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Impact Report:  
**Hands-on STEM  
professional  
development program  
for teachers in  
primary schools  
across New Zealand**

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### About the Authors



**Dr Kate Sparks** leads STEM content development at Nanogirl Labs, with deep interest in learning design and a passion for sharing her love of science to empower others. Kate holds a PhD in Marine Science from the University of Otago.



**Dr Michelle Dickinson MNZM** is a nanotechnologist and fracture mechanics engineer with two decades' experience in the tech sector, and ten years in academia. Now as co-founder of Nanogirl Labs she is dedicated empowering, educating and inspiring through STEM. Michelle holds a PhD in biomedical engineering from Rutgers University.

# Executive Summary

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This report details the effectiveness of a hands-on professional development workshop aimed at increasing primary teachers' confidence in science, and recommends that **STEM-focussed professional development for all primary school teachers in this area be an urgent priority for schools.**

Science achievement in New Zealand schools is declining, and there is a pattern of disengagement with science that starts in primary school for many students.

Negative experiences with science in primary school have often been blamed on teachers' lack of skills and subject-matter knowledge, but teacher confidence in and attitude towards science also plays a crucial role.

This report contains the outcomes of a large, multi-year professional development program for primary and intermediate teachers, aimed at increasing their confidence and readiness to teach science. Teachers were surveyed about their confidence, readiness and opportunities to teach science in their classrooms, as well as the impact of taking a Nanogirl Labs professional development workshop.

## Key findings from these surveys are as follows:

- **7% of primary school teachers surveyed in this study reported that they did not teach any science at all in any of their classes. Only 22% of primary school teachers surveyed reported teaching science in their classroom regularly.**
- **Teachers who “sometimes” taught science were most likely to do so only when it fit into an inquiry topic, or indirectly through topics like baking, gardening or learning about animals.**
- **Low confidence is a major contributing factor to the high portion of teachers who do not teach science.**
- **90% of teachers surveyed who reported that they taught little or no science said that they wanted to teach more science.**
- **Low teacher confidence with science can lead to fewer opportunities for students to study science in primary school, resulting in a lower long-term engagement with science.**
- **After taking a Nanogirl Labs hands-on STEM PLD (Professional Learning & Development) workshop, 95% of teachers reported that their confidence in science had increased significantly and they had an increased willingness to add science teaching into their classrooms.**
- **Teachers reported that a key benefit of a hands-on STEM workshop was that they were able to try the experiments for themselves, which increased their confidence.**
- **Teachers reported that the use of everyday materials in the STEM workshop, combined with fun, practical experiments designed for low-confidence teachers was an important part of what made the workshop so successful.**



# Current Challenges in Teaching Science within New Zealand

## Primary Schools

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The decline in student achievement in science over the past two decades has led to widespread concern for many science educators and policy-makers (NMSSA 2017, Royal Society Te Apārangi 2012, TIMSS 2019, ERO 2021). Globally and in New Zealand, research finds that students are disengaging with science, and more broadly, STEM (science, technology, engineering and mathematics) subjects at primary school, leading to fewer students studying STEM subjects at secondary, NCEA and tertiary levels (Murphy and Beggs 2003).

The need for STEM-qualified workers, on the other hand, is so large that one report estimated that a 34% increase in STEM tertiary graduates every year would be needed to meet the growing demand (Augustine 2005, Xue and Larson 2015).

Science skills are also a foundation for digital competency, which is necessary for work in the fast-growing digital technologies sector (Hindle and Muller 2021). The gap between supply and demand presents a challenge for New Zealand's future as a leader in technology and innovation, and as a nation of science-literate citizens able to make informed, rational decisions.

The reasons why students lose interest in science as they grow older are complex, and not completely understood, but have been documented both within New Zealand and internationally (Bull et al. 2010; Royal Society 2010, Tytler et al. 2008). One widely-discussed aspect of student disengagement is the lack of confident, science-literate teachers in New Zealand primary schools. Currently only 3.5% of Year 4 teachers have a tertiary science qualification, and only 1.5% have work experience in a scientific field (NMSSA 2017).

In addition to a lack of subject knowledge and experience, 20% of primary teachers in New Zealand report that they are not confident teaching science (NMSSA 2017). The knock-on effect of this low confidence is that many of these teachers avoid teaching science in their classroom (Tytler et al. 2008). As a result of this and other factors including the “crowded curriculum,” New Zealand primary school pupils spend less

time (45 hr/ year) learning science than pupils in other countries (TIMSS 2015).

