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Perceptions and Pedagogy: Exploring the Beliefs and Practices of an Effective Primary Science Teacher

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Perceptions and pedagogy:
Exploring the beliefs and practices of an effective primary science teacher

By Angela Fitzgerald, Vaille Dawson and Mark Hackling

Effective science teaching is vital for improved student learning outcomes in primary school science. Therefore, there is a need to tease out the components of effective science teaching to better understand what effective primary teachers do in their classrooms and why they do it.

Four primary teachers, each nominated as effective science practitioners by a professional colleague, entered into this research study. This 'entry' phase involved gathering information from classroom observations and teacher interviews to provide background information about the beliefs and practices of these teachers. This paper reports on the findings drawn from one teacher - 'Deanne'.

Introduction

The tendency for primary teachers to shy away from the teaching of science is well documented (e.g. Appleton, 2006; Tytler, 2007). In fact, research has suggested that as little as three per cent of teaching time, on average, is allocated to the teaching of science within Australian primary schools (Angus, Olney, & Ainley, 2004). Further concerns are raised in light of the 2003 and 2006 national assessments of Year 6 students' science literacy (MCEETYA, 2005; 2008), which indicated that more than 40 per cent of students in the sample had failed to achieve the proficient standard. Armed with statistics such as these, the need to bring about change is evident. However, to improve outcomes the powerful influence that teachers have on student learning needs to be harnessed (Hattie, 2003). To do this an understanding of what constitutes effective science teaching is required.

To further develop our understanding of effective science teaching, this doctoral study has focused on what primary teachers are doing to promote learning in science and what experiences, knowledge and beliefs have led to perceptions of them being effective practitioners. This paper focuses on one aspect of this larger study by examining the beliefs and practices of one teacher, Deanne (a pseudonym).

The notion of 'effective teaching' is slippery and with understandings of 'effectiveness' based on the experiences and opinions of various stakeholders, the task of unravelling what counts as 'effective teaching' is a difficult one. The literature on teacher effectiveness has generated numerous lists of behaviours and attributes (e.g. Brophy & Good, 1986; Hattie, 2003). While these lists have assisted in developing a clearer picture, there is still a general lack of consensus regarding a definition. Within education, a commonsense definition may suggest that effective teaching assists students to learn. However, despite some support for this, there is no universal agreement among researchers regarding what constitutes effective teaching (Tuckman, 1995). Perhaps underlying this debate is Ornstein's (1986) comment that *because we are not able to define precisely what a good teacher is, we can define good teaching any way that we like – so long as it makes sense* (p.176). This implies that we should look towards the features of teaching that work within particular contexts or environments such as, for example, considering the influence that time, place, teaching discipline, student age, country, culture and student ability have on interpretations of effective teaching.

There are three key Australian research documents that have identified characteristics of effective science teaching in Australian schools. These documents are the National Review into the Status and Quality of Science Teaching and Learning in Australian Schools (Goodrum, Hackling & Rennie, 2001), the National Professional Standards for Highly Accomplished Teachers of Science (Australian Science Teachers Association and Monash University, 2002), and the components of effective science teaching as developed by the School Innovation in Science (SIS) Project (Tytler, 2002). The frameworks that these studies provide are useful tools in better understanding the different aspects of effective science teaching. Analysis of these documents (Hackling & Prain, 2005) identified a strong convergence around six characteristics:

1. *Students experience a curriculum that is relevant to their lives and interests*
2. *Classroom science is linked with the broader community*
3. *Students are actively engaged with inquiry, ideas and evidence*
4. *Students are challenged to develop and extend meaningful conceptual understandings*
5. *Assessment facilitates learning and focuses on outcomes that contribute to scientific literacy and*
6. *Information and communication technologies are exploited to enhance learning of science with opportunities to interpret and construct multimodal representations.*
   (Hackling & Prain, 2005, p.19)

These characteristics may help to shed light on the nature of effective science teaching, but on their own they cannot bring effective science teaching to life. Effective science teachers may be able to demonstrate particular attributes or traits, but little is understood about precisely what beliefs and knowledge drive their practice. Therefore, it is not clear how and why 'effective teachers' actually do what they do.

