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Ensuring New Zealand's future prosperity: A Professional Learning Development initiative to bridge the gap between theory and practice

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ABSTRACT: This paper reports on a study investigating the effectiveness of a new professional learning development (PLD) initiative in New Zealand, The Sir Paul Callaghan Science Academy (The Academy). The Academy is designed to provide primary and intermediate (students aged 5 to 13) classroom teachers with the knowledge, materials and support needed for The New Zealand Curriculum (Ministry of Education, 2007). After the Academy's first two years of operation, results indicate that The Academy has shown how relevant, useful and meaningful education through science can impact on both individual classroom teacher's practice and entire school programmes. The implications of this paper support the critical importance effective PLD plays in continued teaching practice.

KEY WORDS: professional learning development, primary education, science education, primary teachers, science academy

INTRODUCTION

In 2012, the New Zealand government launched a nationwide inquiry into the challenges facing science in New Zealand now and into the future. A nationwide media campaign was launched showing young people talking to scientists about what they do and why, with the intention that the 'National Science Challenges' are a way of finding innovative solutions to some of the most fundamental issues New Zealand faces in its future. After several months of consultation with the public, academics and research providers, twelve Challenges were identified. Of these, the Ministry of Business, Innovation and Employment (MBIE) announced that ten had been identified as vital for the future of New Zealand:

- Aging well - harnessing science to sustain health and well-being into the later years of life.

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- A better start - improving the potential of young New Zealanders to have a healthy and successful life.
- Healthier lives - research to reduce the burden of major New Zealand health problems.
- High value nutrition-developing high value foods with validated health benefits.
- New Zealand's biological heritage-protecting and managing our biodiversity, improving our biosecurity, and enhancing our resilience to harmful organisms.
- Our land and water - research to enhance primary sector production and productivity while maintaining and improving our land and water quality for future generations.
- Life in a changing ocean - understanding how we can exploit our marine resources within environmental and biological constraints.
- The Deep South - understanding the role of the Antarctic and the Southern Ocean in determining our climate and our future environment.
- Science for technological innovation - enhancing the capacity of New Zealand to use physical and engineering sciences for economic growth.
- Resilience to nature's challenges - research into enhancing our resilience to natural disasters.

According to the New Zealand Government, "The Challenges are designed to take a more strategic approach to our science investment by targeting a series of goals which, if achieved, would have a major and enduring benefit for New Zealand" (Ministry of Business, Innovation & Employment, 2013, para. 3).

These Challenges were selected to ensure that Government investment in science delivered benefits for New Zealand. However, what these Challenges ignored was the greater issue raised during the consultation process and identified by the National Science Challenge Panel that was tasked with making these Challenge recommendations to the Government. The Panel noted that a 'Science and Society' Challenge, while not meeting the brief set by the Government, was nevertheless central to "giving optimal effect" (Gluckman, 2013, p. 2) to the Challenges.

The Science and Society Challenge was a direct result of questions raised in the consultation process as to where the Government expected the future scientists and science innovators to come from. The past decade has seen significant changes to the New Zealand's national curriculum with the introduction of a single curriculum document (see, Ministry of Education, 2007) for all mainstream school-aged students (students aged 5 – 19). This single curriculum document no longer contained a list of 'possible learning experiences' students at each year level 'could' experience in each

curriculum area (see for example science, Ministry of Education, 1993). The older 1993 documents had resulted in a checklist approach of fragmented and unrelated science lessons in schools.

The science area in the new curriculum focuses learning science through the overarching strand of the Nature of Science and teachers are free to use whatever content is relevant to their students' learning. It needs to be noted this paper refers to the 'Nature of Science' (using upper case letters) as the overarching strand of *The New Zealand curriculum's* (Ministry of Education, 2007) science learning area and not. 'Nature of science.' lower case letters)._The nature of science is the portraying of science as a way of knowing, including the values and beliefs inherent to the development of scientific knowledge (Duschl & Osborne, 2002; Lederman & Neiss, 1997). Erduran (2014) argued that this conventional depiction of the nature of science is not as potentially beneficial as an interdisciplinary approach. One of the strengths of *The New Zealand Curriculum* is its ability to incorporate content in contexts that best allow teachers to present science that their students see as relevant, useful and meaningful.

