This paper outlines the first stage of a whole school mentoring project in a NSW primary school. The Primary Science Mentoring Program is a partnership between a university science educator and all the class teachers in the school. A series of lessons with stage 2 is reported that demonstrates teachers’ willingness to teach science and students’ engagement in working scientifically and technologically.

Introduction
A major challenge for science education is enabling primary teachers to teach science as an integral component of the school curriculum. Science in primary schools across Australia (and other countries) has long suffered for many reasons. Primary teachers’ lower confidence and self-efficacy, and beliefs about teaching science have been reported across decades in the research literature (Appleton, 2008; Skamp, 1991). Limited science in formal education and negative attitudes from their own science learning demotivate primary teachers (Kenny, 2010). Lack of resources is frequently cited by primary teachers as a reason to not teach science (Goodrum, Hackling & Rennie, 2001). A perceived priority towards other subjects remains a significant factor limiting the teaching of science in NSW primary schools (Lum, 2008). Emphasis on student-centred constructivist teaching practices and strategies promoting scientific inquiry are additional challenges for primary teachers (Skamp, 2012; Crawford, 2007). To address these issues, primary teachers require encouragement and support to teach more science.

Research with experienced teachers indicates mentoring can help teachers make lasting changes to their science teaching practice (Appleton, 2008; Peers, Diezmann & Watters, 2003). The following mentor characteristics identified from research were met by the science educator:

- be knowledgeable in at least curriculum, science content, science PCK, general pedagogy, and assessment;
- have high levels of interpersonal skills;
- be recognised by the teacher as an expert who can provide help;
- be classroom current; and
- have considerable time flexibility (Appleton, 2008: 539).

The teachers at the school were committed to the project, and could be described as a Professional Learning Community (PLC) (Jones, Gardner, Robertson & Roberts, 2013). The focus was on collective learning with the common goal of enhanced science experiences and learning outcomes for the students. The presence of the science educator in the school on a regular basis and in contact via electronic communication enabled teachers to receive continued guidance. An additional complexity was how to cater for the diverse learning needs of teachers. Teachers of classes at the same stage level were asked to choose the types of input and roles played by the science educator.

Background to the project
The Primary Science Mentoring Project grew out of an introduction of a science educator to two teachers from the school at a Professional Learning Partners meeting at the University of Sydney. A synergistic desire by the teachers to ‘do more science’ with their students and interest in working at the school level by the science educator was all it took to form the partnership. This led to a meeting with the school principal and executive staff that showed science learning was valued, and confirmed the staff’s commitment to professional development.
Encouraging Primary Teachers to do More Science (continued)

The 2013 school year commenced with a whole school Professional Development Day dedicated to science. An interactive presentation using science toys designed to inspire and enthuse all the teachers towards science conveyed the key message “It’s not rocket science, you can all do it and do it well!” Teachers then engaged in a range of hands-on investigative activities using the science toys in two workshops, one for K-2 and one for year 3-6 level. By the end of the day the teachers were excited about the prospect of learning more ways to involve their students in science learning and were thoroughly convinced they could do it.

In school mentoring

Commencing with stage 2 the science mentor was provided with a copy of the science program for term 1 to assist with planning. Teachers were asked to consider the most effective way their professional development needs could be met. This group decided on a demonstration lesson followed by team teaching. The science mentor arrived at the school with a planned sequence of 3 lessons relating to forces (and the resources to implement them with 3 classes).

Lesson 1

Lesson 1 involved students using a Matchbox car to investigate whether ramp height affects the distance the car travels. The science educator was introduced as a guest teacher to the students and the class teacher assisted in a team teacher role. After a brief introduction to the activity, students recorded their predictions and formed groups ready to commence the investigation. Each group collected a match box car, a wooden board and some blocks to make a ramp, and located rulers they could use for measuring. At this point one teacher said:

“I can bring things like this from home for my students to work with”.

While students worked in groups both teachers circulated around the room. This enabled the science educator to assess the students’ skills in working scientifically and provided an opportunity for the teachers to observe their own class in action. During this time teachers commented, for example:

“Look how engaged they are in doing the task!
They are really working well together”.

After the investigation the Science educator guided students to discuss what they found out and why they think it happened. Mathematics was integrated as students provided answers to some calculations that could quantitatively account for why the cars went further with increasing height. Directed questioning and discussion led students to understand that the force of gravity did not change, but as the height above ground increased, more energy (potential energy) was available for transfer to movement (kinetic energy). The influence of friction was also mentioned with some classes. Students then wrote their own conclusions to answer the question they had just explored.

