

It's great to be doing maths!

Engaging primary students in a lunchtime club



Anne Prescott

University of Technology, Sydney
<Anne.Prescott@uts.edu.au>

Kimberley Pressick-Kilborn

University of Technology, Sydney
<Kimberley.Pressick-Kilborn@uts.edu.au>

In this article it can be seen how primary school students, pre-service and in-service teachers can all benefit from the experience of participating in a lunchtime maths club. A range of activities suitable for an extracurricular club is included.

Background to the project

Maths clubs have been successfully implemented in upper primary and early secondary school contexts with the purpose of engaging students in mathematics learning outside of regular school lessons (Karp & Niemi, 2000; Papanastasiou & Bottiger, 2004). The activities in extracurricular maths clubs can include individual or collaborative problem-solving (Papanastasiou & Bottiger, 2004), or authentic activities that situate mathematics in real-life contexts (Karp & Niemi, 2000). Maths clubs may sometimes target high performing mathematics students and focus on providing extension and enrichment tasks. In such clubs, the focus is on creating an opportunity to engage in learning mathematics content beyond the regular curriculum with other mathematically capable students (Papanastasiou & Bottiger, 2004). Other maths clubs have included students who range in ability, but share an interest in participating in mathematics-related activities outside of class time (Karp & Niemi, 2000).

All pre-service primary teachers engage in professional experience placements in schools in the course of their undergraduate degrees. However it is problematic that the opportunity to plan and implement engaging and hands-on mathematics lessons does not always arise. In response to anecdotal feedback from pre-service teachers that suggested a need for more targeted learning about how to teach mathematics in school-based contexts, we initiated a project

in partnership with a Sydney primary school. In consultation with teachers at the school, we decided that the project could best take the form of a lunchtime maths club for interested students in grades 4, 5 and 6, which would be led and facilitated by pre-service teachers.

From the University's perspective, the key purpose of the project was to promote a discipline-specific form of professional experience for primary pre-service teachers, embedded in a campus-based final year mathematics education subject. This was a new professional experience context for these pre-service teachers enrolled in a Bachelor of Education degree, and one which other Universities also have embedded in their programs (for example, the *Learning for Life Mathematics* project, Australian Catholic University Ballarat). While they had at least some experience teaching mathematics to students in primary schools, the support that they received in preparing and evaluating their lessons was mixed and sometimes limited to textbook-based lessons (Reys, Reys, & Chaves-Lopez, 2004). The pre-service teachers who volunteered to be a part of the maths club project were not necessarily the most confident or capable students in their cohort, but were those who saw an opportunity to practise mathematics teaching in a different context. Running the maths club became an alternative assessment task and involvement therefore was optional for the pre-service teachers. In total, eight pre-service teachers volunteered in 2013 and a further eight in 2014. They formed

collaborative teaching groups of four, with each person taking responsibility for leading one club meeting with the assistance of the other three group members in planning, implementing and evaluating the focal activity. This meant that in total, each teaching group took responsibility for four maths club sessions. Each session ran for 40 minutes allowing for students to arrive and for packing up. The pre-service teachers were given some support from campus-based mathematics education lecturers, through suggested activities, which included explanations of the mathematics concepts. Team teaching while facilitating the maths club provided another layer of support for the pre-service teachers. None of them felt they had to run the whole activity on their own. Their related assessment task also required them to collaboratively engage in and document professional reflection, which is drawn on in this article along with written reflections from teachers and student surveys at the partner school.

Upper primary students at our Sydney partner school were invited to participate in the maths club. At first the students who were a part of the Australasian Problem Solving Mathematical Olympiad team joined. However, once the maths club was under way, other students expressed a desire to join in the activities and this resulted in a wider ability range of students participating each week. Fifteen to twenty students regularly attended the club, with girls and boys equally represented.