National and International data sources have noted how New Zealand has been experiencing a decline in students' enjoyment and engagement with science (Bolstad & Hipkins, 2008; Cooper, Cowie, & Jones, 2010). Bolstad and Hipkins (2008) noted that while approximately 70% of Year 4 (students aged 9) enjoy science, this drops to less than 30% by Year 8 and then to less than 10% by the time they graduate High School. It has been reported that up to 50% of secondary graduates only take science at the tertiary level as requirements for their degree program (Hipkins & Bolstad, 2005). Where does the New Zealand Government expect its future scientist and industry innovators to come from when less than 5% of students enter tertiary education with a history of enjoyment and engagement with science?

What these identified Challenges have highlighted is the importance of relevant, useful and meaningful science in studying education through science. It is argued that this education should start from day one of schooling if New Zealand wants to keep students engaged and interested. Over the next 10, 20, 30 and even 50 years, these Challenges would be expected to change and the people needed to address them would need to be the students in schools today. The Education Review Office (2012) reported that approximately 70% of the schools they investigated do not have the teachers capable of effectively delivering science. While t*he New Zealand Curriculum* was mandated to be fully implemented for the start of the 2010 school year; no professional learning development (PLD) was offered to unpack this new document. As a result of this lack of PLD, Hipkins and Hodgen (2012) noted that more than half of New Zealand teachers did not understand the shift in how science was supposed to be

delivered two years after full implementation. Schools, therefore, were having to seek professional learning development for their teachers.

This paper reports on one such programme. The Sir Paul Callaghan Science Academy, created in 2012 provides classroom teachers with the PLD in science education necessary for *The New Zealand Curriculum.*

SIR PAUL CALLAGHAN SCIENCE ACADEMY

The Sir Paul Callaghan Science Academy (The Academy) is an initiative of the National Science-Technology Roadshow Trust (The Trust). The Academy's goals are to create recognised champions and leading educators of science who are:

- Engaging and enthusiastic.
- Highly skilled, capable and confident.
- Aware of the relevance and interconnected nature of science.
- Inspirers of the science achievers and citizens of tomorrow.
- Their role is to fuel students' interest in science through awareness of:
- How science is the key to almost everything this country must do.
- The impact of science on all New Zealanders.
- The wide variety of science careers available and the many paths to becoming a scientist.
- The importance of a science literate society.
- The vibrancy of people working with science today (heroes).

First delivered in Auckland in 2012, The Academy offers an intensive in-service, four-day, professional learning development programme for teachers of primary (5-11 years old) and intermediate (12-13 years old) students with the aim of creating teacher 'science champions' within schools. In New Zealand, the term science champion refers to a teacher who is willing and able "to assist teachers less confident in providing that sense of scientific enquiry and scientific enthusiasm to young minds" (Gluckman, 2011, p. 4-5). These science champions are needed in every primary school, as they are able to "integrate excitement about the natural world and scientific forms of thinking into literacy and numeracy teaching, and into general educational processes" (Gluckman, 2011, p. 4).

The Academy provides a forum for exchange, encouragement and dissemination of 'best practice' in science teaching. The Academy builds on participating teachers' understanding, skills and prior knowledge through small group discussions, investigations and reflections to promote learning (Erduran, 2014). This is followed by ongoing interaction and support, via a proactively enriched Alumni network and post-academy programme. The Academy operates with a selected group of experts

ranging from classroom practitioners, university academics and government officials to industry personal delivers the programme.

Teacher Participants

Teachers are nominated by their respective schools because of their potential in science leadership. These teachers usually have four or more years of experience, although less experienced teachers whose exceptional talents have been identified, may also attend. Over the past two iterations of The Academy, participation has averaged 20 participants from 16 different schools. Because of their leadership roles, these teachers have the greatest potential to implement initiatives within their schools; to disseminate ideas; and, to inspire and mentor their colleagues and in turn facilitate learning for all students.