Methodology

Deanne was nominated for involvement in this study through being identified as an effective practitioner of science by a professional colleague. With a career in primary education spanning 25 years, Deanne has gathered teaching experience from several schools in remote, rural and urban areas of Western Australia. Deanne has been working at her current school for the past 14 years. The research method used to report on Deanne's beliefs and practices was a pilot case study methodology (Yin, 2003).

At the time of data collection, Deanne was teaching a Year 6/7 class. Her class of 26 students (10 males and 16 females) comprised 13 Year 6 students and 13 Year 7 students. In Western Australia, Year 7 is the final year of primary school.

Information about Deanne's beliefs and practices were collected through classroom observations and an interview.

In Term 4 2007, Deanne and her students were observed for two 100-minute science lessons. The lessons were based on a Primary Connections unit – *Marvellous Micro-organisms* (Australian Academy of Science, 2005) – which examines the role of micro-organisms through the bread-making process. The first lesson was a continuation of an investigation that the class was conducting on moulds and their growth on different types of breads. During this lesson, the students were recording their observations of mould colour, type and growth pattern on each piece of bread. Two days later, the students worked in small groups to conduct an activity looking at the effect of different water temperatures on yeast. Throughout these classroom observations comprehensive field notes were taken.

Two weeks later, Deanne was interviewed to gather information regarding her thoughts and ideas about science teaching and learning. In particular, Deanne was asked what she thinks about when planning a science lesson, what she hopes her students achieve from a science lesson, what she identifies as a successful science lesson and what she thinks characterises effective science teaching.

The data collected from these two sources were examined for the beliefs and practices characterising Deanne's practice. Several themes emerged from the data and were identified through being mentioned or observed numerous times. These themes were presented to Deanne for further clarification. Using an inductive approach to the data analysis allowed for the emergence of Deanne's beliefs and practices rather than imposing existing ideas or thoughts on the data that were gathered (Corbin & Strauss, 2008).

Results

Six themes emerged which characterise Deanne's beliefs and practices regarding science teaching and learning. These were:

- creation of a science-rich/science-friendly environment
- use of variety in classroom activities and pedagogy
- explicit teaching of science skills and concepts
- teaching in concrete way
- preparing students for future science learning and
- development of personal science knowledge.

Within each theme, Deanne's beliefs that lead into and influence her subsequent practice are identified. Each of these themes is discussed below and the inter-relationships between Deanne's beliefs and practice are highlighted.

Creation of science-rich/science-friendly environment

For Deanne, the creation of an interesting and stimulating environment is a *wish, but the reality is it doesn't happen as well as [she'd] like* (email, 17/11/08). Deanne felt that she has a science-friendly class, but that the wonderful science-rich environment she would like has not fully developed yet. However, while not a substitute, Deanne believed that:

> *Children know if a teacher is interested in science and often provides the opportunity for lots of informal chats about science in society [or] daily life [which] are important* (email, 17/11/08).

Science was a focal point in Deanne's classroom in that she created a stimulating and functional classroom environment that encouraged her students to be autonomous in their learning and nurtured their curiosity. For example, there were science experiments on the veranda, silkworms in boxes on the tables and slices of plastic-wrapped bread growing mould by the window.

Variety in classroom activities and pedagogy

The development of a science-rich/science-friendly environment can be fostered through the inclusion of a variety of classroom activities and instructional modes. Deanne planned science lessons that were diverse in instructional modes. For example, *a little bit of group work, a little bit of discussion … a bit of me talking and teaching* (interview, 20/11/07). However, she also felt that students should be provided with not just a variety of classroom activities but with a *variety of experiences* (interview, 20/11/07). By this, Deanne explained that she meant:

> *Not just experiments, but a bit of research, a bit of fieldwork, so if I've done a unit where I've done a bit of that, and we occasionally have guest speakers. Then I feel they've had a variety* (interview, 20/11/07).

