Melaleuca, 151 comments) again confirm that the students understood and appreciated differentiation of their program to meet their individual needs.

The student responses from all three schools indicate that the design of each school's mathematics program had its own differing strengths. However, at this point it is worth noting that these qualitative open-ended student responses have provided a triangulation of the quantitative data presented in Tables 7.3 and 7.4. The ranking of each component differs in the analysis of the qualitative and qualitative data sets, but the two common components present in the top three ranked components for all three schools from Table 7.3 (components 4 and 6) are present in each school's table based on the students' open-ended responses. This strengthens the argument that these two components are major design features that students perceive to be the most useful and are the ones that indicate that differentiation of student mathematics programs has been a result of implementing these programs.

Table 7.5. Summary of comments on the most useful program strategies (Whirrakee)

Most useful parts of program	*Example of individual comments*
3. Individual maths program based on my AusVELS level [42% of comments: (W#1)]	I think doing the pre test is one of the most useful things. This is because we then get to fill out a planner, which tells us which we need to work on. This also means that we are doing work that is at our own level. (W#37) I really enjoyed having my own personal learning program. It has allowed me to focus my learning on the areas that I struggle with, or need to improve within that given topic. As a result, I find that I can strive for higher results and organise / study more effectively come post-topic tests. (W#217)
4. Working in a group of students at the same AusVELS level [33% of comments: (W#2)]	the most useful parts of the program to help me learn maths is working in bse groups because I am doing work that is my own work level. (W#39) The most useful parts of the program to help you learn maths is when we are put into excel, strengthen and build, because they are at the same level as you. (W#56)
6. The teacher teaching me when I need it, individually or in my group [28% of comments: (W#3)]	Having one on one time with the teacher to talk about what I need to learn and not everyone else. (W#12) The most useful parts of the program is when I am working with my teacher when I am confused about a certain part of the task, and having him fully help me get a better understanding of it. (W#294)
15. Use of Mathsmate book/ Mathletics [14% of comments: (W#4)]	The most useful program is using the mathsworld 7 pdf program to complete the planner sheets. (W#78) Math mate because its a good start to every lesson to refresh your brain. (W#351)
11. Completing tasks to demonstrate my understanding [8% of comments: (W#5)]	… Also the planner that we do is also helpful because it helps us to know what we have to do to understand what we are doing. (W#32) Probably using the planner to demonstrate what I've learnt through out the unit. (W#229)

Table 7.6. Summary of comments on the most useful program strategies (Ironbark)

Most useful parts of program	*Example of individual comments*
3. Individual maths program based on my AusVELS level [36% of comments: (I#1)]	were [sic] all at our own individual levels and can work at our own pace and we don't repeat what we already know (I#137) Having a sheet so you know what your working on individually and keeps your work organised. It is a goal to complete. (I#184)
6. The teacher teaching me when I need it, individually or in my group [22% of comments: (I#2)]	Having the teacher explain the topic the way you understand and helping out when I don't understand. (I#211) One on one with the teachers, Working on the board (working out questions with the teacher on the whiteboard) (I#180)
4. Working in a group of students at the same AusVELS level [19% of comments: (I#3)]	That we are in the same group and being at the same AusVELS groups as other people, not mixed up groups. (I#68) I like how we are in our own Vels groups, it works better (I#127)
5. Teacher workshops on different skills [16% of comments: (I#4)]	Workshops by teachers that explain how to do things. (I#177) Teacher doing the workshops at the start of the class. (I#191)
12. Completing assessment sheets and getting the teacher's feedback [11% of comments: (I#5)]	Having a sheet so you know what your working on individually and keeps your work organised. It is a goal to complete. (I#184) The most useful parts include the sheets with all the things you need to do in the level, and using netbooks. (I#98)

Table 7.7. Summary of comments on the most useful program strategies (Melaleuca)

Most useful parts of program	*Examples of individual comments*
6. The teacher teaching me when I need it, individually or in my group [36% of comments: (M#1)]	The teachers teaching us when we need it. (M#65) When the teachers come over individually to help me learn. (M#250)
12. Completing assessment sheets and getting the teacher's feedback [26% of comments: (M#2)]	The mathletics booklets, feedback is useful because it shows what level I can work with in math. (M#7) Mathletics booklets help to back up and cement what you have been learning. (M#256)
11. Completing task descriptions to demonstrate my understanding [23% of comments: (M#3)]	I think that the Rich Task was quite useful because you can choose the level that you want to learn at. (M#48) The general maths teaching and tasks set up by our teachers seem to work well, they are easy to engage in and the teachers do a good job in keeping us occupied. (M#293)
3. Individual maths program based on my AusVELS level [17%of comments: (M#4)]	It is at my own level. I can understand the work I am given in the mathletics booklet. I can also work at my own pace without getting rushed to complete tasks. (M#217) I like that everyone gets to work at their level not the level they are expected to be at because everyone's different. (M#265)
9. Using my device to review videos and post Blogs [11% of comments: (M#5)]	Being able to go onto the site and re watch the video so you can understand it in a better way. (M#219) [with the device] you can watch the video as many times as you want if you don't understand. (M#229)
4. Working in a group of students at the same AusVELS level [9% of comments: (M#6)]	The groups with other people at your level. (M#8) Being put into groups with people who understand at the same level as me. (M#27)