How are The Academy's programmes different?

With some ideas drawn from teacher academy experiences predominantly from the United States of America. This initiative is a first for New Zealand, although there have been previous New Zealand PLD approaches. For the Science Learning Hub (Cooper, Cowie, & Jones, 2010) and learning models for science, such as Milne's (2010) creative exploration. The Science Learning Hub (SLH) offers teachers a one-stop cite for science education and research. Many teachers, however, have found the SLH to be time consuming and difficult to navigate without guided instruction. Cooper, Cowie and Jones (2010) reported that when this was provided, teachers found the SLH useful and promising. Unfortunately, most primary teachers, especially those in the rural regions, are not able to receive this support. Milne's (2010) creative explorations learning model relies on classroom teachers being able to read and implement this model without the opportunity to practice, discuss and reflect with the support of experienced teachers.

The Academy, like the SLH, has a strong emphases on STEM (Science, Technology, Engineering and Mathematics) education; Nature of Science approaches; investigative skills; hands-on skills; communication; careers in science; science for citizenship; and, the interconnected nature of science. Similarly, like Milne's creative exploration, the Academy includes exploration, creativity, curiosity, questioning, inquiry, and effective pedagogy. The Academy, however, offers skilled presenters and guest speakers who deliver within their areas of expertise in a tightly integrated syllabus face-to-face with teachers over a 4-day workshop. A study by Valdmann, Holbrook and Rannikmäe (2012) points out that it is more likely for teachers to make changes in their teaching practice if they experience and reflect on their performance of the new skills. The Academy argues the extended face-to-face workshop with experienced and skilled

teachers working alongside teachers allows the learning of new skills and then the integration into their teaching through the continuity of support and sharing between Academy staff and its Alumni.

A continuing relationship between The Academy and the Alumnus is seen as crucial. The Academy does not end for teachers after the 4-day workshop when they return to their school. The Academy actively facilitates and enriches its Alumni network through its own website (see http://www.scienceacademy.co.nz/) and blog and via post-academy events. Alumni are also encouraged to undertake activities that will have flow-on effects within their school and community, including:

- Mentoring other staff within their school.
- Preparing science resources for their class or school.
- Identifying local science connections and resources in their community.
- Engaging and sharing with other primary and intermediate schools and their alumni staff.
- Engaging with their local secondary school Science Department.

To further the effectiveness of the Academy, it requests both qualitative and quantitative data from participating teachers who voluntarily choose to complete online surveys.

SURVEY METHODOLOGY

The Academy solicits teacher comments at three specific times:

Time 1 (T1) six days after completion of The Academy;
Time 2 (T2) six weeks after The Academy; and finally,
Time 3 (T3) one year after The Academy.

Participating teachers are sent a link to the survey instrument via their email. Each survey includes a mixture of both open and closed questions and offers the option of anonymous responses. As part of the survey, teachers are asked if they have any comments that they would be happy for The Academy to use in future correspondence or in publications.

In addition to the surveys, the ongoing Alumni network also provides a rich source of teacher comments and suggestions. Individual teachers have been contacted about the use of any of their statements for possible publication and only those statements that have been granted permission have been used in this paper.

In 2012 and 2013, the T1 survey instruments were identical with the exception of minor changes to the dates of The Academy and references to accommodation. This allowed for a comparison of participating teachers'

comments on the structure and composition of The Academy. The completion of the survey and individual questions within the survey were optional and as a result, not all participants completed the survey. Similarly, not all questions were completed within each survey. In 2012, the 22 participating teachers were offered the survey instrument and in 2013, 17.

The T2 and T3 survey instruments are unique as they focus on the changes in the Alumni practice within the classroom, student outcomes and methods of communication between The Academy and Alumni.

