

How can professional learning and development for science teachers address the needs of priority learners?

Abstract

Science teaching has come under scrutiny in the last three years in New Zealand as a result of disparities in participation and achievement of Māori and Pasifika learners, those from low socio-economic backgrounds, learners with special education needs and English language learners. This paper draws on professional learning and development (PLD) for science teachers to address the needs of these priority learners in 48 high schools. Three case studies of science teachers highlight changes to pedagogy. The key success factors of the PLD were: teachers establishing positive relationships with their learners; use of multiple forms of formative assessment; and strategies to support learners with literacy in science.

Introduction

Science teaching has come under scrutiny in the last three years in New Zealand as a result of evident disparities in participation and achievement of Māori and Pasifika students and those from low socio-economic backgrounds in high school science achievement standards (Education Counts, 2010; May, Cowles, & Lamy, 2013). As a result of calls to action for science educators (Gluckman, 2011; Conner, 2013) and the knowledge that teachers can make a significant difference (Fullan, 2001; Hattie, 2003), the Ministry of Education is supporting teachers to re-examine how they can develop their practices so that they are able to accelerate the progress of these *priority learners*. Previous meta studies, (e.g. Timperley et al. 2007) identified 97 studies that linked teacher professional development to changes in student outcomes. Despite this number, there are few studies that provide detail and adequate reporting of specific PLD and its consequent outcomes for priority learners. Therefore this study sought to address this gap by providing evidence of key success factors in science teaching and learning contexts through a Ministry of Education funded PLD intervention.

The wider PLD project conducted by facilitators at the University of Canterbury in partnership with Te Tapuae o Rehua Limited (the company set up to support the local tribe, Nga Tahu) has supported high school teacher PLD since 2012 across all curriculum areas. We report here only on how the science teachers involved in the wider project, have used personal and collaborative professional learning to accelerate outcomes for *priority learners* which include Māori, Pasifika, learners with special education needs, learners from low socio-economic backgrounds and English Language Learners (ELL).

Timperley's work on *teaching as inquiry* (TAI) (Timperley, 2011a; 2011b), where teachers inquire into their own classroom practice in response to identified learner needs, was used as the foundation for this intervention study with science teachers in New Zealand schools. In this model, teachers use questions linked to identified learning needs of their students, to drive their own professional learning (Halbert & Kaser, 2012). Facilitators worked alongside middle leaders to support them and their departments to carry out a teaching as inquiry cycles. Facilitators also support individual teachers to focus on aspects of pedagogical change. The overarching research question was:

What are the key success factors in an intervention using 'teaching as inquiry' in science teaching and learning contexts?

Achievement in Science

Many students achieve well in science in New Zealand schools (Vannier, 2012). However there is a stronger relationship between lower socio-economic background and lower achievement in NZ than in many other countries (Bull et al., 2010). Bull and colleagues (2010) alert us to the fact that:

The strong link between students' socio-economic background and achievement in science, and the over representation of some groups among the low achievers means that some groups are more excluded from science than others and this has implications both for the diversity of our science workforce and for issues of social justice. (p. 24)

PISA Results

The Programme on International Student Achievement (PISA) survey from the Organisation for Economic Co-operation and Development (OECD) compares specific assessment of science achievement internationally. Rather than simply testing science content knowledge alone, PISA measures show how well students apply science knowledge in relevant contexts (Vannier, 2012). The 2012 results are concerning for NZ because the average scores in science have declined since 2009. Although NZ's average achievement in science remains above the OECD average, compared to earlier years there are larger proportions of NZ students with very low performance in science. There has been an increase (14% to 16%) performing at very low levels in science, below Level 2. Level 2 is considered the "baseline level at which students begin to demonstrate the competencies that will enable them to participate actively in life situations" (May et al., 2013, p. 7).

Māori learners, and those from low socio-economic backgrounds were represented at all proficiency levels, however all of these groups showed a decline in representation at the highest level, Level 6. Pasifika learners also showed a decline in representation at upper levels, with no representation at Level 6. 25% of Māori learners, 38% of Pasifika learners, and 30% of learners from low socio-economic backgrounds performed below Level 2 in 2012 (May et al., 2013).