The maths club activities

The pre-service teachers decided on their own activities for the maths club (Table 1) and only once did they double up (egg experiments). While not all of the activities were linked specifically to mathematics, emphasis was placed on giving pre-service teachers choice so that they themselves were comfortable and confident in implementing the tasks selected for students. All of the activities appeared to be engaging for both the students (Figure 1) and the pre-service teachers because each was characterised by opportunities for hands-on, active collaboration to develop solutions. While it is difficult to link the activities to specific content descriptors, each task linked to one or more of the *Australian Curriculum Proficiency*

Strands — Understanding, Fluency, Problem Solving and Reasoning (ACARA, 2014). The emphasis on proficiency was particularly important for the students' ability to participate; if the activities had relied on content, many of the activities would have been too difficult for them. The focus was thus on the thinking that the activity promoted rather than the content of the activity itself.



Figure 1. Students at the maths club.

The following activities are indicative of the types of activities in the maths club in that they cross strands in mathematics as well as linking subjects across the curriculum.

Fractals

The pre-service teachers chose this topic for the first week because it was content free and they were unsure about the level of mathematics of the students. Both pre-service teachers and students were excited by the fact that fractals are a relatively new area of mathematics. The pre-service teachers also believed that it would stimulate the children's interest in the maths club. The children individually created their own Sierpinski Triangle (Figure 2) then joined them to make a very large Sierpinski triangle.

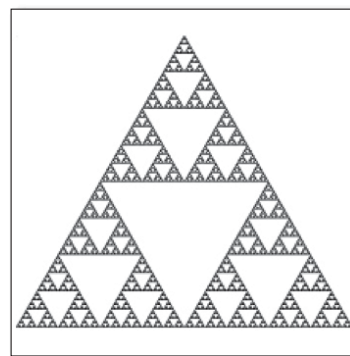


Figure 2. Sierpinski Triangle (http://en.wikipedia.org/wiki/Sierpinski_triangle).

Table 1. The activities implemented at the maths club.

Activity	Detail
Fractals	Looking at the patterns in nature and creating a fractal. (See below for more detail)
Bee-Bots	Exploring concepts of direction, coding and angles. Students programmed Bee-Bots to navigate around a course, then drew their own course and programmed the Bee-Bot to move around it. An app on the iPad, allowed students to progress through various levels of expertise in programming. http://www.bee-bot.us https://itunes.apple.com/au/app/bee-botid500131639?mt=8
Egg experiment	Creating a device to safely sail an egg to the ground from the first floor. Students created a cradle from paper and sticky tape to protect an egg as it dropped from a first floor balcony. http://www.sciencekids.co.nz/projects/eggdrops.html
Creating a cube with different colours	Students were given 27 blocks of 9 different colours and built a 3×3 cube so that each colour appeared on all 6 faces.
Tessellations	Creating an Escher-like tessellation http://www.youtube.com/watch?v=NYGIhZ_HWfg (See below for more detail.)
Capacity activities	Exploring lung capacity; the number of marbles in a container. Students calculated their lung capacity by blowing up a balloon, collecting and measuring the overflow when the balloon was pushed into a bucket of water. http://www.youtube.com/watch?v=MCEUW8moLeI Students developed a strategy to estimate the number of marbles in a jar.
Maths club flags	Using percentages to create a Maths Club Flag Students used graph paper to colour a maths club flag, given the percentages for the colours. The design was linked to symmetry, patterns or mathematical symbols.
Tangrams	Creating the square and then other shapes. http://www.activityvillage.co.uk/tangrams .
Tall towers	Using straws and plasticine to build a tall tower. Students considered various options to produce a tall tower that could support a weight as well as its own structure.
Sudoku	Teaching the techniques of Sudoku The students were given simple sudoku puzzles and the groups worked on different techniques that could be used. Students who were confident sudoku solvers helped the other students. http://www.sudoku.com
Paper aeroplanes	The dynamics of flying paper planes Students were given an A3 sheet of paper, sticky tape, masking tape, etc to create a plane to fly across the classroom.

Tessellations

The students started by creating tessellations using single shapes (Figure 3) and then, inspired by Escher drawings and a video explaining how to create the flying horse tessellation, modified

a square into their own unique shape that tessellates. Students used their newly created shape to create a tessellation artwork. This activity provided students with the opportunity to explore and discover shapes that tessellate, integrating mathematics and visual arts.