On average, primary school students in New Zealand spend approximately 4% of their time each school year in class learning science, way below the international average of 8.2% (TIMSS 2019).

Teacher confidence, as well as skills and subject-matter knowledge, is therefore likely to directly affect student achievement and engagement when it comes to science in primary school. STEM focussed professional learning & development (PLD) can help improve the confidence of primary school teachers in science, resulting in better teaching practice and raising student achievement in science (Blank and de las Alas 2009, Kennedy 2016, Kowalski et al. 2020). Up to 50% of New Zealand schools, however, have not accessed external PLD in science over the last five years (NMSSA 2017). This is despite evidence that access to PLD improves teacher confidence - one of the main reasons why teachers choose to take PLD, ranked above community engagement, subject-specific knowledge gains, and updates to pedagogy (Bull 2016a, 2016b).

# Impact of Hands-on STEM PLD

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Teacher confidence therefore needs to be supported in order to help reverse the trend of student and teacher disengagement with science at primary school.

Nanogirl Labs has been delivering hands-on STEM focussed PLD workshops to primary school teachers since 2017. Taught by trained STEM professionals, these workshops are aimed at increasing teacher confidence and familiarity with science and STEM based subjects. The workshops are designed to increase teachers' confidence and knowledge around science topics and science teaching by giving teachers the opportunity to carry out hands-on experiments for themselves.

Starting with basic experiments, the workshops work towards building up science experiment skill levels with the goal of supporting teachers to try a practical science lesson with their class. These PLD workshops have reached over 1000 teachers across New Zealand, 30% of whom taught in low socio-economic communities (classed as decile 1-4).

Nanogirl Labs has recieved many requests for access to the PLD workshop from low decile schools that do not have the budget available for the training. As a social enterprise committed to increasing STEM access for all, Nanogirl Labs has gifted many of these workshops to low decile schools since 2017 thanks to funding from The MacDiarmid Institute and Foodstuffs North Island.

To understand the effectiveness of these workshops on teachers' science confidence and capability, teachers were asked to respond to two questionnaires, one given before and one after attending and participating in a Nanogirl Labs hands-on STEM PLD workshop.

## PLD Workshop Design

The workshop content was built for all primary school teachers, but with great consideration to teachers who identify as having low STEM confidence.

All of the practical science experiments used in the workshops are low-cost with the materials used designed to be familiar, affordable and recognisable to teachers that don't have any science expertise. Rather than the traditional bunsen-burners-and-test-

tubes approach to science, the workshops use items sourced from around the home and classroom. The use of "found" objects is important to help teachers to overcome some of their preconceptions about science being inaccessible or expensive. Found objects also provide an entry point to discussions around sustainability, recycling and reuse of materials in a scientific and practical context.

Teachers were given access to curriculum-aligned resources which consolidated and extended the content covered in the workshop, so that teachers could retain and expand the taught content long term.

By designing a STEM PLD workshop that was accessible to all participants, regardless of their attitude and experience in science teaching the goal was to increase STEM teaching and confidence across all primary school teachers in New Zealand.

## Teacher Demographic

Teachers who attended the Nanogirl Labs PLD workshop represented schools from a variety of regions, sizes, and socio-economic areas.

In total, 424 teachers answered both surveys delivered before and after attending a Nanogirl Labs hands-on STEM PLD workshop. 50% of these teachers were from decile 1-3 schools, 29% from decile 4-7 schools, and the remaining 21% were from decile 8-10 schools.

The teachers that responded to the survey had 14 years teaching experience on average, but this varied widely from 0 - 50 years. 85% were female and 15% male which matches the gender diversity within the teaching profession estimated by Stats New Zealand.

## Baseline Teacher Survey Results

Before taking part in the STEM PD, 7% of teachers surveyed reported that they did not teach any science at all in their classes (Fig.1). 70% of teachers reported that they "sometimes" taught science and only 22% of teachers said that they regularly taught science in their class.