NCEA (National Standards) Results

In 2009, 75% of all year 11 learners participated in the NCEA standards in general science; 80% of European decent year 11 students participated compared with 68% of Pasifika learners and 66% of Māori students. In the same year, only 30% of both Māori and Pasifika participants gained 14 or more credits in general science. The standards within NCEA have variable credits and 14 credits is the minimum number of credits required to attain a subject at any level of NCEA. The participation of all students in sciences dropped considerably at year 12 and 13, with participation and achievement disparities for Māori and Pasifika learners even more evident at years 12 and 13 (Education Counts, 2010).

The PLD intervention

The PLD intervention was characterised by a reflective process for teachers to take teaching action, based on their observations and knowledge of students. Teachers actively identified questions of importance to them and their students with the help of the facilitators and their colleagues. They gathered and monitored progress data on 4-5 of their *priority learners*. In some cases, this included identifying literacy levels and needs of students. The facilitators guided multiple inquiry cycles and supported dissemination of the findings to other members

of the science department and more widely within and across schools. The sharing at department level was crucial in disseminating and scaling ideas for wider implementation. There was wide variability in how teachers approached their inquiries about their own teaching. However, three case studies highlight the key factors that have been identified to make a difference to a range of students' outcomes.

Case Studies of TAI

The instrumental case studies (Creswell, 2013) illustrated how aspects of inquiry (teacher processes, facilitation, individual learning, changes to teaching, collaboration, sharing etc) improved outcomes for the *priority learners*. The case studies were developed from teacher reflections, student data, classroom observations and interviews with senior science teachers and heads of departments as they were undergoing cycles of TAI. Audio recordings were transcribed verbatim and supporting data about the context was recorded. Data was coded using a word table and analysed using a thematic approach with an open mind so that the data can "speak for itself" (Mutch, 2005, p. 130). Ethical approval was obtained through the university.

The significance of the findings are that using an inquiry process, supported by facilitators, enabled the teachers to shift their beliefs about *priority learners*; the students' prior knowledge and capabilities and what their needs were for next steps in learning. As a consequence, their teaching behaviours and pedagogies changed in relation to developing more positive relationships with students, providing quality feedback or formative assessment for developing students' and their own knowledge about progress, and identifying the challenges for ELLs.

A key shift was that around understanding of the importance of forming positive learning relationships with students. One of our case study teachers commented:

'One particular student – we didn't get on particularly well at the start of the year – I spoke with his parents, I spoke with his dean, got a bit of background, then spoke with him – had a meeting with him and his dean as well – and we sort of looked at how we could make the science more applicable to him – and I could see the change in his desire – you know – to be in the science classroom – and actually take part in the activities. There was a change in his whole desire to just take part in what we were doing. The fact that I took the time to find out about what he was – what his background was – the fact that I was concerned about his learning – or his lack of learning at some stage – maybe that was – maybe he saw that as me taking interest - he's come on board – to a degree – he's still a bit of a struggle – but there's definitely improvement.'

Teachers also made significant changes in their approaches to assessment, particularly the use of formative assessment and the observations they made during the learning process as illustrated by this case study teachers comment:

'Taking more time – rather than rush through topics – taking more time to assess where students are at rather than just thinking that I've got to get this done, this done, and this is the amount of time we're going to take. Looking at – well, have they actually learned what we've discussed, do they know the words, do they know the literacy – and spending a bit more time looking for other methods to help them learn ... last year I took out that extra topic to give us that extra time to do that – I think that was the key to the class doing a lot better than they possibly would have.'

Teachers have also become a lot more aware of how they need to support students to “unpick” the language of the questions related to the national standards in the senior science classes. They use exemplars of previous years exam questions and answer schedules to help students understand the question and therefore what is required to achieve well.