Afterwards one teacher commented:

“The first part of the lesson I could easily do, it’s the last part that I would have more trouble with.”
Encouraging Primary Teachers to do More Science (continued)

The anecdotal comments from teachers above show a realisation about: resources – special materials are not required; their students – they get actively involved in investigative activities; and their capabilities – what they would be confident to do or not do.

Lesson 2
Lesson 2 was designed to integrate working technologically with investigating. Students were challenged to design and make a gravity-powered car. This lesson was implemented by the class teachers while the science educator was working with other classes. Students received various levels of scaffolding by their teachers. For example, Figure 2 shows some questions Priscilla asked her students to think about when making their cars. Teachers reported that students had lots of fun making their cars and were ready for the science educator to return for the testing stage. The science educator was impressed that the teachers were willing to take on this technology lesson themselves. This provided clear evidence of the interest and eagerness of the teachers to do more science.

Lesson 3
Lesson 3 involved the students testing their cars to see how well they worked. The science educator returned as guest teacher for this lesson and the students proudly displayed the cars they had made.

This lesson began with a brainstorm about what factors would show that their gravity car designs were successful. Students came up with the ideas that: the car would move, gravity would make it go, it would travel more than 25 cm, and go in a straight line. This lesson was interesting because it created a few challenges for the teachers (and students).

Firstly, some of the cars did not move, either because the wheels were above the ground or they were taped up and could not turn. These students had focussed more on making something that looked like a car (aesthetic features) rather than one with working elements (functional features). This was in part impacted on by resource provision and a lack of skills development in working technologically. Fortunately the science educator came prepared with additional materials. After a quick analysis of what was wrong, a few techniques were suggested and students quickly understood how they could modify their cars so the wheels could work (see figure 3).

Secondly, resources became an issue when the number of classes involved expanded from the original 3 classes to all 7 classes in the stage (due to requests by the other teachers). This meant the materials provided by the science educator were no longer sufficient for all students to construct their cars as the same time (which is what eventuated). Students in some classes brought in their own
Encouraging Primary Teachers to do More Science (continued)

materials, greatly expanding the design variables. The biggest shortage was that of wheels which resulted in some cars having 2 wheels rather than 4, bottle tops and other materials being used and some cars ending up with no wheels at all. Some teachers resourced other materials from within the school such as Mobilo pieces from kindergarten.

Thirdly, there was considerable diversity in students’ completion of responses to questions on the recording page. In some cases this was obviously linked to students’ low English literacy and other times indicative of lack of experience with ways of recording science investigations (scientific literacy). The scope of this range became apparent to the science educator when marking all the students’ work and providing feedback using a marking rubric and written comments. This formative assessment provided useful evidence of students’ science and technology knowledge and skills.

Fourthly, the students’ reactions to the task were extremely positive. Some students were delighted that their cars travelled way further than predicted. They said, for example:

“Our car worked really well; and there’s nothing we needed to make it better.”

Others who had modified their cars and gained some degree of success were satisfied, commenting:

“We actually got it to move a little way.”

“If we just had another wheel it could have been better.”

Even students whose cars did not move at all remained positively, saying:

“It’s O.K. that our car didn’t work; we still had fun making it.”

“I’ve learnt some things about wheels that I didn’t know before.”

Improvisation was also observed when the science educator suggested to one group ‘the car might be too light’. Figure 4 shows the addition of a pencil case solved the problem. However, three pencil cases was too heavy resulting in a flattened car (and shared laughs between teachers and students).

Clearly there were lessons to be learnt by the students, teachers and the science educator just from this sequence of three lessons. Future science lessons can be planned to target student needs in individual classes. To provide further insights into the Primary Science Mentoring Project one teacher’s perspectives are provided next.

One teacher’s experience

As a classroom teacher, I am continually looking for fresh ways to engage my students in the acquisition of science skills and knowledge. However, like many, I sometimes find teaching big ideas in science to be quite challenging. Luckily for me (and my colleagues) I was able to take part in a series of workshops designed and run by Dr Chris. The aim of the program was twofold; (1) to motivate teachers to incorporate more hands-on science which would ultimately lead to more student-centred learning opportunities and (2) to increase student engagement and interest in science. As Dr Chris delivered the initial demonstration lesson I could see the immediate benefits to my students. I found the chance to observe my class in detail was invaluable. It allowed me to focus on: how the children interacted
Encouraging Primary Teachers to do More Science (continued)

...with each other; the conversations they created; and how they responded to the activities. Straight away it had me thinking of ways to implement future science activities.

I thoroughly enjoyed how the students were given opportunities to explore and manipulate various materials before the concept (the relationship between height and distance travelled) was explained. It allowed the students to go into the activities with no pre-conceived ideas of what to expect. A pleasing result from this was that my students’ understanding of the concepts covered was firmly cemented into their long term knowledge. Even a term later, my students can still clearly recall the activities and explain in their own words, what was happening and why.

