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# BELIEFS, KNOWLEDGE AND PRACTICES OF TWO EFFECTIVE PRIMARY SCIENCE TEACHERS

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## Abstract

*Within the literature, there is little research examining how effective primary teachers actually draw on their beliefs and knowledge to develop a coherent and integrated sequence of lessons over the course of a science topic. To address this gap, this doctoral research has focused on what effective primary teachers are doing to promote student understanding of science and what experiences, knowledge and beliefs have influenced their practice. Two primary school teachers, nominated as effective teachers of science, participated in Phase 1 of this study. Data was collected through classroom observations of science lessons and teacher interviews about their beliefs and knowledge regarding science teaching and learning. This paper summarises the preliminary findings drawn from the Phase 1 of the study. Several themes were identified as characterising the beliefs, knowledge and practices of the two teachers. It was found that the beliefs and knowledge of the teachers influenced how they teach science in their classrooms and why they teach science in the ways they do. The themes were reflective of the different contexts that the teachers were working within and were essentially linked to the development of student interest towards and understanding of science.*

## Introduction

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 effective teaching is (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. 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 *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 why effective teachers' actually do what they do.

## **Rationale**

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 3% 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 national assessments of Year 6 students' science literacy (MCEETYA, 2005; 2008) conducted in 2003 and 2006, which indicated that more than 40% of students in the sample 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 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 an aspect of this larger study by examining the beliefs, knowledge and practices of two teachers, Deanne and Lisa (pseudonyms).

## **Methods**

Deanne and Lisa were nominated for involvement in this study through being identified as effective practitioners 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. Lisa has 14 years teaching experience working in remote and rural primary and secondary schools across Western Australia. With a background in science, Lisa completed a degree and honours project in the area of biology before studying to become a teacher. The research method being used to report on Deanne and Lisa's beliefs, knowledge and practices on entering this study was a pilot case study methodology (Yin, 2003).

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## Deanne

At the time of the 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, knowledge 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 about 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 her thoughts about what characterises effective science teaching.

## Lisa

At the time of data collection, Lisa was teaching a Year 3/4 class. Her class of 26 students (18 males and eight females) comprised eight Year 3 students and 18 Year 4 students. Information about Lisa's beliefs, knowledge and practices were also collected through classroom observations and an interview.

In Term 4 2007, Lisa and her students were observed during two very different science lessons with one lesson running over the course of a day and the other for 60 minutes. The lessons, based on units of Lisa's own design, examined students' investigative skills and the life cycle of plants, respectively. The first lesson was part of a whole school 'extended' investigation, which mapped student progress and ability in terms of investigative science skills across the year and from year to year. In this lesson, the students examined and manipulating O-wing gliders. Students worked as a class to plan this investigation and worked in small groups for the conducting phase. Each student individually completed a booklet documenting their results and analysis of the findings. Six days later, the students were involved in an activity, which required them to move around the schoolyard to observe and record four different types of flowers. The students' observations included providing a written description of their flower, the dimensions of the flower and a labelled diagram. Throughout these classroom observations comprehensive field notes were also taken.

Two days later, Lisa was interviewed to gather information regarding her thoughts and ideas about science teaching and learning. As with Deanne, Lisa was asked about 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 her thoughts about what characterises effective science teaching.

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

## Results

The table below summarises the themes that were identified in relation to the beliefs held, knowledge applied and practices used by Deanne and Lisa. Identification of these themes were based on the data collected through classroom observations and teacher interviews in Phase 1 of this study.

Table 1. Themes characterising Deanne and Lisa's beliefs, knowledge and practices regarding science teaching and learning.

Deanne	Lisa
<ul style="list-style-type: none"> <li>• Creation of a science-rich/science-friendly environment</li> </ul>	<ul style="list-style-type: none"> <li>• Building students' science knowledge and skills</li> </ul>
<ul style="list-style-type: none"> <li>• Use of variety in classroom activities and pedagogy</li> </ul>	<ul style="list-style-type: none"> <li>• Understanding and catering for students' needs and interests</li> </ul>
<ul style="list-style-type: none"> <li>• Explicit teaching of science skills and concepts</li> </ul>	<ul style="list-style-type: none"> <li>• Teaching in concrete ways</li> </ul>
<ul style="list-style-type: none"> <li>• Teaching in concrete ways</li> </ul>	<ul style="list-style-type: none"> <li>• Explicit teaching of investigative process</li> </ul>
<ul style="list-style-type: none"> <li>• Preparing students for future science learning</li> </ul>	<ul style="list-style-type: none"> <li>• Importance of planning and preparation</li> </ul>
<ul style="list-style-type: none"> <li>• Development of personal science knowledge</li> </ul>	

While the two teachers held differing sets of beliefs and knowledge about science teaching and learning, they each enacted aspects of these beliefs and knowledge within their classroom practices

## Conclusions and Implications

Six themes reflected Deanne's beliefs, knowledge and practices regarding science teaching and learning. An exploration of Deanne's beliefs, knowledge and practice has identified some of the ways that 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 of 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 were 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 were Deanne's additional beliefs about creating an appropriate classroom 'environment' for the teaching and learning of science, preparing students for science in high school and the development of the teacher's personal science knowledge.

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Five themes reflected Lisa's beliefs, knowledge and practices regarding science teaching and learning. An exploration of Lisa's beliefs, knowledge and practice also identified that some of the emergent themes were in keeping with the literature examining effective science teaching. In relation to the characteristics of effective science teaching, areas such as using curriculum relevant to students, active engagement of students with science ideas through inquiry-based methods and assisting students to develop meaningful conceptual understandings could be identified within Lisa's beliefs, knowledge and practice. While Lisa did not make specific reference to the use of information and communication technologies (ICTs), the use of different technologies (e.g. interactive whiteboard, digital microscope) as part of her teaching and learning approach in science were prominent in her classroom practice. Similarly, Lisa did not express her ideas about assessment and the ability to contribute to scientific literacy, but again it was evident in her practice. In the observed lessons, Lisa's students undertook the four phases of an investigation (planning, conducting, processing the data and evaluating) and developed skills in drawing labelled scientific diagrams. While Lisa made no mention, nor were there any evidence in her observed lessons, of connecting the science in her classroom with the broader community, this could be connected to the very small sample of Lisa's teaching that was observed and to contextual factors, such as the topic.

Emerging from this case study were also Lisa's additional beliefs and knowledge about the need to explicitly teach students about the investigative process and the importance of teachers' planning and being prepared for the teaching of science.

It is important to consider that these themes reflect the contexts that Deanne and Lisa were working within, which suggests that the themes are bounded by factors such as parental expectations, the science topic being taught and the year level it is being taught to. These two case studies illustrate how the beliefs, knowledge and practice of a teacher may be influenced by the context. The beliefs and knowledge held by Deanne and Lisa regarding each of the themes are not only enacted throughout her practice, but strongly intertwined with their practices making it difficult to separate the themes into separate entities. Deanne and Lisa's beliefs and knowledge seemed to have a significant influence on their practice, in terms of how they teach science in their classrooms and why they teach science in the ways they do. Their beliefs and practice have also developed in relation to contexts they work within. This interconnectedness between Deanne and Lisa's beliefs, knowledge, practices and context suggests that effective science teaching is quite dynamic in its nature and consist of components that interact in different and changing ways.

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