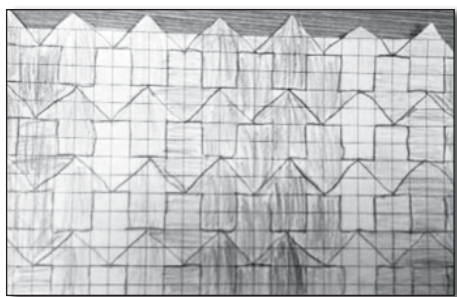


Figure 3. Using a single shape to tessellate.

What did the primary students gain from participating in the maths club?

The in-service teachers at the partner school who observed the primary students were able to see broad benefits for participants in the maths club. The teachers commented on the disappointment of maths club students when the pre-service teachers were undertaking their own professional experience and could not attend. As a result of the powerful message that maths club was fun, many other students were keen to take part. This meant that although the original group was chosen because of their mathematical ability (to take part in the Australasian Problem Solving Mathematical Olympiads), the ability of the participants changed as many students decided to join in the activities because it looked like an enjoyable way to spend their lunchtime. This change led one in-service teacher to say “even some less capable children can excel with support from adults, from the opportunity to work with a group and when being engaged by the activity”. Allied with this was her comment that “I can see how engaged students are with hands-on activities and it reminds me how important they are. This was evidenced by many ‘non-mathematicians’ volunteering to do maths at lunch time!” For many students, the problem solving element of mathematics can be quite difficult because they want to get to the right answer quickly, especially for the more capable mathematicians. “So I think one thing that maths club did was to support and engage the process of problem solving, to allow students to think and verbally justify their answers” (in-service teacher).

When the students were asked about what they liked about the maths club, many mentioned particular activities but other answers included “It was a lot of fun and challenging”, “the variety of

working with other students as well as the teachers”, “[the pre-service teachers] were more fun than teachers”, “the teachers were very enthusiastic and interested in teaching maths”, “Doing fun maths stuff!” When asked what they did not like about maths club, most of the answers were “Nothing” but a couple found it difficult to eat lunch while doing the maths club activities.

The question about what they would always remember about the maths club elicited responses about particular activities, but also responses about maths club being fun “even though it’s maths”. Several believed that the experience of the maths club was what they would always remember. The students all recommended maths club to their friends because “you learn, practice and experience maths”, “it’s good to get your mind moving”, “it was mind twisting and entertaining”, “it’s fun and you learn new things”. In summary, the students benefitted from the opportunity to see mathematics in a new light.

Practical issues to consider in establishing a maths club

As student attendance at maths club was voluntary, there was not necessarily regular attendance from all participants, but the total numbers increased over the life of the club. It appeared as though word-of-mouth amongst the students, who informally shared with their peers their enjoyment of belonging to this group, was important. The pre-service teachers learned to plan to accommodate latecomers and students eating their lunch i.e., joining existing pairs or groups. Importantly, those leading the session also learned more about building discussion time into the activity itself, as well as sharing student outcomes and achievements at the end of the session. One in-service teacher observed the usefulness in keeping a maths journal so that the students could document their maths club activities for future reference and reflection.

In their discussions about whether they would run a maths club in future in their own schools, the pre-service teachers recognised the benefit of working with other enthusiastic teachers to run the club, which acknowledges the value that they perceived in co-teaching. They also recognised

that they might be the teacher responsible for running the club. This would mean planning activities carefully so they were manageable because some very engaging, hands-on activities may require more resources, adult support and student management. They suggested that such activities should be dispersed throughout a term, perhaps recruiting another teacher to assist for one or two activities. Other suggestions they made were:

- students leading an activity themselves, developing self confidence and presentation skills;
- having different activities available, and the students choose which activity they would like to do (work stations);
- asking the students what activities they would like to do (i.e., a suggestion box);
- advertising the maths club throughout the school (i.e., detailing the activities of the maths club in assemblies, promotion through the school newsletter and website, posters around the school); and
- employing a reward system for attending maths club (e.g., certificates or stickers).