These beliefs about variety were evident in Deanne's practice and were also highlighted in her reflections on a successful science lesson.

> *We were doing natural and processed materials [a chemistry-based conceptual strand in the WA curriculum] and I set up six stations with different activities so that we just rotated – we had a whole morning and maybe a bit into the afternoon* (interview, 20/11/07).
>
> For Deanne, the success of this lesson was the structure of *hands-on [activities], short [and] sharp with small group interaction, lots of talk and some teaching of skills* (interview, 20/11/07).

Explicit teaching of science skills and concepts

In addition to the use of variety in her lessons, Deanne also identified the need to explicitly teach her students science skills and concepts. Deanne hoped that from a science lesson her students would achieve *a concept* *a skill, [and] some enjoyment* (interview, 20/11/07). The development of science skills was a particular focus for Deanne as she indicated *primary school teachers should be teaching skills, lots of skills* (interview, 20/11/07). For example:

> *…the specific teaching of predicting how to do a table or how to set up a graph, that sort of thing. So actually teaching it* (interview, 20/11/07).

In conjunction with teaching science skills, Deanne believed that primary school teachers should also be focusing on teaching science concepts.

> *I don't think we are doing enough conceptual teaching. I still think it is all a bit airy-fairy – we're all doing the investigative work and all those four stages [of an investigation], but I still think we need to hammer those concepts* (interview, 20/11/07).

The explicit teaching of skills and concepts in science connected strongly with Deanne's beliefs about effective science teaching:

> *If I had, or what makes me feel like I've had, an effective science lesson is if maybe I've done a bit of skill work, improved a skill, or taught or revised a concept* (interview, 20/11/07).

Deanne's students demonstrated a number of skills (e.g. drawing a labelled diagram, observing and recording data, cooperative group work) during the observed science lessons, although Deanne was not observed teaching those skills explicitly. As the observations did occur during Term 4 it is likely that these skills had been developed over the course of the year. However, Deanne did spend a significant amount of time in the second lesson providing scaffolding (e.g. a handout with sections to fill in, asking questions that would stimulate thinking) to assist her students in the development of a journal entry that summarised their findings from the lesson.

Teaching in concrete ways

The explicit teaching of science skills and concepts is an important aspect of the teaching and learning process, but teachers should also be considering how they teach science. In presenting scientific information, Deanne focused on using concrete examples or representations, such as *models, simulations, [and] drawing* (email, 17/11/08). During science lessons, she also focused on teaching concepts in ways to which her students could relate:

> *I'm trying to present the concept in a concrete way, so I do try to think of really simple ways of presenting… I do that with everything actually. Just [something] straightforward – if I can use a model or something real rather than [being] abstract* (interview, 20/11/07).
>
> Deanne believed that *the concrete cements understanding and helps with the transfer to the abstract* (email, 17/11/08).

To help students better understand the conditions that yeast needs to grow, and to apply the knowledge that they had been developing in class, Deanne provided her students with a homework task that required them to make pizza. Students were provided with packets of yeast and a recipe for making pizza dough. Deanne asked her students to prepare a pizza (with at least one type of vegetable on it!) for their family as an evening meal and have their parents sign off their completion of the task.

Preparing students for future science learning

While teaching in concrete ways may assist with learning in science, teachers may also need to consider what scientific skills and knowledge students should be equipped with for their future interactions with science. As an upper primary teacher in recent years, Deanne considered part of her teaching role as preparing her students for their learning experiences in high school and beyond. For Deanne, it was important to prepare students for the transition from the primary to the secondary approach to teaching science. which she believed *concentrates on concepts, is abstract, often out of texts, [and] with much less emphasis on experiments* (email, 17/11/08).