"I learnt that the higher the ramp surface, the more speed the car will pick up."

That’s the sort of education I hope for my students, being able to understand and explain observations using scientific concepts in practical situations well after the lessons have been done.

To build on this, I altered my science program to allow my students to explore their own ideas and concepts through a hands-on discovery process. I would pose a question and the students would use their own background knowledge and experience, together with selected science equipment to find evidence to support their thinking. At this stage it was mostly trial and error. Once they had explored the concepts for themselves and come to their own conclusions, I then set about expanding their understanding through a series of related science experiments. My students seemed to enjoy this new approach to science very much.

It was pleasing to see how the workshops helped to lessen the fear of my reluctant learners. Working as part of a small team meant they weren’t solely responsible for the outcomes, and this gave them the confidence to share their knowledge more freely. Furthermore, working with three or four of their peers rather than the whole class created a less intimidating environment. This prevented the quieter students from taking a back seat in the group and losing focus. As a result, they were more engaged and interested in sharing their ideas. They felt comfortable to take learning risks as they explored the science concepts of energy due to gravity, (gravitational potential energy), energy of movement (kinetic energy), resistance to movement (friction) and weight (force due to gravity).

Similarly, the small, mixed ability groupings seemed to benefit the students’ social and emotional skills. Firstly, the more capable students were able to work on their leadership skills. It created opportunities for them to put into practice the skills surrounding the positive inclusion of all. Subsequently, this helped to keep the more capable students engaged as they took ownership of the groups’ outcomes. When asked what they learnt from working in their groups they said...

"I enjoyed sharing my ideas and seeing how everybody’s ideas could turn into something big!"

Secondly the higher needs students were able to learn from their peers through the modelling of good group-work skills such as turn-taking, compromising, active listening, and building on other’s opinions and thoughts. It was pleasing to hear students saying; “What do you think we should do?”, “Do you have anything to add?”, “That’s a
good idea but what about...” and, “We’ll go around the circle and each show our designs”. One student said afterwards...

“I enjoyed working in a team because we got to see other people’s ideas.”

Usually I would ability-group my students, and work more closely with the higher needs groups. However, I began exploring the use of mixed-ability groups for science experiments and once again I had pleasing results.

Another positive outcome was the benefit to the literacy skills. The program designed by Dr Chris was heavily reliant on verbal communication skills. The students needed to be able to share their individual ideas with the aim of combining, compromising and altering their opinions so they could make the best gravity powered car possible.

“I was surprised that our group worked really well because at first we didn’t communicate well, but at the end we communicated with each other and listened to other’s opinions.”

By talking about it more they were able to write more useful information. So now, before the groups fill in their worksheets, I get them to discuss their ideas and findings with a partner. This helps order their thoughts before putting them down on paper. As a result, I’ve seen improved articulation in both their written and verbal communication.

Overall, there were clear benefits to both my students and myself. The energy and knowledge that Dr Chris delivered the lessons with, spurred on my students’ enthusiasm, has revitalised my passion for teaching science, and motivated me to look towards promoting science on a whole school level. With the support of both my teaching colleagues and principal I have set about creating a K-6 science storeroom. I have delivered my own hands-on science workshop as part of our Term 2 Staff Development Day. I’ve also started team teaching science with teachers of other classes. This has helped to spread the enjoyment of science further, with teachers now coming to me for more science experiments, possible equipment and ideas. This is all thanks to the support and encouragement resulting from our partnership with Sydney University in this Primary Science Mentoring Project.

**Conclusion**

Overall the science educator was delighted with the way that all the stage 2 teachers responded to the project. Every teacher wanted their class to be involved. They each eagerly entered into a collegial learning partnership with the science educator, and were ready to expand their expertise in teaching science. That one of teachers (co-author Priscilla) was particularly inspired was a bonus because this now provides a teacher in the school to continue promoting teaching science.

The project is continuing with in-class mentoring with a new group of stage teachers each term and on-going support for previous groups. Whilst formal evaluation of the project is yet to be conducted, the enthusiasm and engagement shown by all the teachers (and students) provide indicators of its likely success. It seems all it takes to encourage primary teachers to do more science is for role models to ‘get in there’ and support the teachers to do it themselves.

**About the authors**

Dr Christine Preston is a lecturer at the University of Sydney. Priscilla Mussone is a stage 2 teacher at Haberfield Public School.

**Acknowledgement**

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Copies of the lesson sequence and marking rubric can be obtained by emailing Dr Chris: christine.preston@sydney.edu.au
Encouraging Primary Teachers to do More Science (continued)

References