Of the teachers who answered “sometimes”, they were most likely to say that they taught science only when it fit into an inquiry topic, or that they taught science indirectly through topics like baking, gardening, or learning about animals. PLD can help improve the confidence primary school teachers in science resulting in better teaching practice and raising of student achievement in science (Blank and de las Alas 2009, Kennedy 2016, Kowalski et al. 2020). However, up to 50% of New Zealand schools have not accessed external PLD in science over the last five years (NMSSA 2017).

This is despite evidence that access to PLD improves teacher confidence - one of the main reasons why teachers choose to take PD, ranked above community engagement, subject-specific knowledge gains, and updates to pedagogy (Bull 2016a, 2016b).

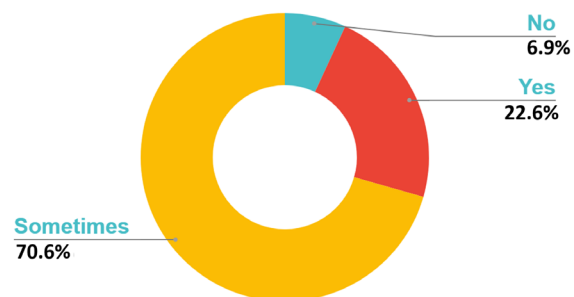


Fig 1. Response from primary school teachers to the survey question “Do you teach science in your class”

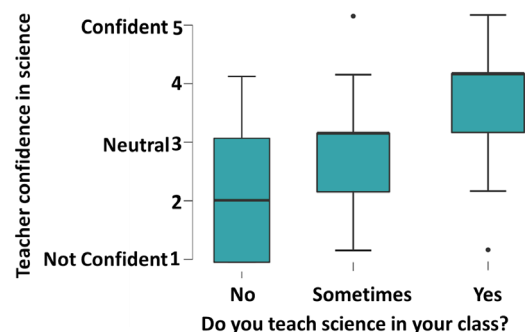


Fig 2. Distribution of teachers' perception of confidence in science and whether or not they teach science in their classroom.

Teacher confidence therefore needs to be supported in order to help reverse the trend of student and teacher disengagement with science at primary school. Out of the teachers who answered ‘No’ or ‘Sometimes’ to the question “do you teach science in your class”, 90% said that they wanted to teach more science, reflecting an understanding of the value of science teaching and learning to their students.

Teachers were also asked to rate their confidence with science on a scale of 1-5 where 1 was the lowest score (No confidence), 3 was neutral, and 5 was the highest score (Confident). The average confidence of all teachers was 3.1 out of 5. In general teachers with more teaching experience ranked themselves as more confident in teaching science (Fig. 2).

Teachers who ranked themselves as having low science confidence were also more likely to report that they either did not teach science at all, or taught it infrequently (Fig. 2). Teachers who reported that they did not teach any science had an average confidence score of 2.11, teachers who answered that they ‘sometimes’ teach science had an average confidence score of 2.96, and teachers who answered that they regularly teach science had an average confidence score of 3.57. Low teacher confidence therefore contributes to fewer opportunities for their students to learn science, and in turn to lower student engagement in science.

### Impact of Professional Learning & Development

After taking either a 1-hour or 5-hour Nanogirl Labs hands-on STEM PLD workshop, 95% of teachers reported that their confidence in science had increased significantly (Fig. 3). 95% of the teachers also said that after taking the workshop they felt that they would be able to add hands-on science to their classroom. Encouragingly, 93% of teachers who previously said that they did not teach any science at all in their classes felt empowered to teach some of the content that they had learned from the workshop in their own classrooms (Fig. 4).

Feedback from the teachers indicated that the hands-on component of the workshop was especially helpful in gaining confidence. Many reported that it was easy to “have a go” once they had tried an experiment for the first time. This was consistent across deciles, geographic areas, experience levels and genders, indicating that the benefits of hands-on STEM PLD are high even for teachers who already consider themselves confident in teaching science.

One teacher responded, “Love how [we] used everyday stuff and enviro-friendly [materials]!” while another said that “the practicality of the resources and materials needed means that it’s doable.”

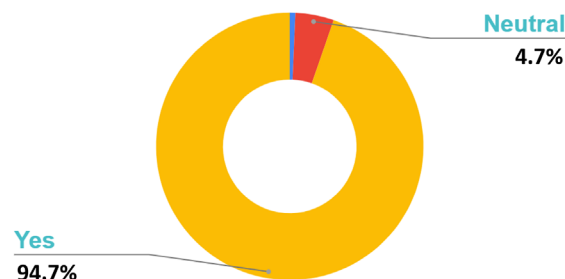


Fig 3. Response from PLD participating teachers to the survey question "Did the workshop increase your confidence in science?"