RESULTS FROM THE SURVEY

Time 1: Six days after the Academy

Teacher participant feedback was sought within six days after both the 2012 and 2013 Academies. When asked 'How effective do you think the Academy concept is? 55% responded 'Extremely' and 36% responded 'Very' (n =31). Teachers were able to explain how and why they thought The Academy was effective. Below specific comments ae included with permission of the teachers and their schools. Jill Marsh from St John's Mairangi Bay after the 2012 Academy stated, **"**At the Academy I learnt that in order to inspire and nurture future Scientists in New Zealand, we as teachers must gain more confidence and knowledge in the delivery of Science. The Academy is the place to start this vital change." This acknowledgement of The Academy's influence on teaching practice was supported in 2013 by Madeleine Collins from Laingholm Primary School, **"**The academy was life-changing. I go back to my job seeing it through new eyes, seeing it as a career. I now feel like I have a new focus, enthusiasm and valuable skills I can share with colleagues."

When asked 'Would you recommend the Academy to a colleague?' 100% (n = 32) of participants who responded said they would. Susan Revell of Belmont Intermediate (students in Years 7 to 8 who are 11 to 13 year olds) after the 2013 Academy stated, **"**Every school should send their HOD [Head of Department] science to this academy." One 2012 participant who chose not to be identified was even more generous in his or her praise, "Participation should be mandatory for every school."

Participants were asked to rank ten statements about their teaching practices as a result of their attendance at The Academy. They were asked to rank these statements using the following four conditions: already doing this, highly likely, likely unlikely. Their responses are included in Figure 1, below.

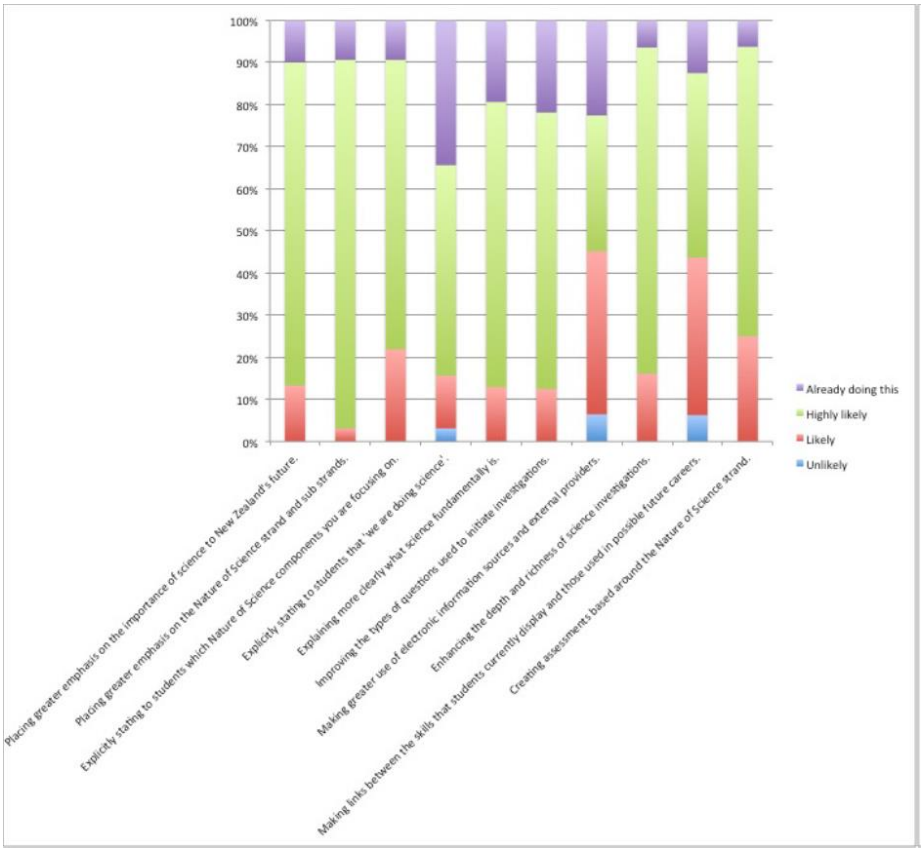

Figure 1 Teaching practice changes because of the Academy experience.