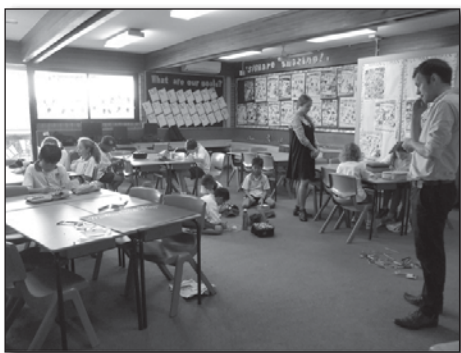


Figure 4: On-task learning in the maths club.

Conclusion

The maths club project benefited the learning of primary students, pre-service and in-service teachers, and teacher educators by providing an authentic and highly engaging context that supported all participants in developing new

insights into the nature of mathematics education. For primary students, the main purpose of the mathematics club was to provide an opportunity to enjoy and have fun with mathematics with peers who shared their interest. In this context, the importance of students ‘playing’ with maths in their lunch break was paramount. The lunchtime maths club raised the profile and visibility of maths in the school. The whole school in fact experienced the enjoyment and wonder of maths when they observed the maths club participants testing their parachutes in the egg experiment. Although this activity could be considered a science or ‘design and produce’ task rather than a mathematics one, the pre-service teachers were rewarded by the enthusiasm and excitement that the activity generated. The whole school watched the successes (and a couple of failures) with many cheers when the egg survived the fall and support when the egg did not.

Participating in the maths club supported pre-service primary teachers to develop deeper, broader content knowledge in specific topics in mathematics, which sometimes took them outside of the syllabus documents that they regularly used to plan classroom-based maths lessons. In addition, the pre-service teachers’ confidence was increased in designing, teaching and evaluating hands-on activities with children in a partner primary school, with the main aim of experimenting with mathematics. As one pre-service teacher reflected, “Gaining real life mathematical teaching to engaged students in a supportive environment, provided us with experience no written assignment could ever do.” Through their involvement in the maths club, pre-service teachers were equipped with critical skills and understandings to enable them to implement innovative programs in primary schools. They gained new insights into the possibilities of hands-on activities for mathematics learning. They were provided with an opportunity to experience membership of an authentic professional learning community, as they interacted with the teachers at the school and the mathematics teacher educators.

Both in-service teachers and teacher educators contributed positively to the professional learning of pre-service teachers through involvement in this project, however the professional learning was bi-directional. The creativity and responsiveness of the pre-service teachers in designing and

implementing the maths club activities were a source of inspiration for the teachers at the school and the teacher educators, who were, in turn, encouraged to reflect on their own practice, especially in relation to hands-on tasks. The in-service teachers appreciated the resources shared by the pre-service teachers, some of which they now incorporate into their classroom teaching, and the opportunity to observe their own students, some of whom they would not previously have considered as mathematics-oriented. For us as teacher educators, the choices of activities made by pre-service teachers possibly need greater guidance, so that the focus of the maths club is firmly in mathematics. The pre-service teachers' written evaluations of the sessions that they designed and implemented, and their feedback about the perceived benefits of participating in the maths club for their own learning about primary mathematics teaching, were of particular value. These have provided encouragement for us to continue to develop and refine our partnership with the school, but also to seek further opportunities to embed pre-service primary teachers' learning in mathematics-specific professional experiences in schools.

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Web-based resources for maths clubs

Teachers interested in starting a maths club with students at their own school or with other local schools may find it useful to draw on the resources developed by Rhodes University in South Africa, which can be accessed at <http://www.ru.ac.za/sanc/mathclubs/>.

Another useful website is the University of Cambridge's Nrich site, which can be accessed at <http://nrich.maths.org/frontpage>. Further information about the Learning for Life Mathematics project can be accessed at http://www.acu.edu.au/about_acu/faculties,_institutes_and_centres/education_and_arts/about_the_faculty/news/learning_for_life_mathematics_project

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