> *Science concepts seem harder from Year 7 to 8, so introducing some of the scientific language [or] facts [in upper primary school] may stop students from thinking science is too hard and hence losing interest* (email, 17/11/08).

Deanne aimed to equip her students with the science skills and knowledge that she felt they would require in high school. For example, in the observed lessons Deanne worked with her students to further develop their skills in areas such as summarising information, recording observations in an appropriate format and creating labelled diagrams.

Development of personal science knowledge

To assist with preparing students for learning about science beyond primary school, teachers may need to develop their own scientific knowledge. With no formal science training, Deanne needed to identify ways that allowed her to increase her science knowledge. Accessing different resources, such as Primary Connections, and redesigning them to suit her teaching style and approach, Deanne felt *helps [my] understanding of the topic* (email, 17/11/08).

> *Because I'm not science-based, I often need to do a lot of research or learn about something, so that's what I consider. And I always read* (interview, 20/11/07).

Deanne believed effective science teachers acknowledge that they do not know the answer to every science question. When in this situation, Deanne directs her students to different resources to assist them in answering their own questions.

> *I try to but I don't always do it – say I want you to bring up [sic] or go on the Internet and you come back and tell me* (interview, 20/11/07).
>
> In achieving this, Deanne identified feeling *effective in teaching [her students] and giving them a tool to research* (interview, November 20, 2007).

For Deanne, the experience of *having a child in high school and reading his texts has helped [me] re-learn a lot of the science [I] learnt and forgot in high school* (email, 17/11/08). This realisation has led Deanne to argue the need for greater coverage of science in pre-service teacher education:

> *It should be compulsory for trainee teachers to study or relearn up to Year 9 in chemistry, physics and biology as part of the teacher training course* (email, 17/11/08).

Discussion and Conclusion

Six themes reflected Deanne's beliefs and practices regarding science teaching and learning: creating a science-rich/science-friendly environment, use of variety in classroom activities and pedagogy, explicit teaching of science skills and concepts, teaching in concrete ways, preparing students for future science learning, and the development of personal science knowledge.

An exploration of Deanne's beliefs and practice has identified some of the ways in which the emergent themes are in keeping with the literature examining effective science teaching. In relation to the characteristics of effective science teaching derived from the Australian literature (Hackling & Prain, 2005), areas such as using curriculum relevant to students, active engagement of students with science ideas and assisting students to develop meaningful conceptual understandings could be identified within Deanne's beliefs and practice. Deanne did make passing references to the development of community links through using visiting speakers and the use of information and communication technologies (ICTs) by students searching for information on the Internet. However, they were not prominent within the data collected on Deanne's classroom practice and her beliefs about science teaching and learning. Deanne made no mention, nor was there any evidence in her observed lessons, of using assessment to assist student learning. The limited evidence obtained in relation to these three characteristics (community links, use of ICTs and assessment for learning) may be related to the very small sample of Deanne's teaching that was observed, and to contextual factors, such as the topic.

Emerging from this case study are additional beliefs about creating an appropriate classroom 'environment' for the teaching and learning of science, preparing students for science in high school and developing the teacher's personal science knowledge.

It is important to consider that these themes reflect the context in which Deanne was working, and suggest that the themes are bounded by factors such as parental expectations, the science topic being taught and the year level to which it is being taught. This case study illustrates how the beliefs and practice of a teacher can be influenced by the context. The beliefs held by Deanne regarding each of the themes were not only enacted throughout her practice, but strongly intertwined with her practice, which makes it difficult to separate them into separate entities. Deanne's beliefs seem to have a significant influence on her practice, in terms of how she teaches science in her classroom and why she teaches science in the ways she does. Her beliefs and practice have also developed in relation to the context within which she works. This interconnectedness between Deanne's beliefs, practices and context suggests that effective science teaching is quite dynamic in its nature and consists of components that interact in varied and changing ways.

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