Janine Fryer from Pukekohe Intermediate in 2012 commented upon her responses saying, **"**It has re-sparked my love of teaching science and also provided me with an on-going resource bank to share with my colleagues and students." One participant was able to provide an extended comment about the Academy's influence. Irene Streten from St John's Mairangi Bay in 2012 noted:

> *Even though I teach science at my school I came to the academy feeling intimidated by the mysteries of science that lay beyond my grasp. Like so many, I left science in early high school thinking it was too hard and too inaccessible for the likes of me. But 4 days later, I left the academy reframing my entire thinking about what it means to teach science and technology. Moreover, the academy gave me something I never learnt at school, the simple joy of wondering about the world around me and*

> *the profound satisfaction of pursuing answers. What more could I ask for than that? I had always thought that scientists and specialist science teachers were crazy nuts that lived in an academic bubble of their own self-importance. What I discovered were lovely people, who know a lot more than me, who don't despise me for my limited knowledge but invite me to explore the world they have come to love.*

Time 2: Six weeks after The Academy

The purpose of this new initiative is to ensure New Zealand's future prosperity by thinking laterally and combining efforts to promote and deliver positive science learning experiences to all students around the country. Therefore, in 2013 this programme went back to participants six-weeks later to enquire about how The Academy had made an impact on their teaching practice once back in their classrooms. Belinda Hitchman from Newmarket Primary School still felt the Academy was, **"**A transformative experience. The best PD [professional development] I have had in many years. Excellent model. Thank you so much for such rich and meaningful experiences." This acknowledgment of The Academy's impact on staff was also noted by Kelly Slater-Brown of Stanley Bay Primary School, **"**Have run a number of successful staff meetings using materials from the course. Teachers are highly motivated. The science hub was a popular resource. Will continue to upskill teachers each term. This will go into our strategic plan."

As rewarding as both Belinda's and Kelly's statement are about the programme, the Academy wants to improve the learning experiences for students. Six-weeks after The Academy may not have been long enough for schools to introduce and then implement new initiatives. Eleanor Hart of Laingholm School implies that changes will take place, **"**Many staff are keen to follow in our footsteps now! … With the learning and confidence we gained on the Academy, we feel ready to implement an inspiring science programme from which all children at the school will benefit." Continued follow-up from The Academy should be able to support Laingholm School in its future science programme.

Time 3: One year on from the 2012 Academy

Ten participants from the 2012 Academy provided comments on their teaching practice in science one year after their experience. Their combined responses are presented in the Figure 2, below.

Figure 2 One year on from the 2012 Academy.

Most notably, 100% of the participants said:

1. They have used what they learnt at the Academy to assist other colleagues in their science teaching.
2. They have now improved the types of questions used to initiate investigations, and
3. That their science teaching overall has benefitted.

Soon after the 2012 Academy, Jill and Irene both from St John's Mairangi Bay set up a teacher staff meeting to introduce science learning to the rest of the school. Their emphasis was on planning and delivering a high quality science teaching programme across the entire school using ideas from the Academy. To achieve this, they encouraged planning with a greater emphasis on the Nature of Science, focused on developing inquisitive minds, on how scientists think and on the 5Es learning model (Skamp, 2004). They led further teacher meetings and organised staff to plan collaboratively and deliver science units, integrating these with a social

science unit on 'thinking like a scientist'. "Science has radically changed within the school and students are loving it."

Alumni Network

The Academy has created an Alumni network of attendees as a point of difference for this initiative. Participants who attend are informed that they join a growing body of Alumni that both are supported by the Academy staff and are able to support other teachers. This network is already seeing positive results. Participants from both 2012 and 2013 were asked to rank how much they learnt from other alumni. These results along with two other questions about how much they enjoyed the Academy and how much they learnt from the sessions are presented in Figure 3, below.