The teachers also demonstrated a better appreciation of the challenges faced by ELLs, and developed specific strategies to support their learning and became more aware of their own language use when describing and explaining concepts. For example one teacher said:

‘I’ll give you an example – we were talking about electric wires piggy back, you know the banana clips – you know. I’d say – “in a parallel circuit we piggy back” – and then I thought, the ELLs have no idea what that means. Then we talked about it – so I got the other students to say what that meant; and then you could see the light bulbs – and the students said “oh now I know what that means”. And so examples of that kind of thing – I’m much more aware of that – and using language and making sure that they have – you know, that things are broken down for them.’

They also now value the power and leveraging and sharing their inquiry processes with others. This aligns with previous studies (Boyle, White & Boyle, 2004) that showed that observations of colleagues and sharing practice were considered to be the most effective activities for longer-term PLD.

The cases highlight that the key factors that made a difference to learner outcomes were:

1. teachers knowing the learner, their strengths, interests and needs in order to form a positive relationship based on high expectations;
2. formative assessment was crucial to provide feedback to students and teachers about next steps for learning;
3. learners needed literacy support in science, particularly science-specific and academic vocabulary (including support to understand formal assessment questions).

Macfarlane (1997) has indicated that the continuation of a dominant and mono-cultural classroom delivery will perpetuate the underachievement of Māori students. This statement could also apply to other *priority learners*. Therefore it is important that teachers make pedagogical changes to accommodate the specific needs of their learners, and may require a change of mindset of teachers (Halbert & Kaser, 2012).

References

- Boyle, B., White, D., & Boyle, T. (2004). A longitudinal study of teacher change: What makes professional development effective? *Curriculum Journal*, 15(1), 45-68.
- Bull, A., Gilbert, J., Barwick, H., Hipkins, R., & Baker, R. (2010). *Inspired by science*. Wellington: New Zealand Council for Educational Research.
- Conner, L. N. (2013). Meeting the needs of diverse learners in New Zealand. *Preventing School Failure*, 57(3), 157-161.
- Creswell, J. (2013). *Qualitative inquiry and research design: choosing among five approaches* (3rd ed.). Thousand Oaks, CA: Sage.
- Education Counts. (2010). *Participation and Attainment of the National Certificate of Educational Achievement in Science*.

http://www.educationcounts.govt.nz/_data/assets/pdf_file/0007/88594/Participation-and-Attainment-in-NCEA-in-Science.pdf

- Fullan, M. (2001). *The New Meaning of Educational Change* (3rd ed.). New York: Teachers College Press.
- Gluckman, P. (2011). Looking ahead: Science education for the 21st century. Auckland: Office of the Prime Minister's Science Advisory Committee.
- Halbert, J., & Kaser, L. (2012). Inquiring learning environments: New mindsets required. http://youngreaders.ca/downloads/CSE%20Seminar%20Paper%202014_U-1.pdf
- Hattie, J. (2003). *Teachers make a difference: what is the research evidence?* Paper presented at the Australian Council for Educational Research Annual Conference, Auckland, New Zealand. http://www.visionschools.co.nz/assets/documents/john_hattie.PDF
- May, S., Cowles, S., & Lamy, M. (2013). PISA 2012: New Zealand summary report. Wellington: Research Division, Ministry of Education.
- Macfarlane, A. (1997) The Hikairo Rationale: Teaching students with emotional and behavioural difficulties. *Waikato Journal of Education* 3: 153-168.
- Mutch, C. (2005). *Doing educational research; a practitioner's guide to getting started*. Wellington: NZCER Press.
- Timperley, H. (2011a). Knowledge and the leadership of learning. *Leadership and Policy in Schools*, 10(2), 145-170. doi: 10.1080/15700763.2011.557519
- Timperley, H. (2011b). *Realizing the Power of Professional Learning*. Maidenhead: Open University Press.
- Timperley, H., Wilson, A., Barrar, H., & Fung, I. (2007). *Teacher professional learning and development: best evidence synthesis iteration*. Wellington: Ministry of Education.
- Vannier, D. M. (2012). Primary and secondary school science education in New Zealand (Aotearoa): Policies and practices for a better future. http://ndhadeliver.natlib.govt.nz/delivery/DeliveryManagerServlet?dps_pid=IE13743179&dps_custom_att_1=ilsdb