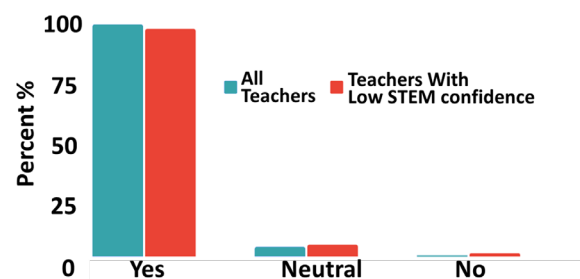


Fig 4. Response from PLD participating teachers after the workshop to question "Has this workshop increased your ability to teach science in your class?"

#### Teachers reported that the key benefits of the workshop were:

- The practical, hands-on structure of the workshop, which gave them the opportunity to try experiments for themselves.
- The cost-effectiveness of the activities, and the accessibility of the equipment.
- The materials used were familiar and not intimidating.
- The language used was everyday language and not jargon-filled.
- The potential for the science experiments to be used across multiple year groups.
- The connections with other areas of the primary curriculum, especially literacy.
- The experiments were relatable to experiences that students were familiar with outside the classroom.
- Working as a group allowed teachers from the same school to discuss how to add the content in a cross-curriculum way.
- Having scientific experts leading the PLD enabled discussions around STEM careers and experiences in STEM industries.

## Recommendations

To help increase cross-curricular STEM teaching by all teachers in primary schools STEM focussed professional development workshops should include content, facilitation techniques, and resources specifically designed to cater to teachers with low confidence in science.

The effectiveness of even a short 60 minute hands-on STEM PLD workshop on teachers' confidence and ability to add science to their classroom is clear, and this type of PLD should be accessible to primary teachers throughout New Zealand.

This report agrees with the findings of other international studies (e.g. McClure et al. 2017), that in order to counter anxiety and low confidence around teaching science, primary school teachers need to experience the same hands-on, engaging learning environments and practices that they could introduce into their own classrooms. Hands-on STEM PLD which emphasises curiosity, exploration and play rather than just subject and curriculum knowledge can help to develop teachers' confidence and willingness to 'have a go' at science, even for teachers who previously have not done so.

New Zealand's ability to lead in science and technology based industries depends on a steady supply of science-literate and STEM-qualified workers, a journey which starts in primary school. Implementing professional development in STEM subjects for all primary school teachers can help to strengthen the development of the next generation of thought leaders and innovators.

Low teacher confidence is one of the main reasons why primary school teachers do not teach STEM subjects in their classrooms. This confidence can be boosted effectively with well-designed, accessible and supportive STEM focussed professional development solutions. Teacher confidence in STEM fields needs to be supported in order to help reverse the trend of student and teacher disengagement with science at primary school.

Funding for STEM PLD is a struggle for many schools across New Zealand and additional funding support will likely be required to achieve sufficient upskilling of teachers in STEM fields.

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# About Nanogirl Labs

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Based in New Zealand, Nanogirl Labs believes that everyone, everywhere should have the opportunity to dream bigger and achieve more through a meaningful relationship with STEM – science, technology, engineering and mathematics.

We work globally with our partners to bring that about, designing, creating and delivering products and experiences that bring about meaningful change. From our work in schools to our global impact programmes delivered in partnership with NGOs and Government Aid programmes to our pioneering work bringing artificial intelligence to bear in democratising access to world-class learning, everything we do lives in service of that clear and urgent mission.

A socially conscious business, we strive to do well by doing good. Everything we do is designed to be both commercially successful, and genuinely impactful. We measure and report on the impact of everything we do.

Science is for everyone, and increasing diversity and inclusion in STEM fields is one of the key outcomes of our work. We specialise in designing inclusive ways to reach and empower wide audiences, including those who are too often left behind.

Founded in 2016 by Joe Davis and Dr Michelle Dickinson MNZM, Nanogirl Labs is also the home of Nanogirl, our world-famous science superhero loved by young scientists-in-training in more than 120 countries.

## Find out more

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