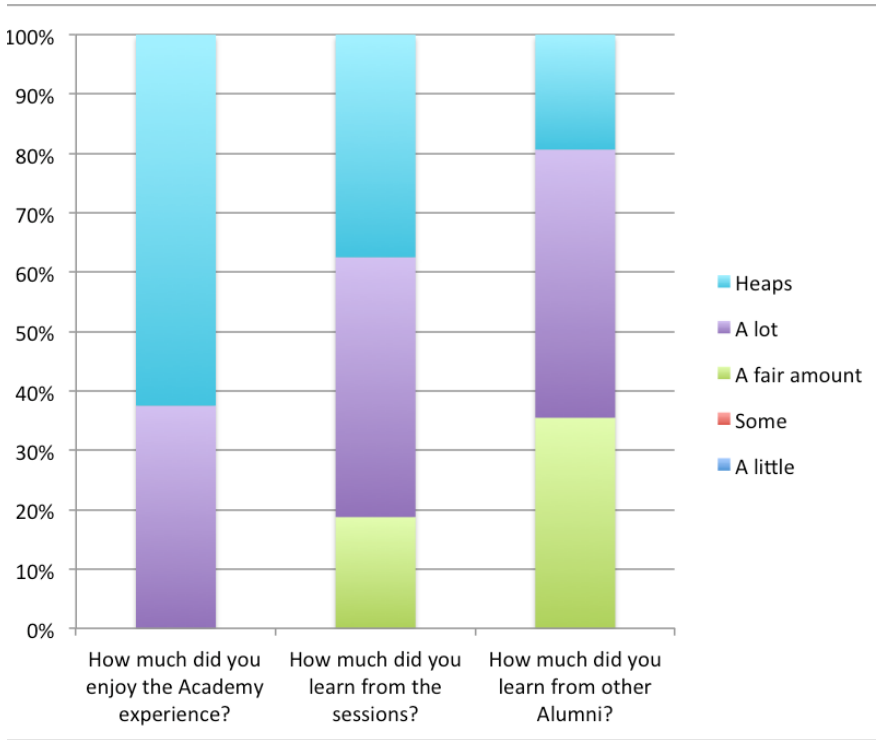

Figure 3 Enjoyment and Learning

Laingholm School is an example of how the continuity provided by the Academy and its Alumni network is already starting to make an impact. After attending the 2013 Academy, Madeleine and Eleanor soon set about transforming their school's science programme. Using Professional Development time they guided staff and students through weekly science investigations using the 5Es model and Nature of Science concepts in order to model inquiry learning. Having primed the staff, they are now launching

a science focus for 2014, starting with a teachers' only Professional Development day. Throughout the planning phase Academy staff have been giving advice and encouragement. As well as greater involvement from the rest of the staff, Madeleine has been appointed to a specialist science teacher role in which she will be teaching science three days a week, taking classes in their teacher's release time. The year will culminate in a science fair or symposium.

CONCLUSIONS

The Sir Paul Callaghan Science Academy provides a forum for exchange, encouragement and dissemination of 'best practice' primary and intermediate science teaching. The Academy aims to equip the primary or intermediate teacher with skills, resources and techniques to gain confidence in delivering the science curriculum. This is followed by on-going interaction, support and enrichment via our alumni network and post-academy programme. The Academy, therefore, helps teachers raise students' interest in and awareness of science.

Moving forward

The spectacularly positive outcomes so far are being built on by introducing both more academies and less expensive Academy programmes. In 2014, subject to enrolments, at least three are proposed for different main centres throughout New Zealand. While feedback suggests that the live-in model run in the first two years was very effective, to further reduce costs to schools, the 2014 Academies will be non-live-in courses. The Ministry of Education allocates schools professional development funding (based on staff numbers) that can be used by schools to support the continued professional development of its staff. Individual schools have a great deal of autonomy in how this money is spent; however, this is contestable within the school as to what curriculum areas and who within each school is able to access this money. We think it is essential that schools use this contestable funding to put teachers through more professional training in science, and to gain the greatest benefit from limited funding, choose highly effective programmes such as those delivered through the Sir Paul Callaghan Academy.

Footnote

There are major issues affecting primary and intermediate science teaching and learning, which are worsening. We continue to take proactive steps at the grassroots level by providing powerfully engaging programmes. Ongoing funding to support our work is our biggest challenge. Dianne Sanson from Waverly Primary School summed up the importance of this

initiative the best when she stated, **"**The academy opened my eyes to a whole new way of thinking."

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