DISCUSSION AND CONCLUDING REMARKS

Improving low SES students' performance in mathematics has been conceptualised in the literature as a predominantly curricular and teacher expertise challenge (Black, 2007; Greenberg et al., 2004; Luke et al., 2003) with strong socio-psychological dimensions around the need for students to connect with school and post-school aspirations (Yeager & Walton, 2011). Our findings confirm the need for high expectations of learners, and extended teacher contact with students to improve mathematics performance (Lewis, 2000; Mogari et al., 2009; Tomlinson, 2005). There is also the need to establish supportive structures to underpin student learning and thus improve student self-efficacy and aspiration (Bandura, 1986, 1994, 1997; Blackwell, Trzsniewski, & Dweck, 2007; Cohen et al., 2006; Walton & Cohen, 2007, 2011; Yeager & Walton, 2011). Students in this study were encouraged to set goals and recognise their progress and achievement in this subject to overcome the challenge of negative contextual factors (Sirin, 2005), with some evidence of the development of positive attitudes.

In addressing these aspects of mathematics learning, students were experiencing quality learning as claimed by Schoenfeld (2014). The quantitative and qualitative results presented in Tables 7.3 to 7.7 provide evidence of this claim from a student perspective. Curricular coherence is provided through a focus on student learning intentions, individualised mathematics programs, and teacher workshops on specific skills; cognitive demand of tasks is provided through pre-testing, individualised programs, students working in groups at the same level, and teacher workshops; student access to mathematical content is provided through pre-testing, targeted timely teacher coaching, completion of tasks that demonstrate understanding, completion checkpoints, and successful use of resources such as textbooks; opportunities for student agency, authority, and identity are provided though the components already mentioned, but also through peer assistance as both adviser and recipient, and opportunities to resubmit work; and effective use of assessment is provided through a combination of many of these components.

Our case study also draws attention to the potential for broader structural changes to the physical context of mathematics learning to support these curricular goals. The opportunities for teachers to team, to conceptualise, enact and evaluate processes to support student learning in mathematics are not currently systemic, as noted by Horn (2010), Domina and Soldana (2011) and others. While the heightened visibility of teachers to one another and the potential for flexible space use in this setting were not the dominant factors in student learning gains, these conditions complemented other key elements, including strong school leadership to address student academic attainment, expert curricular support, and effective use of mandated testing programs as a resource for focusing student motivation and achievement, and sustained teacher commitment to student success. These conditions are clearly not easily up-scaled to address the needs of larger low SES mathematics student cohorts in many countries, but they point to the need for significant investment to address this persistent significant challenge in changing learning outcomes in this subject.

This study also points to the potential value of using standardised testing regimes, common to many countries, as one practical diagnostic resource, among many, for analysing and improving low SES student performance in high stakes subjects. As in many countries, standardised testing regimes are trenchantly criticised for their reductive effects on curricular content and methods, and their putative self-fulfilling outcomes in relation to student SES (for critique and analyses of NAPLAN outcomes, see Leder, 2012). However, in this case study, these results enabled both teachers and students to pinpoint levels of student achievement as a basis for tailoring curricular experiences and progressions to meet the developmental needs of individuals in mathematics.

Despite these positive aspects, the students' mathematics performance gains were relatively modest against standardised progression expectations. This points to the significant long-term challenge of improving low SES student engagement and sustainable success in this subject. There were attitudinal gains for both students and teachers, but there is clearly scope, and need, for more academic gains. On the basis of the students' NAPLAN performance in 2014, the principal and teachers had further aims for the mathematics program, including: (1) increased specific and clear feedback about progress to students and parents; (2) the use of common assessment sheets and moderation to ensure consistency across the faculty; (3) a focus on key concepts linking students' mathematical understandings in different units, increasing conceptual understandings; (4) further improvement in attainment across the whole school in mathematics; and (5) more students enrolling in higher level mathematics beyond Year 10.

In the gains made so far, and in the projected refinements, a common feature has been the focus on setting up and adhering to enabling structures and protocols that create a shared positive culture for staff and students. This is evident in expectations around teacher and student roles and behaviour in living the mathematics curriculum as a set of flexible routines that serve individual student learning. The new open-plan settings have supported teacher teamwork and provided a potential impetus for re-imagining how students' learning experiences in mathematics and other subjects could be achieved. The collaborative design and enactment of the program in each school supported gains in teacher pedagogical and content knowledge in this field. However, such student and teacher learning also depends to a large extent on establishing and sustaining the quality and timeliness of the enacted curriculum.

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